CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS

Prepared for the
City of Crestview
Crestview, Florida

Volume 1 of 3
Specifications

For information regarding
this project, contact:
SCOTT JERNIGAN
25 WEST CEDAR STREET,
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PENSACOLA, FL 32502
PHONE: 850-941-7282

Jacobs

Project No. D3403200

APRIL 2021

BID DOCUMENTS

CITY OF CRESTVIEW

DEPARTMENT OF PUBLIC SERVICES

CRESTVIEW WWTP SOLIDS HANDLING IMPROVEMENTS PROJECT

FY-2021

Bid No. 21-05-11

Brona D. Steele
Director of
Public Services

Marc D. Bonifay, P.E.
City Engineer

Prepared by:
Jacobs Engineering Group
25 West Cedar Street, Suite 350
Pensacola, FL 32502

CITY OF CRESTVIEW

CRESTVIEW, FLORIDA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

CRESTVIEW WWTP SOLIDS HANDLING IMPROVEMENTS PROJECT

Jacobs Contract No. D3403200

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JACOBS

Pensacola, Florida

April 2021

Project No. D3403200 Copy No.____

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END OF SECTION

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SECTION 00020

ADVERTISEMENT FOR BIDS
FOR
CITY OF CRESTVIEW

BID NO. 21-05-11

NOTICE IS HEREBY GIVEN: That sealed bids will be received by the City of Crestview, at the City Clerk's Office 198 N. Wilson Street, Crestview, Florida 32536; for the **Crestview WWTP Solids Handling Improvements** until **Tuesday, May 11, 2021 at 2:00 p.m.**

Any bids received after the above time will not be accepted under any circumstances. Any uncertainty regarding the time a bid is received will be resolved against the bidder.

Bid opening will be promptly at **2:00 p.m. on May 11, 2021** at the City Hall Council Chambers, 198 N. Wilson Street, Crestview, Florida 32536, at which time all bids received will be publicly opened and read aloud.

A pre-bid meeting will be held on **April 20, 2021, at 10:00 a.m.** local time at the City of Crestview WWTP, 5101 Arena Road, Crestview, FL 32536. The pre-bid meeting shall be mandatory.

DESCRIPTION OF WORK: All work for the Project shall be done in accordance with the Drawings and Specifications and shall be awarded and constructed, if award is made, under one Contract. Bids shall be submitted for furnishing, delivering, and installing all materials, equipment, and services, including labor for the Work described:

This project is to furnish and install a new Biosolids Dewatering Facility, two additional sludge digesters, as well as other improvements. The contractor shall provide the new facilities in accordance with the Drawings and Specifications and shall include all materials and labor to provide fully functioning systems.

Bidders are urged to visit the site prior to submitting a bid. If you have any questions, contact **Jacobs Engineering Group, 25 West Cedar Street, Suite 350, Pensacola, FL 32502.** The project engineer is **Scott Jernigan, PE,** and can be reached at **850-941-7282** or **scott.jernigan@jacobs.com**

BIDDING DOCUMENTS can be obtained on the city website: www.cityofcrestview.org and reviewed at:

Department of Public Services
715 N. Ferdon Blvd.
Crestview, FL 32536
(850) 682-6132

The City of Crestview reserves the right to accept or reject, in part or total, any or all bids and to waive any informalities as deemed in the best interest of the City. All bids must be marked on the outside of the envelope with the bid name, the time and date of opening. It shall be the Bidder's responsibility to ensure that bids are delivered to the above address by the appointed time.

Bids shall be prepared from complete Bidding Documents.

BID SUBMITTAL: A single bid shall be submitted for the work. The contract will be awarded pursuant to the requirements of applicable state and federal laws and regulations.

Award will be made to the lowest responsible and responsive bidder. The City of Crestview will in no way be liable for any costs incurred by any bidder in the preparation of its Bid in response to this Invitation to Bid.

The City reserves the right to waive technicalities or irregularities, to reject any or all bids, and to accept that Bid which is in the best interest of the City.

The CITY OF CRESTVIEW, FLORIDA does not discriminate on the basis of race, color, national origin, sex, religion, age, and handicapped status in employment or provision of service.

CITY OF CRESTVIEW, FLORIDA
Office of the City Clerk
198 N. Wilson Street
Crestview, Florida 32536

END OF SECTION

INSTRUCTIONS TO BIDDERS

General

BIDS will be received by the City of Crestview (herein called the "OWNER") as specified in the Invitation to Bid. The BIDS will be publicly opened and read aloud at the designated time and place.

Each BID must be submitted in a sealed envelope addressed to the City of Crestview. Each sealed envelope containing a BID must be plainly marked on the outside with the name and the number of the project for which the BID is submitted; and the envelope should also show on the outside, the BIDDER's name and address.

BIDDERS must satisfy themselves as to the required quantities for the work by examination of the site and a review of the drawings and specifications including any addenda. After BIDS have been submitted the BIDDER shall not assert that there has been any misunderstanding concerning the quantities of work or of the nature of the work to be done.

All BIDS must be made on the required BID form. All blank spaces for BID prices must be filled in, in ink or typewritten, and the BID form must be fully completed and executed when submitted. Only one copy of the BID form is required. The Bid form is the only document to be completed and signed at the bid opening.

A BIDDER may not modify its BID after BID opening. Errors in the extension of unit prices stated in a BID or in multiplication, division, addition, or subtraction in a BID may be corrected by the Director of Public Services prior to award. In such cases, unit prices shall not be changed.

Any BID may be withdrawn prior to the above scheduled time for the opening of BIDS or authorized postponement thereof. Any BID received after the time and date specified shall not be considered. No BIDDER may withdraw a BID after the actual date of the opening thereof.

The OWNER may waive any informalities or minor defects or reject any and all BIDS. A conditional or qualified BID may not be accepted.

BID tabulations will be posted for review on the city website: www.cityofcrestview.org

The OWNER may make such investigations as deemed necessary to determine the ability of the BIDDER to perform the work, and the BIDDER shall furnish to the OWNER all such information and data for this purpose as the OWNER may request. The OWNER reserves the right to reject any BID if the evidence submitted by, or investigation of, such BIDDER fails to satisfy the OWNER that such BIDDER is properly qualified to carry out the obligations of the AGREEMENT and to complete the work contemplated herein. The low BIDDER will be required to perform at least fifty percent (50%) of the contract work with his/her own employees. The BIDDER to whom the contract is being awarded shall supply the names and addresses of major material suppliers and subcontractors when required to do so by the OWNER.

A PERFORMANCE BOND and PAYMENT BOND each in the amount of l00 percent of the contract price, with a corporate surety approved by the OWNER, will be required for the faithful performance of the contract, when the AGREEMENT is executed. Attorneys-in-fact who sign PAYMENT BONDS and PERFORMANCE BONDS must file with each BOND a current certified copy of their power of attorney.

Certificate of Insurance, as specified herein, shall be submitted at the time of signing the AGREEMENT.

The BIDDER to whom the contract is being awarded will be required to execute the AGREEMENT and obtain the PERFORMANCE BOND, PAYMENT BOND and Insurance on or before ten (10) calendar days following delivery of the notice of award to the BIDDER. If the BIDDER fails to properly execute the AGREEMENT or obtain the required PERFORMANCE BOND, PAYMENT BOND, or Insurance within the allotted time, the OWNER may consider the BIDDER in default.

The OWNER within ten (10) days of receipt of acceptable PERFORMANCE BOND, PAYMENT BOND, INSURANCE CERTIFICATES and the AGREEMENT signed by the CONTRACTOR to whom the contract is being awarded shall sign the AGREEMENT and return to such CONTRACTOR an executed duplicate of the AGREEMENT. Should the OWNER not execute the AGREEMENT within such period, the BIDDER may by written notice withdraw the signed AGREEMENT.

The CONTRACTOR shall thereupon record the PAYMENT and PERFORMANCE BONDS at the Okaloosa County Courthouse and return the recorded originals to the OWNER within seven (7) days.

The NOTICE TO PROCEED shall be issued within ten (10) days of the receipt of the recorded bonds by the OWNER. Should there be reasons why the NOTICE TO PROCEED cannot be issued within such period, the time may be extended by agreement between the OWNER and CONTRACTOR. If the NOTICE TO PROCEED has not been issued within the ten (10) day period or within the period mutually agreed upon, the CONTRACTOR may terminate the AGREEMENT by written notice to the OWNER.

Bid Protest Procedure

Any person whose substantial interests are directly and adversely affected by the award or intended award of a purchase order or contract or by plans or specifications contained in an invitation to bid or request for proposals may file a protest.

Notice of protest of plans, specifications or other requirements contained in an invitation to bid or in a request for proposals shall be filed not later than 5:00 P.M. of the third business day following receipt of the plans or specifications. Notice of protest of the rejection of a bid or proposal as non-responsive shall be filed not later than 5:00 P.M. of the third business day following notice to the bidder of the rejection. Notice of protest of the award or intended award of a purchase order or contract to the lowest bidder shown on a posted bid tabulation shall be filed not later than 5:00 P.M. of the third business day following the posting of the bid tabulation. Notice of protest of the award or intended award of a purchase order or contract to a bidder other than the lowest bidder shown on a posted bid tabulation shall be filed not later than 5:00 P.M. of the third business day following notice of the award of a purchase order or contract.

A notice of protest shall be in writing and shall state the subject matter of the protest.

A formal written protest shall be filed within seven (7) business days after the filing of notice of protest. A formal written protest shall state with particularity the facts and the law on which the protest is based.

Notice of protest and formal written protest of plans or specifications for or the award or intended award of a contract shall be filed with the city clerk or her designee.

Failure to file a notice of protest or failure to file a formal written protest within the times permitted shall constitute a waiver of proceedings.

END OF SECTION

PUBLIC ACCESS

Contractor shall comply with the requirements of Florida's Public Records law. In accordance with Section 119.0701, Florida Statutes hereby certifies that shall:

a. Keep and maintain public records that would be required by the public agency to perform the service.
b. Upon request from the public agency's custodian of public records, provide the public agency with a copy of the requested records or allow the records to be inspected or copied within a reasonable time at a cost that does not exceed the cost provided under Florida's Public Law or as otherwise provided by law.
c. Ensure that public records that are exempt or confidential and exempt from public records disclosure requirements are not disclosed except as authorized by law for the duration of the contract term and following completion of this contract if Contractor does not transfer the records to the public agency: and
d. Upon completion of the contract, transfer, at no cost, to the public agency all public records in possession of Contractor or keep and maintain public records required by the public agency to perform the service. If the Contractor transfers all public records to the public agency upon completion of the contract, Contractor shall destroy any duplicate public records that are exempt or confidential and exempt from public records disclosure requirements. If Contractor keeps and maintains public records upon completion of this contract, the Contractor shall meet all applicable requirements for retaining public records. All records stored electronically must be provided to the public agency, upon request from the public agency's custodian of public records, in a format that is compatible with the information technology systems of the public agency.

e. If Contractor has questions regarding the application Chapter 119, Florida Statutes, to Contractor's duty to provide public records relating to this Agreement, Contractor shall contact the Custodian of Public Records at:

City Clerk, City of Crestview
198 North Wilson Street
P.O. Box 1209
Crestview, Florida 32536
(850) 682-1560 Extension 250
cityclerk@cityofcrestview.org

f. In the event the public agency must initiate litigation against Contractor in order to enforce compliance with Chapter 119, Florida Statutes, or in the event of litigation filed against the public agency because Contractor failed to provide access to public records responsive to a public record request, the public agency shall be entitled to recover all costs, including but not limited to reasonable attorneys' fees, costs of suit, witness, fees, and expert witness fees extended as part of said litigation and any subsequent appeals.

SECTION 00300

BID FORM

SUBMITTED: _____
Date

PROJECT IDENTIFICATION: **CITY OF CRESTVIEW SOLIDS HANDLING IMPROVEMENTS**

NAME OF BIDDER: _____

BUSINESS ADDRESS: _____

Phone No.: _____ Fax No.: _____

E-Mail Address: _____

CONTRACTOR'S FLORIDA LICENSE NO.: _____

THIS BID IS SUBMITTED TO: City of Crestview, Florida (hereinafter called Owner) acting through its City Commission.

1. The undersigned Bidder offers and agrees to enter into an Agreement with Owner in the form included in the Bidding Documents, to complete all work for the Contract Price and within the Contract Time, all in accordance with the Contract Documents.

2. Bidder accepts all of the terms and conditions of the Bidding Documents, including without limitation those dealing with the Owner's time for accepting for Bid and the disposition of Bid Bond.

3. In submitting this Bid, Bidder makes all representations required by the Instructions to Bidders and further warrants and represents that:

   (a) Bidder has examined copies of all the Bidding Documents and of the following addenda:

No.	_____	Dated	_____;	No.	_____	Dated	_____
No.	_____	Dated	_____;	No.	_____	Dated	_____
No.	_____	Dated	_____;	No.	_____	Dated	_____
No.	_____	Dated	_____;	No.	_____	Dated	_____

   (Receipt of all which is hereby acknowledged) and also copies of the Advertisement for Bids and the Instructions to Bidders.

   (b) Bidder has examined the site and locality where the Work is to be performed and the legal requirements (Federal, State and local laws, ordinances, rules and regulations) and conditions affecting cost, degree of difficulty, progress or performance of the Work and has made such independent investigations as Bidder deems necessary.

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

(d) Bidder hereby agrees if this Bid is accepted, to commence work under this contract on or before a date to be specified in the Notice to Proceed and to fully complete all work of the Project within the Contract Time stipulated in the Agreement (Section 00500). Bidder further agrees to pay as liquidated damages the amount stated in the Agreement for each consecutive calendar day completion of the work is delayed.

4. Bidder submits the following unit prices to perform all the Work as required by the Drawings and Specifications for the City of Crestview. Bid shall be awarded based on Total Base Bid. Estimated quantities may exceed items listed. Payment based on installed quantities.

5. All Bid Items shall include all materials, equipment, labor, permit fees, taxes, tests, miscellaneous costs of all types, overhead, and profit for the item to be complete, in place, and ready for operation in the manner contemplated by the Contract Documents.

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

(a) Bid Security (Section 00410 and surety bond or cashier's check).
(b) Power of Attorney (for surety bond only).
(c) Public Entities Crime Form (Section 00470).
(d) Noncollusion Affidavit (Section 00480).
(e) Trench Safety Affidavit (Section 00490).
(f) Corporate authority to execute Bid (for any corporate employee other than president or vice president.
(g) Questionnaire and Subcontractor Listing (Sections 00301 and 00301-A).
(h) Evidence of Bidder’s Certification and License to perform the work.
(i) Experience and financial statement demonstrating the Bidder’s ability to successfully complete the work.
(j) References (Section 00302).
(k) Similar Projects (Section 00303).
(l) Drug Free Workplace (Section 00310).

7. The terms used in this Bid, which are defined in Article 1 of the General Conditions shall have the meanings assigned to them in the General Conditions as amended by the Supplementary Conditions.

8. **COMPLIANCE WITH FLORIDA TRENCH SAFETY ACT (90-96, LAWS OF FLORIDA)**

Bidder hereby acknowledges that all costs for complying with the Florida Trench Safety Act (90-96, Laws of Florida) are included in the various items of the proposal and in the Total Bid Price. For informational purposes only, the Bidder is required to further identify these costs, to be summarized below:

	Trench Safety Measure Description	Units of Measure (LF, SY)	Unit (Quantity)	Unit Cost	Extended Cost
A	_____	_____	_____	$_____	$_____
B	_____	_____	_____	$_____	$_____
C	_____	_____	_____	$_____	$_____
D	_____	_____	_____	$_____	$_____
				TOTAL:	$_____

THIS IS NOT A PAY ITEM. The purpose of this form is to disclose information on the costs associated with trench safety measures and to insure that the Bidder has considered these costs and included them in the Bid Price. Contractor will not receive additional payment if actual quantities differ from those estimated above or if the Contractor uses a safety measure different than those listed.

Failure to complete the above may result in the Bid being declared non-responsive.

BID SUMMARY

TOTAL BASE BID

Bidder will complete the work in accordance with the Contract Documents for the following price:

_____ **$** _____

(In words) (In numbers)

NAME OF BIDDER: _____

If Bidder is: (ALL SIGNATORIES MUST HAVE THEIR NAME PRINTED OR TYPED BELOW THEIR SIGNATURE)

SOLE PROPRIETORSHIP

_____(SEAL)
(Individual's Signature)

_____(SEAL)
(Individual's Name)

Doing Business as: _____

Business Address: _____

_____

Phone No.: _____

Fax No.: _____

E-Mail Address: _____

Florida License No.: _____

A PARTNERSHIP

_____(SEAL)
(Partnership Name)

_____(SEAL)
(General Partner's Signature)

_____(SEAL)
(General Partner's Name)

Business Address: _____

_____

Phone No.: _____

Fax No.: _____

E-Mail Address: _____

Florida License No.: _____

NAME OF BIDDER: _____

A CORPORATION

_____
(Corporation Name)

_____
(State of Incorporation)

By _____
(Name of Person Authorized to Sign)

_____
(Title)

_____
(Authorized Signature)

(Corporate Seal)

Attest _____
(Secretary)

Business Address: _____

_____

Phone No.: _____

Fax No.: _____

E-Mail Address: _____

Corporation President: _____

Florida License No.: _____

NAME OF BIDDER: _____

A JOINT VENTURE

By _____(SEAL)
(Name)

_____
(Address)

By _____(SEAL)
(Name)

_____
(Address)

Business Address: _____

_____

Phone No.: _____

Fax No.: _____

E-Mail Address: _____

Florida License No.: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above).

List the following in connection with the Surety which is providing the Bid Bond.

Surety's Name: _____

Surety's Address: _____

_____

_____

Name and address of Surety's resident agent for service of process in Florida:

_____

_____

_____

SCHEDULE OF MANUFACTURERS/SUPPLIERS

The Contract Documents are based upon the equipment or products available from the manufacturers/suppliers denoted as "A", "B", etc. However, the Bidder must indicate in his Bid which Base Bid manufacturer/supplier he intends to use for each item of equipment listed by circling one (1) of the listed manufacturers/suppliers. Should the Bidder fail to circle a named supplier, he hereby agrees to provide the item listed as "A". After receipt of bids, the Bidder may not substitute for any manufacturer or supplier circled.

If the Bidder desires to propose one (1) or more substitution or "or equal" manufacturers/ suppliers, he may write in the name of such substitution or "or equal" in the spaces provided on the pages following the lists, but he must, nevertheless, also circle one of the listed manufacturers/suppliers. All substitutions or "or equal" items must be identified at the time of Bid (see Paragraph 6.05 of the General Conditions as amended by the Supplementary Conditions). Substitutions or "or equal" items will **not** be considered when determining the Apparent Low Bidder. Substitutions or "or equal" items will **not** be evaluated or considered until after the "Effective Date" of the Agreement. The Bidder shall base his Bid on providing one of the listed manufacturers and shall assume for bidding purposes that all substitutions or "or equal" items will not be accepted.

If the proposed substitution or "or equal" manufacturer/supplier is determined "not equivalent" by the Engineer, the Bidder must use the circled manufacturer/supplier. If the Bidder fails to indicate which listed manufacturer/supplier he intends to use or if a substitution or "or equal" is rejected, he must use the supplier listed as "A". Also, if the Bidder circles more than one listed manufacturer/supplier, he must use the first manufacturer/supplier circled (unless a substitution or "or equal" is approved).

Each proposed substitution or "or equal" will be evaluated in accordance with Paragraph 6.05 of the General Conditions following the Effective Date of the Agreement.

In addition to the reimbursement required under Paragraph 6.05 of the General Conditions, the Contractor shall also reimburse the Owner for any engineering costs directly attributable to the change in manufacturers/suppliers, caused by the acceptance of proposed substitutions or "or equal" items, such as; additional field trips for the Engineer, additional redesign costs, and additional review costs, etc. Other costs directly attributable to the change in manufacturers/suppliers caused by the acceptance of proposed substitutions or "or equal" items such as increased electrical requirements, larger buildings, modifications to structures, additional pumps, piping or tankage, etc., shall be borne by the Contractor and not by the Owner. Bidder further agrees that the use of substitute equipment offered will not affect the completion date.

The Owner may request, and the Bidder shall supply any additional information on proposed substitutes or "or equal" items prior to Notice of Award.

SCHEDULE OF BASE BID MANUFACTURERS/SUPPLIERS

Item No.	Equipment Item or Material	Specification Section No.	Base Bid Manufacturer/Supplier
1.	Metal Building Systems	13 34 19	
2.	Low-Voltage Transformers	26 22 00	
3.	Low-Voltage Motor Control	26 24 19	
4.	Prestressed Concrete Storage Tank	33 16 13	
5.	High Speed Mechanical Floating Aerator	44 42 13	
6.	Polymer Feed System Liquid	44 44 63	
7.	Screw Conveyor System	44 46 13	
8.	Belt Filter Press Dewatering Equipment	44 46 16	

SUBSTITUTIONS AND "OR EQUAL"

The undersigned as Bidder agrees that substitutions, or "or equal" items will not be considered until after the "Effective Date of the Agreement" and will be evaluated in accordance with Paragraph 6.05, of the General Conditions as amended by the Supplementary Conditions. If Bidder intends to propose substitutions or "or equal" items after the "Effective Date of the Agreement", it is agreed that these items will be listed on the Substitution List that must be included with the Bid (form provided herein). Only the proposed substitutions or "or equal" items listed on the Substitution List and submitted at the time of Bid will be evaluated by the Engineer in accordance with the General Conditions.

SUBSTITUTION LIST OF
MANUFACTURERS/SUPPLIERS

Bidder proposes the following substitutions and "or equal" items of alternate manufacturers/suppliers for the equipment of material categories so identified:

	Equipment Item Material	Drawing No.	Spec. Section	Substitute/"or equal" Manufacturer/Supplier (List One Only)	Proposed Price Deduct
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

END OF SECTION

SECTION 00301

QUESTIONNAIRE

DATE: _____

PROJECT IDENTIFICATION: **CITY OF CRESTVIEW, FLORIDA**

NAME OF BIDDER: _____

BUSINESS ADDRESS: _____

_____ Phone No._____

CONTRACTOR'S FLORIDA LICENSE NO._____

The undersigned warrants the truth and accuracy of all statements and answers herein contained. Include additional sheets if necessary.

1. How many years has your organization been in business as a Florida Licensed Contractor?

   _____

2. Describe and give the date and owner of the last project that you have completed similar in type, size, and nature as the one proposed?

   Refer to Section 00303 (Similar Projects)_____

   _____

   _____

   _____

3. Have you ever failed to complete work awarded to you? If so, where and why?

   _____

   _____

4. Name three (3) municipalities for which you have performed work and to which you refer:

   Refer to Section 00302 (References)

5. Have you personally inspected the sites of the proposed work? Describe any anticipated problems with the site and your proposed solutions?

6. Will you subcontract any part of this work? If so, describe which portions:

7. What equipment do you own that is available for the work?

8. What equipment will you purchase for the work?

9. What equipment will you rent for the work?

END OF SECTION

SECTION 00301-A

SUBCONTRACTOR LISTING

List all proposed subcontractors to be used for this project regardless of racial or gender grouping.

****THE BIDDER SHALL SELF-PERFORM AT LEAST 50% OF THE PROJECT****

Firm Name, Address and Telephone Number	Trade	Estimated Dollar Amount
*		
*		$
*		$
*		$
*		$
*		$
*		$
*		$

Use additional sheets if necessary.

END OF SECTION

SECTION 00302

REFERENCES

Project Name: City of Crestview

OWNER	CONTACT PERSON	TELEPHONE NUMBER

SECTION 00303

SIMILAR PROJECTS

Project Name: City of Crestview

List at least five (5) similar projects completed in the last three years that indicate the experience and qualifications of the Bidder (relative to this project). Information should include Owner's name with contact person; description of work including Bidder's responsibilities; original contract price; final contract price; original contract time; actual time to complete the project; and any relevant circumstances or conditions about the project.

PROJECT NAME: _____

OWNER'S NAME: _____

CONTACT: _____ PHONE: _____

PROJECT DESCRIPTION: _____

_____

_____

_____

ORIGINAL CONTRACT AMOUNT: $_____

FINAL CONTRACT AMOUNT: $_____

NUMBER AND DOLLAR AMOUNT OF CHANGE ORDERS: _____

ORIGINAL CONTRACT TIME (Substantial Completion): _____

ACTUAL TIME TO COMPLETE (Substantial Completion): _____

OTHER RELEVANT INFORMATION: _____

_____

_____

PROJECT NAME: _____

OWNER'S NAME: _____

CONTACT: _____ PHONE: _____

PROJECT DESCRIPTION: _____

_____

_____

_____

ORIGINAL CONTRACT AMOUNT: $_____

FINAL CONTRACT AMOUNT: $_____

NUMBER AND DOLLAR AMOUNT OF CHANGE ORDERS: _____

ORIGINAL CONTRACT TIME (Substantial Completion): _____

ACTUAL TIME TO COMPLETE (Substantial Completion): _____

OTHER RELEVANT INFORMATION: _____

_____

_____

PROJECT NAME: _____

OWNER'S NAME: _____

CONTACT: _____ PHONE: _____

PROJECT DESCRIPTION: _____

_____

_____

_____

ORIGINAL CONTRACT AMOUNT: $_____

FINAL CONTRACT AMOUNT: $_____

NUMBER AND DOLLAR AMOUNT OF CHANGE ORDERS: _____

ORIGINAL CONTRACT TIME (Substantial Completion): _____

ACTUAL TIME TO COMPLETE (Substantial Completion): _____

OTHER RELEVANT INFORMATION: _____

_____

_____

PROJECT NAME: _____

OWNER'S NAME: _____

CONTACT: _____ PHONE: _____

PROJECT DESCRIPTION: _____

_____

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PROJECT NAME: _____

OWNER'S NAME: _____

CONTACT: _____ PHONE: _____

PROJECT DESCRIPTION: _____

_____

_____

_____

ORIGINAL CONTRACT AMOUNT: $_____

FINAL CONTRACT AMOUNT: $_____

NUMBER AND DOLLAR AMOUNT OF CHANGE ORDERS: _____

ORIGINAL CONTRACT TIME (Substantial Completion): _____

ACTUAL TIME TO COMPLETE (Substantial Completion): _____

OTHER RELEVANT INFORMATION: _____

_____

_____

PROJECT NAME: _____

OWNER'S NAME: _____

CONTACT: _____ PHONE: _____

PROJECT DESCRIPTION: _____

_____

_____

_____

ORIGINAL CONTRACT AMOUNT: $_____

FINAL CONTRACT AMOUNT: $_____

NUMBER AND DOLLAR AMOUNT OF CHANGE ORDERS: _____

ORIGINAL CONTRACT TIME (Substantial Completion): _____

ACTUAL TIME TO COMPLETE (Substantial Completion): _____

OTHER RELEVANT INFORMATION: _____

_____

_____

Section 00310

DRUG-FREE WORK PLACE

The undersigned vendor, in accordance with Florida Statute 287.087, hereby certifies that

_____ does:
(Name of Business)

1. Publish a statement notifying employee that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the workplace and specifying the actions that will be taken against employees for violations of such prohibition.

2. Inform employees about the dangers of drug abuse in the workplace, the business's policy of maintaining a drug-free workplace, any available drug counseling, rehabilitation, and employee assistance programs, and the penalties that may be imposed upon employees for drug abuse violations.

3. Give each employee engaged in providing the commodities or contractual services that are proposed a copy of the statement specified in subsection (1).

4. In the statement specified in subsection (1), notify the employees that, as a condition of working on the commodities or contractual services that are under bid, the employee will abide by the terms of the statement and will notify the employer of any conviction of, or plea of guilty or nolo contendere to, any violation of Chapter 893 or of any controlled substance law of the United States or any state, for a violation occurring in the workplace no later than five (5) days after such conviction.

5. Impose a sanction on, or require the satisfactory participation in a drug abuse assistance or rehabilitation program if such is available in the employee's community, by any employee who is so convicted.

6. Make a good faith effort to continue to maintain a drug-free workplace through implementation of this section.

As the person authorized to sign this statement, I certify that this firm complies fully with the above requirements.

X _____
Proposer's Signature

_____
Date

(THIS FORM MUST BE COMPLETED IF APPLICABLE AND RETURNED WITH YOUR PROPOSAL)

SECTION 00410

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned, _____ as Principal, and _____ _____ as Surety, are hereby held and firmly bound unto the City of Crestview, Florida as Owner in the penal sum of, (five percent (5%) of the Contract Bid) _____ for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, successors and assigns to pay Owner upon default of Bidder the penal sum set forth on the face of this Bond.
Signed, this _____ day of _____, 20___.

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

NOW THEREFORE,

1. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents and Contract Documents.

2. This obligation shall be null and void if:

   2.1 Owner accepts Bidder's bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents and Contract Documents, or

   2.2 All bids are rejected by Owner, or

   2.3 Owner fails to issue a notice of award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by paragraph 5 hereof).

3. Payment under this Bond will be due and payable upon default of Bidder and within thirty (30) calendar days after receipt of Bidder and Surety of written notice of default from Owner which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

4. Surety waives notice of any and all defenses based on or arising out of any time extension to issue notice of award agreed to in writing by Owner and Bidder, provided that the time for issuing notice of award including extensions shall not in the aggregate exceed ninety (90) days from Bid Due without Surety's written consent.

5. No suit or action shall be commenced under this Bond prior to thirty (30) calendar days after the notice of default required in paragraph 3 above is received by Bidder and Surety, and in no case later than one year after Bid Due Date.

6. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

7. Notice required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the part concerned.

8. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent or representative who executed this Bond on behalf of Surety to execute, seal and deliver such Bond and bind the Surety thereby.

9. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of the Bond conflicts with any applicable provision of any applicable statute, then the provision of said statute shall govern and the remainder of the Bond that is not in conflict therewith shall continue in full force and effect.

10. The term 'bid" as used herein includes a bid, offer or proposal as applicable.

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.

Principal (Print Full Name):	Surety (Print Full Name):
_____	_____(Seal) Surety's Name and Corporate Seal
By:_____(L.S.)	By:_____ Signature (attach power of attorney)
Title:_____	Title:_____
Attest:_____ Signature and Title	Attest:_____ Signature and Title

IMPORTANT - Surety companies executing bonds must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the State of Florida. See Article 5 of the General Conditions as amended by Supplementary Conditions.

END OF SECTION

SECTION 00470

SWORN STATEMENT PURSUANT TO SECTION 287.133(3)(a),
FLORIDA STATUTES, ON PUBLIC ENTITY CRIMES

THIS FORM MUST BE SIGNED AND SWORN TO IN THE PRESENCE OF A NOTARY PUBLIC OR OTHER OFFICIAL AUTHORIZED TO ADMINISTER OATHS.

1. This sworn statement is submitted to _____
(print name of the public entity)

by _____
(print individual's name and title)

for _____
(print name of entity submitting sworn statement)

whose business address is

_____

_____

and (if applicable) its Federal Employer Identification Number (FEIN) is _____

(If the entity has no FEIN, include the Social Security Number of the individual signing this sworn statement: _____.)

2. I understand that a "public entity crime" as defined in Paragraph 287.133(1)(g), **Florida Statutes**, means a violation of any state or federal law by a person with respect to and directly related to the transaction of business with any public entity or with an agency or political subdivision of any other state or of the United States, including, but not limited to, any bid or contract for goods or services to be provided to any public entity or an agency or political subdivision of any other state or of the United States and involving antitrust, fraud, theft, bribery, collusion, racketeering, conspiracy, or material misrepresentation.

3. I understand that "convicted" or "conviction" as defined in Paragraph 287.133(1)(b), **Florida Statutes** means a finding of guilt or a conviction of a public entity crime, with or without an adjudication of guilt, in any federal or state trial court of record relating to charges brought by indictment or information after July 1, 1989, as a result of a jury verdict, nonjury trial, or entry of a plea of guilty or nolo contendere.

4. I understand that an "affiliate" as defined in Paragraph 287.133(1)(a), **Florida Statutes**, means:

1. A predecessor or successor of a person convicted of a public entity crime; or
2. An entity under the control of any natural person who is active in the management of the entity and who has been convicted of a public entity crime. The term "affiliate" includes those officers, directors, executives, partners, shareholders, employees, members, and agents who are active in the management of an affiliate. The ownership by one person of shares constituting a controlling interest in another person, or a pooling of equipment or income among persons when not for fair market value under an arm's length agreement, shall be a prima facie case that one person controls another person. A person who knowingly enters into a joint venture with a person who has been convicted of a public entity crime in Florida during the preceding 36 months shall be considered an affiliate.

5. I understand that a "person" as defined in Paragraph 287.133(1)(e), **Florida Statutes**, means any natural person or entity organized under the laws of any state or of the United States with the legal power to enter into a binding contract and which bids or applies to bid on contracts for the provision of goods or services let by a public entity, or which otherwise transacts or applies to transact business with a public entity. The term "person" includes those officers, directors, executives, partners, shareholders, employees, members, and agents who are active in management of an entity.

6. Based on information and belief, the statement which I have marked below is true in relation to the entity submitting this sworn statement. (indicate which statement applies.)

____ Neither the entity submitting this sworn statement, nor any of its officers, directors, executives, partners, shareholders, employees, members, or agents who are active in the management of the entity, nor any affiliate of the entity has been charged with and convicted of a public entity crime subsequent to July 1, 1989.

_____ The entity submitting this sworn statement, or one or more of its officers, directors, executives, partners, shareholders, employees, members, or agents who are active in the management of the entity, or an affiliate of the entity has been charged with and convicted of a public entity crime subsequent to July 1, 1989.

_____ The entity submitting this sworn statement, or one or more of its officers, directors, executives, partners, shareholders, employees, members, or agents who are active in the management of the entity, or an affiliate of the entity has been charged with and convicted of a public entity crime subsequent to July 1, 1989. However, there has been a subsequent proceeding before a Hearing Officer of the State of Florida, Division of Administrative Hearings and the Final Order entered by the Hearing Officer determined that it was not in the public interest to place the entity submitting this sworn statement on the convicted vendor list. (attach a copy of the final order.)

I UNDERSTAND THAT THE SUBMISSION OF THIS FORM TO THE CONTRACTING OFFICER FOR THE PUBLIC ENTITY IDENTIFIED IN PARAGRAPH 1 (ONE) ABOVE IS FOR THAT PUBLIC ENTITY ONLY AND, THAT THIS FORM IS VALID THROUGH DECEMBER 31 OF THE CALENDAR YEAR IN WHICH IT IS FILED. I ALSO

UNDERSTAND THAT I AM REQUIRED TO INFORM THE PUBLIC ENTITY PRIOR TO ENTERING INTO A CONTRACT IN EXCESS OF THE THRESHOLD AMOUNT PROVIDED IN SECTION 287.017, **FLORIDA STATUTES** FOR CATEGORY TWO OF ANY CHANGE IN THE INFORMATION CONTAINED IN THIS FORM.

_____
(signature)

Sworn to and subscribed before me this _____day of _____, 20___.

Personally known _____

OR Produced identification_____

_____
(type of identification)

_____
Notary Public - State of Florida

My commission expires _____

_____
(printed, typed or stamped commissioned name of notary public.)

END OF SECTION

SECTION 00480
NONCOLLUSION AFFIDAVIT

STATE OF _____

COUNTY OF _____

_____, being first duly sworn deposes and says that:

1. He (it) is the _____, of _____, 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 affidavit, 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 Contract for which the attached Bid has been submitted; or to refrain from bidding in connection with such Contract; 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 Contract;

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 affidavit.

By_____

Sworn and subscribed to before me this _____ day of _____, 20___, in the State of _____, County of _____.

_____ Notary Public

My Commission Expires: _____

END OF SECTION

SECTION 00490

TRENCH SAFETY COMPLIANCE

Trench excavations on this Project are expected to be in excess of 5 feet deep. The Occupational Safety and Health Administration excavation safety standards, 29 CFR 1926.650 Subpart P trench safety standards, will be in effect during the period of construction of the Project.

Bidder acknowledges that included in the Bid Price are costs for complying with the Florida Trench Safety Act (90-096, Laws of Florida) effective October 1, 1990, and hereby gives assurance that, if awarded the Contract, the Contractor or Subcontractor performing trench excavation work on the Project will comply with the applicable trench safety standards. The Bidder further identifies the costs as follows:

Trench Safety Item (Description) and Estimated Cost

_____

_____

_____

(Cost in Words)

TOTAL $ _____

FAILURE TO COMPLETE THE ABOVE MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE.

Company Name: _____

Date: _____ By: _____

SECTION 00500

AGREEMENT

THIS AGREEMENT made and entered into this ___ day of _____ 2021, by and between the CITY OF CRESTVIEW, FLORIDA, a municipality organized and existing under the laws of the State of Florida, hereinafter called the OWNER, and _____ _____hereinafter called CONTRACTOR;

WITNESSETH:

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

ARTICLE I - SCOPE OF WORK

CONTRACTOR shall complete all work as specified or indicated in the Contract Documents. The Work is generally described as follows:

CITY OF CRESTVIEW
CRESTVIEW WWTP SOLIDS HANDLING IMPROVEMENTS

BID # 21-05-11

All work for the Project shall be constructed in accordance with the Drawings and Specifications prepared by Jacobs and the proposed improvements will be awarded and constructed, if award is made, under one Contract. Bids shall be submitted for furnishing, delivering, and installing all materials, equipment and services, including labor, for the Work described.

This project is to furnish and install a new Biosolids Dewatering Facility, two additional sludge digesters, as well as other improvements. The contractor shall provide the new facilities in accordance with the plans and specifications and shall include all materials and labor to provide fully functioning systems.

ARTICLE II - ENGINEER

The Engineer, Scott L Jernigan, P.E. (Jacobs), whose address is 25 West Cedar Street, Suite 350, Pensacola FL 32502, hereinafter referred to as ENGINEER and who will assume all duties and responsibilities and will have the rights and authority assigned to the Engineer in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE III - CONTRACT TIME

3.1 The Work will be substantially completed within **300** days after the date when the Contract Time commences to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within **360** days after the date when the Contract Time commences to run. Additionally, the OWNER desires to utilize the new digesters as soon as possible. The digesters

shall be completed in 180 days and be ready for operation by the City 210 calendar days after Notice to Proceed.

3.2 Damages for Delay. OWNER and CONTRACTOR recognize that **TIME IS OF THE ESSENCE** in this Agreement and that the OWNER will suffer financial loss if the Work is not completed within the time specified in Paragraph 3.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions.

3.2.1 Uniqueness of the Work. The OWNER and the CONTRACTOR expressly acknowledge the unique characteristics of the Work, which cause time to be of the essence in this contract.

3.2.2 Liquidated Damages. OWNER and CONTRACTOR recognize that **TIME IS OF THE ESSENCE** in this Agreement and that Owner will suffer financial loss if the work is not substantially complete in the time specified in Paragraph 3.1 above. The parties also recognize the delays, expense and difficulties involved in proving in a legal proceeding the actual loss suffered by the OWNER if the Work is not substantially complete on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) CONTRACTOR shall pay OWNER $1,000.00 (One Thousand Dollars) for each day that expires after the time specified in Paragraph 3.1 for Substantial Completion until the Work is substantially complete, and that the liquidated damages set forth herein bear a reasonable relationship to the estimated actual damages that the OWNER would suffer.

ARTICLE IV - CONTRACT PRICE

4.1 OWNER shall pay CONTRACTOR for performance of the Work in accordance with the Contract Documents in current funds at the lump sum or unit prices as presented in the Bid Form, which is incorporated herein and made a part hereof by this reference.

4.2 OWNER shall pay CONTRACTOR for completion of the work in accordance with the Contract Documents an amount in correct funds equal to the amount below:

Bid Total: _____
(use words)

Bid Total: $_____
(use figures)

4.3 The parties expressly agree that the Contract Price is a stipulated sum, except with regard to those items in the Bid which are subject to unit prices.

ARTICLE V - PAYMENT PROCEDURES

5.1 CONTRACTOR shall submit Applications for Payment in accordance with the Contract Documents. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

5.2 OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR'S monthly Applications for Payment, as approved by the ENGINEER, which shall be submitted by the CONTRACTOR on or before the 10th day after the end of each calendar month for which payment is requested.

5.3 Progress payments prior to Substantial Completion will be made in the following manner:

5.3.1 Prior to Substantial Completion and prior to fifty percent (50%) of the Work being completed, progress payments shall be ninety percent (90%) of the value of Work complete and ninety percent (90%) of the value of materials and equipment not incorporated into the Work, but delivered and suitably stored, less in each case the aggregate of payments previously made.

5.3.2 After fifty percent (50%) of the Work has been completed as determined by the ENGINEER, and if the character and progress has been satisfactory to the OWNER and ENGINEER, OWNER, on the recommendation of ENGINEER, may determine that as long as the character and progress of the Work remain satisfactory to them, there will be no retainage on account of subsequent Work and materials and equipment not incorporated into the Work, but delivered and suitably stored, which results in the Owner withholding a retainage equal to five percent (5%) of the Contract Price until Substantial Completion. However, OWNER shall reserve the right to reinstate withholding a retainage of ten percent (10%) if OWNER, on the recommendation of ENGINEER, determines that the progress or character of the Work is not satisfactory.

5.3.3 Upon Substantial Completion of the Work, OWNER shall pay an amount sufficient to increase total payments to the CONTRACTOR to ninety-five percent (95%) of the Contract Price, less such amounts as ENGINEER shall determine in accordance with Article 14 of the General Conditions."

5.4 Final Payment. Upon final completion of the Work in accordance with the Contract Documents, OWNER shall pay CONTRACTOR an amount sufficient to increase total payments to ninety-eight percent (98%) of the Contract Price. However, not less than two percent (2%) of the Contract Price shall be retained until Record Drawings, specifications, addenda, modifications and shop drawings, including all manufacturers instructional and parts manuals are delivered to and accepted by the ENGINEER.

ARTICLE VI - CONTRACTOR'S REPRESENTATIONS

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

6.1 CONTRACTOR has visited the work site and familiarized himself with the nature and extent of the Contract Documents, Work, locality, and all local conditions and federal, state and local laws, ordinances, rules and regulations that in any manner may affect cost, progress or performance of the Work.

6.2 CONTRACTOR has studied carefully all reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the Work which were relied upon by the ENGINEER in the preparation of the Drawings and Specifications, and which have been identified in the General and Supplementary Conditions of the Contract Documents.

6.3 CONTRACTOR has made or caused to be made examinations, investigations, tests and studies of such reports and related data in addition to those referred to in Paragraph 6.2 above as he deems necessary for the performance of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents; and no additional examinations, investigations, tests, reports or similar data are, or will be, required by CONTRACTOR for such purposes.

6.4 CONTRACTOR has correlated the results of all such observations, examinations, investigations, tests, reports and data with the terms and conditions of the Contract Documents.

6.5 CONTRACTOR has given ENGINEER written notice of all conflicts, errors or discrepancies that he has discovered in the Contract Documents and the written resolution thereof by ENGINEER is acceptable to the CONTRACTOR.

ARTICLE VII - CONTRACT DOCUMENTS

The Contract Documents which comprise the entire Agreement between the OWNER and CONTRACTOR are attached to this Agreement, are made a part hereof and consist of the following:

7.1 This Agreement (Section 00500) (pages __ to __, inclusive).

7.2 Exhibits to this Agreement (sheets __ to __, inclusive). N/A

7.3 Performance Bond, Payment Bond and Certificates of Insurance.

7.4 Notice of Award and Notice to Proceed.

7.5 General Conditions (Section 00700) as amended by the Supplementary Conditions.

7.6 Supplementary Conditions (Section 00800).

7.7 Project Manual bearing the general title: "CRESTVIEW WWTP SOLIDS HANDLING IMPROVEMENTS" and consisting of Divisions 0 through 44 as listed in the table of contents.

7.8 Drawings bearing the following general title: "CRESTVIEW WWTP SOLIDS HANDLING IMPROVEMENTS" and consisting of the sheets as listed in the Drawings Index.

7.9 Addenda Numbers ___ through _____, inclusive.

7.10 Bid Form (Section 00300) (Pages 1 to 11, inclusive).

7.11 All applicable provisions of State and Federal Law and any modification, including Change Orders or written amendments duly delivered after execution of Agreement.

7.12 Advertisement for Bids, Instructions to Bidders, Bid Bond, Noncollusion Affidavit, General Requirements, Field Orders and State of Florida Contract Provisions.

There are no Contract Documents other than those listed above in this Article VII. The Contract Documents may only be altered, amended, or repealed in accordance with Article 3 of the General Conditions as modified in the Supplementary Conditions.

ARTICLE VIII - MISCELLANEOUS

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

8.2 OWNER and CONTRACTOR each binds himself, his partners, successors, assigns and legal representatives to the other party hereto, his partners, successors, assigns or legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.

8.3 Terms used in this Agreement, which are defined in Article 1 of the General Conditions, shall have the meanings indicated in the General Conditions, as modified in the Supplementary Conditions.

ARTICLE IX - GOVERNING LAW

This Agreement shall be governed by the laws of the State of Florida. Both parties agree that the courts of the State of Florida shall have jurisdiction of any claim arising in connection with this Agreement. In the event of litigation arising out of this Agreement, the prevailing party shall be entitled to the award of attorney's fees and costs at both the trial and appellate level. Venue for any litigation arising out of this agreement shall be in Orange County, Florida.

IN WITNESS WHEREOF, the parties hereto have signed this Agreement in triplicate. One (1) counterpart each has been delivered to OWNER, CONTRACTOR and ENGINEER. All portions of the Contract Documents have been signed or identified by OWNER and CONTRACTOR or by ENGINEER on their behalf.

This Agreement will be effective on _____, 2021.

OWNER: CITY OF CRESTVIEW, FLORIDA

By: _____
_____
_____

ATTEST: _____

CITY CLERK

APPROVED AS TO FORM AND CORRECTNESS: _____

CITY ATTORNEY

CONTRACTOR:

By: _____
_____

Title: _____

(CORPORATE SEAL)

ATTEST: _____

SECRETARY

END OF SECTION

Performance Bond

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

CONTRACTOR (Name and Address):

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

OWNER (Name and Address):

CONTRACT
Date:
Amount:
Description (Name and Location):

BOND
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

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

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature: _____
Name and Title:

SURETY
Company: (Corp. Seal)

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

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

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature: _____
Name and Title:

SURETY
Company: (Corp. Seal)

Signature: _____
Name and Title:

EJCDC No. 1910-28-A (1996 Edition)
Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, and the American Institute of Architects.

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

2. If the CONTRACTOR performs the Contract, the Surety and the CONTRACTOR have no obligation under this Bond, except to participate in conferences as provided in paragraph 3.1.

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

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

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

3.3. The OWNER has agreed to pay the Balance of the Contract Price to:

3.3.1. The Surety in accordance with the terms of the Contract;

3.3.2 Another contractor selected pursuant to paragraph 4.3 to perform the Contract.

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

4.1. Arrange for the CONTRACTOR, with consent of the OWNER, to perform and complete the Contract; or

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

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the OWNER for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by the OWNER and the contractor selected with the OWNER's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the Bonds issued on the Contract, and pay to the OWNER the amount of damages as described in paragraph 6 in excess of the Balance of the Contract Price incurred by the OWNER resulting from the CONTRACTOR Default; or

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

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

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

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

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

6.1. The responsibilities of the CONTRACTOR for correction of defective Work and completion of the Contract;

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

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

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

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

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

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

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

12. Definitions.

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

12.2. Contract: The agreement between the OWNER and the CONTRACTOR identified on the signature page, including all Contract Documents and changes thereto.

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

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

(FOR INFORMATION ONLY--Name, Address and Telephone)
AGENT or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):

Payment Bond

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

CONTRACTOR (Name and Address):

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

OWNER (Name and Address):

CONTRACT
Date:
Amount:
Description (Name and Location):

BOND
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

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

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature: _____
Name and Title:

SURETY
Company: (Corp. Seal)

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

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

CONTRACTOR AS PRINCIPAL
Company: (Corp. Seal)

Signature: _____
Name and Title:

SURETY
Company: (Corp. Seal)

Signature: _____
Name and Title:

EJCDC No. 1910-28-B (1996 Edition)
Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, the American Institute of Architects, the American Subcontractors Association, and the Associated Specialty Contractors.

1. The CONTRACTOR and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the OWNER to pay for labor, materials and equipment furnished for use in the performance of the Contract, which is incorporated herein by reference.

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

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

2.2. Defends, indemnifies and holds harmless the OWNER from all claims, demands, liens or suits by any person or entity who furnished labor, materials or equipment for use in the performance of the Contract, provided the OWNER has promptly notified the CONTRACTOR and the Surety (at the addresses described in paragraph 12) of any claims, demands, liens or suits and tendered defense of such claims, demands, liens or suits to the CONTRACTOR and the Surety, and provided there is no OWNER Default.

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

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

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

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

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

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

3. Not having been paid within the above 30 days, have sent a written notice to the Surety and sent a copy, or notice thereof, to the OWNER, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to the CONTRACTOR.

5. If a notice required by paragraph 4 is given by the OWNER to the CONTRACTOR or to the Surety, that is sufficient compliance.

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

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

6.2. Pay or arrange for payment of any undisputed amounts.

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

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

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

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

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

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

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

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

15. DEFINITIONS

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

15.2. Contract: The agreement between the OWNER and the CONTRACTOR identified on the signature page, including all Contract Documents and changes thereto.

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

(FOR INFORMATION ONLY--Name, Address and Telephone)
AGENCY or BROKER: OWNER'S REPRESENTATIVE (Engineer or other party):

SECTION 00650

CERTIFICATE OF INSURANCE

A. INSURANCE REQUIREMENTS

1. Contractor shall purchase and maintain such comprehensive general liability and other insurance as required by this document. Should any of the required insurance policies be canceled before the expiration date thereof, the insuring company shall provide written notice to each insured 30 days prior to cancellation.

B. CERTIFICATE OF INSURANCE FORM

1. The Certificate of Insurance submitted to the Owner and Engineer shall be on the Insurance Company's form with a format similar to the popular ACORD Corporation form.

2. The Owner's project name and project number shall be shown on the Certificate.

3. Three (3) Certificates shall be submitted along with the executed Contract Agreement.

a. Minimum Scope of Insurance:

Coverage shall be at least as broad as:

1. Insurance Services Office Form No. CG 0001 (11/85) or CG 0002 (2/86) Commercial General Liability; and Insurance Services Office Form No. GL 0404 (5181) Broad Form Comprehensive General Liability; endorsement, and

2. Insurance Services Office form No. CA 0001 (Ed. 1/87) covering Automobile Liability, code 1 "any auto", and CA 0002 (1/87), and

3. Workers' Compensation as required by the State of Florida and Employers' Liability insurance:

b. Minimum Limits of Insurance:

Contractor shall maintain coverage’s and limits as follows:

1. General Liability:

Aggregate Limit: $1,000,000.
Products and completed operation aggregate limit: $500,000.
Personal and advertising injury limit: N/A.
Each occurrence limit: $500,000.
Fire damage limit: $50,000 any one fire.

Medical expense limit: $5,000 per person.
Blanket: no.

(1) Designated contractors (specify): City of Crestview

2. Automobile Liability:
   (a) Business auto with symbol(s): one (1)
   (b) Limit per accident: $1,000,000.

3. Workers' Compensation as required by Florida laws, and Employer's Liability with the following minimum limits:
   (a) Each accident: $100,000.
   (b) Per employee disease: $100,000.
   (c) All claims disease: $500,000.

C. Deductibles and Self-Insured Retentions:

Any deductible or self-insured retention must be declared to and approved by the City. At the option of the City, either the insurer shall reduce or eliminate such deductibles or self insured retentions as respects the City, its officials and employees, or the contractor shall procure a bond guaranteeing payment of losses and related investigation, claim administration and defense expenses.

D. Acceptability of Insurers: Insurance should be placed with insurers having a Bests' rating of A-Excellent and Xiii Financial Size.

E. Verification of Coverage: Successful Contractor shall furnish the City with certificates of insurance and with original endorsements affecting coverage's required by this appendix. The certificates and endorsement for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf. The certificate and endorsement are to be on forms provided or approved by the City and are to be received and approved in final form by the City before work commences.

F. Subcontractors: Contractor shall include all subcontractors as insured's under its policies or shall furnish separate certificates and endorsements for each subcontractor. All coverage's for subcontractors shall be subject to all of the requirements stated herein.

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

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

ACEC
American Council of Engineering Companies

The Associated General Contractors of America
Skill Responsibility Integrity

ASCE American Society of Civil Engineers

National Society of Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

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ASSOCIATED GENERAL CONTRACTORS OF AMERICA

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AMERICAN SOCIETY OF CIVIL ENGINEERS

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

Endorsed by

CONSTRUCTION SPECIFICATIONS INSTITUTE

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

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

30. *PCBs*—Polychlorinated biphenyls.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.02 *Terminology*

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

B. *Intent of Certain Terms or Adjectives:*

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

C. *Day:*

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

D. *Defective:*

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

a. does not conform to the Contract Documents; or

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

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

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

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

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

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

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

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

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

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

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

2.02 *Copies of Documents*

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

2.03 *Commencement of Contract Times; Notice to Proceed*

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

2.04 *Starting the Work*

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

2.05 *Before Starting Construction*

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

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

2. a preliminary Schedule of Submittals; and

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

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

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

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

2.07 *Initial Acceptance of Schedules*

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

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

the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

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

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

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

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

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

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

3.02 *Reference Standards*

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

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

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

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

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

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

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

B. *Resolving Discrepancies:*

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

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

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

3.04 *Amending and Supplementing Contract Documents*

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

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

1. A Field Order;

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

3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier shall not:

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

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

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

3.06 *Electronic Data*

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

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

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

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

4.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the

Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

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

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

4.02 *Subsurface and Physical Conditions*

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

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

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

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

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

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

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

4.03 *Differing Subsurface or Physical Conditions*

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

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

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

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

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

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

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

C. *Possible Price and Times Adjustments:*

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

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

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

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

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

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

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

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

4.04 *Underground Facilities*

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

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

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

   a. reviewing and checking all such information and data;

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

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

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

B. *Not Shown or Indicated:*

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

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

4.05 *Reference Points*

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

4.06 *Hazardous Environmental Condition at Site*

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

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

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

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

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

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

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

permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.

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

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

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

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

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

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

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

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

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

5.02 *Licensed Sureties and Insurers*

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

5.03 *Certificates of Insurance*

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

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

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

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

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

5.04 *Contractor's Insurance*

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

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

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

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

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

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

   b. by any other person for any other reason;

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

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

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

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

employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

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

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

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

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

6. include completed operations coverage:

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

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

5.05 *Owner's Liability Insurance*

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

5.06 *Property Insurance*

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

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of

them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;

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

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

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

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

6. include testing and startup; and

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

B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.

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

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

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

5.07 *Waiver of Rights*

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

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

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

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

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

5.08 *Receipt and Application of Insurance Proceeds*

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

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

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

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

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

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

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

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

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

6.02 *Labor; Working Hours*

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

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

6.03 *Services, Materials, and Equipment*

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

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

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

6.04 *Progress Schedule*

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

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

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

6.05 *Substitutes and "Or-Equals"*

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

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

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

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

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

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

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

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

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

2. *Substitute Items:*

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

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

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

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

      1) shall certify that the proposed substitute item will:

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

         b) be similar in substance to that specified, and

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

      2) will state:

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

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

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

      3) will identify:

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

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

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

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

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

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

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

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

6.06 *Concerning Subcontractors, Suppliers, and Others*

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

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

entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

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

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

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

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

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

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

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

6.07 *Patent Fees and Royalties*

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

use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

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

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

6.08 *Permits*

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

6.09 *Laws and Regulations*

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

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

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner

and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

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

6.11 *Use of Site and Other Areas*

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

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

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

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

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

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

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

6.12 *Record Documents*

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

6.13 *Safety and Protection*

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

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

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

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

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

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

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

E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts

any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

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

6.14 *Safety Representative*

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

6.15 *Hazard Communication Programs*

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

6.16 *Emergencies*

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

6.17 *Shop Drawings and Samples*

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

1. *Shop Drawings:*

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

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

2. *Samples:*

a. Submit number of Samples specified in the Specifications.

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

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

C. *Submittal Procedures:*

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

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

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

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

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

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

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

D. *Engineer's Review:*

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

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the

Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

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

E. *Resubmittal Procedures:*

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

6.18 *Continuing the Work*

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

6.19 *Contractor's General Warranty and Guarantee*

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

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

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

2. normal wear and tear under normal usage.

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

1. observations by Engineer;

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

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

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

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

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

7. any correction of defective Work by Owner.

6.20 *Indemnification*

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

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

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

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

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

6.21 *Delegation of Professional Design Services*

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

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

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

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

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

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

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

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

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

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner, and Owner, if Owner is performing other work with Owner's employees, proper and safe

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

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

7.02 *Coordination*

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

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

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

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

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

7.03 *Legal Relationships*

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

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

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

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

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

8.02 *Replacement of Engineer*

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

8.03 *Furnish Data*

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

8.04 *Pay When Due*

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

8.05 *Lands and Easements; Reports and Tests*

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

8.06 *Insurance*

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

8.07 *Change Orders*

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

8.08 *Inspections, Tests, and Approvals*

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

8.09 *Limitations on Owner's Responsibilities*

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

and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

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

8.11 *Evidence of Financial Arrangements*

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

8.12 *Compliance with Safety Program*

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

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

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

9.02 *Visits to Site*

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

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

9.03 *Project Representative*

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

9.04 *Authorized Variations in Work*

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

9.05 *Rejecting Defective Work*

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

9.06 *Shop Drawings, Change Orders and Payments*

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

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

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

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

9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations

on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

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

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

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

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

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

9.09 *Limitations on Engineer's Authority and Responsibilities*

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

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

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

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

and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.

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

9.10 *Compliance with Safety Program*

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

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

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

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

10.02 *Unauthorized Changes in the Work*

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

10.03 *Execution of Change Orders*

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

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

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

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of

executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

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

10.05 *Claims*

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

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

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

1. deny the Claim in whole or in part;

2. approve the Claim; or

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

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

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

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

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

11.01 *Cost of the Work*

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

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

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

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

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

5. Supplemental costs including the following:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

11.02 *Allowances*

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

B. *Cash Allowances:*

1. Contractor agrees that:

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

b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in

the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. *Contingency Allowance:*

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

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

11.03 *Unit Price Work*

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

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

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

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

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

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

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

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

12.01 *Change of Contract Price*

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

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

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

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

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

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

1. a mutually acceptable fixed fee; or

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

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

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

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

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

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

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

12.02 *Change of Contract Times*

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

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

12.03 *Delays*

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

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

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

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

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

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

13.01 *Notice of Defects*

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

13.02 *Access to Work*

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

13.03 *Tests and Inspections*

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

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

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

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

3. as otherwise specifically provided in the Contract Documents.

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

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

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

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

13.04 *Uncovering Work*

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

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

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

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

13.05 *Owner May Stop the Work*

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

13.06 *Correction or Removal of Defective Work*

A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers,

architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

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

13.07 *Correction Period*

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

1. repair such defective land or areas; or

2. correct such defective Work; or

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

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

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

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

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

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

13.08 *Acceptance of Defective Work*

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

13.09 *Owner May Correct Defective Work*

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

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

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

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

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

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

14.02 *Progress Payments*

A. *Applications for Payments:*

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

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

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

B. *Review of Applications:*

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

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's

review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

a. the Work has progressed to the point indicated;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

C. *Payment Becomes Due:*

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

D. *Reduction in Payment:*

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

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

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

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

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

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

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

14.03 *Contractor's Warranty of Title*

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

14.04 *Substantial Completion*

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

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

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

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

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

14.05 *Partial Utilization*

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

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

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

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

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

14.06 *Final Inspection*

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

14.07 *Final Payment*

A. *Application for Payment:*

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

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

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

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

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

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

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

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

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

C. *Payment Becomes Due:*

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

14.08 *Final Completion Delayed*

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

14.09 *Waiver of Claims*

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

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

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

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

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

15.02 *Owner May Terminate for Cause*

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

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

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

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

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

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

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

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

3. complete the Work as Owner may deem expedient.

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

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

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

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

15.03 *Owner May Terminate For Convenience*

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

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

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

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other

dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. reasonable expenses directly attributable to termination.

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

15.04 *Contractor May Stop Work or Terminate*

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

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

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

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

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

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

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

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

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

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

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

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

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

17.02 *Computation of Times*

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

17.03 *Cumulative Remedies*

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

17.04 *Survival of Obligations*

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

17.05 *Controlling Law*

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

17.06 *Headings*

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

SECTION 00800

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (ACEC/NSPE/ASCE) Document No. C-700, 2007 edition) and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect. Where conflicts exist between these Supplementary Conditions and the FDEP Supplementary Conditions, the FDEP Supplementary Conditions shall govern.

SC-1.01 The terms used in these Supplementary Conditions which are defined in the Standard General Conditions of the Construction Contract (No. C-700, 2007 Edition) have the meanings assigned to them in the Standard General Conditions.

SC-1.01.12 Delete the definition of "Contract Documents" in Article 1 of the General Conditions. "Contract Documents" are the documents enumerated in Article 8 of the Agreement.

SC-1.01.44 Delete the definition of Substantial Completion and insert the following in its place:

Substantial Completion - The Work (or a specified part thereof) has progressed to the point where, in the opinion of the ENGINEER as evidenced by ENGINEER's definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents and that all conditions precedent to Substantial Completion have been met in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to any Work refer to Substantial Completion thereof.

Add the following definitions:

SC-1.01.52 Compensable Delay - Any delay beyond the control and without the fault or negligence of the CONTRACTOR resulting from OWNER-caused changes in the Work, differing site conditions, suspensions of the Work, or termination for convenience by the OWNER.

SC-1.01.53 Correction Period - The time during which the CONTRACTOR must correct defective Work or remove defective Work from the site and replace it with non-defective Work, all at no cost to the OWNER, pursuant to paragraph 13.07 of the General Conditions, as supplemented.

SC-1.01.54 Final Completion - The date upon which the final payment is due to be paid by OWNER to CONTRACTOR.

SC-1.01.55 Excusable Delay - Any delay beyond the control and without the fault or negligence of the CONTRACTOR, the OWNER, or any other contractor caused by events or circumstances such as, but not limited to, acts of God or of the public enemy, acts of interveners, acts of the government, fires, floods, epidemics, quarantine restrictions, freight embargoes, and hurricanes, tornadoes, or new sink holes. Labor disputes and above average rainfall shall give rise only to Inexcusable Delays.

SC-1.01.56 Float or Slack Time - The time available in the progress schedule during which an unexpected activity can be completed without delaying the Substantial Completion of the Work.

SC-1.01.57 Inexcusable Delay - Any delay caused either (i) by events or circumstances within the control of the CONTRACTOR, such as inadequate crewing, slow submittals, etc., which might have been avoided by the exercise of care, prudence, foresight, or diligence on the part of the CONTRACTOR, (ii) by weather conditions (other than hurricanes and tornadoes) or (iii) labor disputes.

SC-1.01.58 Nonprejudicial Delay - Any delay impacting a portion of the Work within the available total Float or Slack Time, as that term is used in Section 01310: Progress Schedules and not necessarily preventing completion of the Work within the Contract Time.

SC-1.01.59 Prejudicial Delay - Any Excusable or Compensable Delay impacting the Work and exceeding the total Float Time available in the progress schedule, thus preventing completion of the Work within the Contract Time unless the Work is accelerated.

SC-1.01.60 Preoperational Testing (Check-Out-Testing) - All field inspections, installation checks, water tests, performance tests, and necessary corrections required of the CONTRACTOR as a condition or conditions to achieving Substantial Completion to demonstrate to the OWNER and ENGINEER that individual components of the Work have been properly constructed and operate in accordance with the Contract Documents for their intended purposes.

SC-1.01.61 Start-Up Testing (Demonstration Testing) - A predefined trial period required as a condition to Substantial Completion during which CONTRACTOR is to operate the entire Work (or any part thereof agreed to by the OWNER) under actual and simulated operating conditions for the purpose (i) of making such minor adjustments and changes to the Work as may be necessary for the Work

to comply with the Contact Documents and (ii) of complying with the final test requirements in the Contract Documents.

SC-2.02 Delete paragraph 2.02 of the General Conditions in its entirety and insert the following in its place:

2.2.1 After the Agreement has been executed, the CONTRACTOR will be furnished one (1) complete set of reproducible Drawings (24 x 36) and one (1) reproducible copy of the Project Manual (Contract Requirements and Specifications) and all addenda.

2.2.2 The CONTRACTOR shall furnish each of the Subcontractors, Suppliers, Permitting Agencies, and others such copies of the Contract Documents as may be required for their Work. All copies of the Contract Documents shall be printed from the reproducible.

SC-2.03 Delete paragraph 2.03 of the General Conditions in its entirety and insert the following in its place.

2.03 The Contract Time will commence to run on the day indicated in the Notice to Proceed. The Notice to Proceed may be given at any time after the Effective Date of the Agreement. In no event will the Contract Time commence to run later than the sixtieth (60th) day after the Effective Date of the Agreement.

SC-2.05 Add the following immediately after subparagraph 2.05.3 of the General Conditions:

2.05.4 The submittals required in subparagraphs 2.05.1, 2.05.2 and 2.05.3 shall be as specified in Section 01310, 01340, and 01370, respectively.

SC-2.07 Delete paragraph 2.07A.2 of the General Conditions in its entirety and insert the following in its place:

2.07.A.2 CONTRACTOR'S schedule of shop drawings and sample submittals will be acceptable to ENGINEER only if it provides a minimum of thirty (30) days for reviewing and processing the submittals. Shop Drawings requiring resubmission and review shall not rise to an excusable or compensable delay.

SC-3.03 Add the following immediately after paragraph 3.03 A of the General Conditions:

3.03 B Measurements

1. When measurements are affected by conditions already established or where items have to be fitted into construction conditions, it shall be the CONTRACTOR's responsibility to verify all such dimensions at the site and the actual job dimensions shall take precedence over scale and figure dimensions on the Drawings.

2. The CONTRACTOR shall carefully study and compare all Drawings, Specifications and other instructions; shall test all figures on the Drawings before laying out the Work; shall notify the ENGINEER of all errors, inconsistencies, or omissions which he may discover; and obtain specific instructions before proceeding with the Work. The CONTRACTOR shall not take advantage of any apparent error or omissions which may be found in the Contract Documents, and the ENGINEER shall be entitled to make such corrections therein and interpretations thereof as may be deemed necessary for the fulfillment of their intent. The CONTRACTOR shall be responsible for all errors in construction which could have been avoided by such examination and notification and shall correct, at CONTRACTORS own expense, all Work improperly constructed through failure to notify the ENGINEER and request specific instructions.

3.03 B Amend paragraph 3.03 B to read 3.03 C.

SC-3.06 Add the following immediately after paragraph 3.06.C:

3.06.D The CONTRACTOR shall submit hard copies of all information required by Sections 01027, 01340 and 01730 and all forms that require the CONTRACTOR signature. Other CONTRACTOR submittals may be electronic data if approved by the ENGINEER.

SC-4.03.A.4 In the last paragraph of 4.03.A after "then CONTRACTOR shall" amend "promptly" to read "within three (3) days".

SC-4.04.B.1 In the first sentence of 4.04.B.1 amend "promptly" to read "within three (3) days".

SC-4.06.E Add the following immediately after paragraph 4.06.E of the General Conditions:

The provisions of paragraphs 4.06.A, 4.06.B, 4.06.C, 4.06.D and 4.06.E shall not apply where the Work is performed upon public lands, rights-of-way, easements or other properties of which the OWNER does not own. In such case, Contractor's sole remedy shall be an extension of contract time.

SC-4.07 Add a new paragraph immediately after paragraph 4.06 of the General Conditions which is to read as follows:

4.07 No claim of the CONTRACTOR under paragraphs 4.03, 4.04 and 4.06 shall be allowed unless, (1) the CONTRACTOR has given the notice required in the respective sub-paragraph above, and (2) within thirty (30) days (but before final payment) after the CONTRACTOR has given written notice, the CONTRACTOR submits to the OWNER a detailed claim setting forth the CONTRACTOR's right to an increase in the Contract Price or extension of the Contract Time as provided in Articles 11 and 12 of the General Conditions.

SC-5.01 Add the following immediately after paragraph 5.01 C of the General Conditions:

D. The Surety shall be rated as "A" or better as to General Policyholders Rating and Class X or better as to Financial Category by Best's Key Rating Guide, published by Alfred M. Best Company, Inc., of 75 Fulton Street, New York, New York, 10038.

E. All Surety Companies are subject to approval and may be rejected by the OWNER without cause.

F. The bonding limit of the Surety shall not exceed ten percent (10%) of the policyholder surplus (capital and surplus) as listed by the aforementioned Best's Key Rating Guide, on any one risk (penalty or amount of any one bond).

G. The Agent countersigning the bond shall be resident in the County where the Project is located and/or other counties that are acceptable to the OWNER.

SC-5.04.A The limits of liability for the insurance required by paragraph 5.04 of the General Conditions shall provide coverage for not less than the following amounts or where required by Law and Regulations.

Worker's Compensation, Employer's Liability etc., (under paragraphs 5.04.A.1 and 5.04.A.2 of the General Conditions):

(1) State: Coverage A: Statutory

(2) Applicable Federal: Statutory

(3) Employer's Liability:

Each Accident	$ 500,000
Each Employee	$ 500,000
Disease	$ 100,000

5.04.A.3 thru 5.04.A.6 of the General Conditions which shall also include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of Contractor:

(1) Commercial General Liability (Bodily Injury and Property Damage single limit each occurrence): $ 1,000,000

(2) Umbrella Liability $ 2,000,000

(3) Business Automobile Liability:

Combined Single Limit -
(Bodily Injury and Property Damage)
$ 1,000,000 Each Occurrence

SC-5.04.B.1 Additional Insureds:

Owner:	Engineer:
City of Crestview	(To Be Named At A Later Date)
_____	
Crestview, FL _____	

The Contractual Liability coverage required by paragraph 5.04 of the General Conditions shall provide coverage for not less than the following amounts:

(1)	Each Aggregate	$ 1,000,000
(2)	Each Occurrence (Bodily Injury and Property Damage)	$ 1,000,000

SC-5.06.A Revise paragraph 5.06.A. of the General Conditions as follows: Replace the word "Owner" with the word "CONTRACTOR" such that CONTRACTOR is required to purchase property insurance.

5.06.A.1 Name Additional Property Insureds (as previously listed).

5.06.A.2 Include coverage for hurricanes, floods, wind, and sinkholes.

5.06.A.7 Delete paragraph 5.06.A.7 in its entirety and replace with the following:

Be maintained in effect until Final Completion, unless otherwise agreed to in writing by OWNER, CONTRACTOR and ENGINEER with thirty (30) days written notice to each other additional insured to whom a certificate of insurance has been issued.

The policies of insurance required to be purchased and maintained by CONTRACTOR in accordance with this paragraph 5.06 shall comply with the requirements of GC-5.08.

SC-5.06.B Delete paragraph 5.06.B in its entirety.

SC-5.10 Delete paragraph 5.10 of the General Conditions in its entirety and insert the following in its place:

5.10 The CONTRACTOR shall maintain all insurance as required in Paragraph 5.06 for the Work and allow OWNER to occupy or use a portion or portions of the Work prior to Substantial Completion. CONTRACTOR shall make appropriate provisions with insurers providing the proper endorsements, if required. The property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

SC-6.01.B Add to the end of 6.01.B "Resident superintendent shall be fluent in English."

SC-6.02 Add the following sub-paragraphs immediately after paragraph 6.02.B of the General Conditions which are to read as follow:

6.02.B.1 Maintenance work may be performed during hours other than regular working hours. Regular working hours are defined as daylight hours between one-half hour after sunrise to one-half hour before sunset but not more than eight (8) hours per day forty (40) hours per week during weekdays. Requests to Work during other than regular working hours must be submitted to

the OWNER at least seventy-two (72) hours in advance of the period proposed for such irregular working hours and shall set forth the proposed schedule for such hours to give the OWNER ample time to arrange for its personnel to be at the site of the Work.

6.02.B.2 The OWNER will pay for charges of ENGINEER and construction observation performed during regular working hours. The CONTRACTOR shall pay for additional engineering and construction observation charges required during irregular hours which may be authorized under the provisions of paragraph SC-6.02.B.1.

6.02.B.3 The CONTRACTOR shall also pay for the costs of additional engineering charges and construction observation required during the correction of defective Work. Such additional costs incurred during irregular working hours and during the correction of defective Work, shall be subsidiary obligation of the CONTRACTOR and no extra payment shall be made by the OWNER on account of such Work.

SC-6.05 Delete the first paragraph in 6.05.A of the General Conditions in its entirety and insert the following in its place:

6.05.A ENGINEER and OWNER have no obligation to consider "or equal" items or substitutions unless such items are specifically identified in Section 00300 by CONTRACTOR at the time of bid. All "or equal" items and substitute items must be identified at the time of bid. It is the OWNER's sole prerogative to have ENGINEER review proposals, other than those identified in Section 00300, proposed by CONTRACTOR during the course of the Work. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function and quality required. Unless the specification or description contains or is followed by words "or equal" or "or approved equal" no substitution is permitted. Other items of material or equipment of other Suppliers will be reviewed by ENGINEER, with OWNER's approval, if the material or equipment is not named in Section 00300.

SC-6.08 Add the following to the end of paragraph 6.08.A in the General Conditions:

"The OWNER, prior to the advertisement of the Project, has applied for or has secured permits and/or licenses for the Project as referenced in Section 01065: Permits and Fees. The CONTRACTOR shall obtain and pay for all other construction permits required."

SC-6.11.B Add the following the end of 6.11.B:

"Contractor shall remove and dispose of waste materials, rubbish, and other debris on a weekly basis or when directed by the OWNER or ENGINEER."

SC-6.11.C Add to the end of 6.11.C:

"Contractor shall clean the site and the Work to the satisfaction of the OWNER."

SC-6.11 Add a new sub-paragraph immediately after paragraph 6.11.D of the General Conditions which are to read as follows:

6.11.E Use of the OWNER's existing washrooms, lavatories, sanitary facilities or plumbing fixtures by the CONTRACTOR or any of its employees or Subcontractors will not be permitted.

SC-6.13.C The Owner does not have safety programs that are specifically applicable to the Work. All safety programs associated with the Work shall be the responsibility of the Contractor.

SC-6.13.D Replace paragraph 6.13.D with the following:

"Contractor's duties and responsibilities for safety and protection of the Work shall continue until Final Completion and at all times during the correction period that Contractor, subcontractor, supplier, or any other individual directly or indirectly employed by any of them are on site to perform work."

SC-6.13 Add the following paragraph 6.13.G:

"The CONTRACTOR shall be completely responsible for any tanks, wet wells or similar structures that may become buoyant during the construction and modification operations due to the ground water or floods and before the structure is put into operation. Should there be any possibility of buoyancy of a structure, the CONTRACTOR shall take the necessary steps to prevent its buoyancy either by increasing the structures weight, by filling it with approved material or other acceptable methods. The proposed final structures have been designed against buoyancy; however, during various construction stages, methods employed by the CONTRACTOR and other conditions which

may affect the buoyancy, the CONTRACTOR shall take the necessary precautions against buoyancy. Damage to any structures due to floating or flooding shall be repaired or the structures replaced at the CONTRACTOR's expense."

SC-6.17 E.1 Add the following at the end of paragraph 6.17.E.1 in the General Conditions:

"Shop Drawings and other submittal data shall be reviewed by the ENGINEER for each original submittal and first re-submittal; thereafter, the CONTRACTOR shall reimburse OWNER for services rendered by ENGINEER for review time and other associated costs of subsequent re-submittals."

SC-6.22 Add the following new paragraphs after paragraph 6.21 of the General Conditions to read as follows:

6.22 Additional Costs: The CONTRACTOR shall reimburse the OWNER for services rendered by the ENGINEER when made necessary by the following:

6.22.1. Work damaged by fire, flood, lightning, or any other cause during construction.

6.22.2. Default by CONTRACTOR or any Subcontractor.

SC-7.01.C In the first sentence of paragraph 7.01.C, amend "promptly" to read "within three (3) days."

Amend the last sentence to read, "Contractor's failure to so report within three (3) days will constitute an acceptance of such other work as fit and proper for integration with Contractor’s Work except for latent defects and deficiencies in such other work."

SC-7.02 Delete paragraph 7.02 of the General conditions in its entirety and insert the following in its place:

7.02 The parties expressly acknowledge that the Work to be done by the CONTRACTOR under this contract may interface with the Work of other contractors. Thus, in addition to the foregoing paragraphs in this Article 7, the following provisions apply.

7.02.A The CONTRACTOR shall cooperate with all other contractors who may be performing Work on behalf of the OWNER in the vicinity of the Work to be done under this contract, and CONTRACTOR shall conduct his operation as to interfere to the least possible extent with the Work of such contractor.

7.02.B The CONTRACTOR shall promptly make good, at its own expense, any injury or damage that may be caused by it to other contractors, employees or subcontractors or suppliers thereof.

7.02.C Any difference or conflict which may arise between the CONTRACTOR and other contractors in regard to their respective Work shall be adjusted and determined by the OWNER.

7.02.D If the Work is delayed because of any acts or omissions of any other contractor, the CONTRACTOR shall have no claim against the OWNER on that account.

SC-8.06 Delete paragraph 8.06 of the General Conditions in its entirety.

SC-9.08.D Add the following sentences to the end of paragraph 9.08.D of the General Conditions:

"No action, either at law or at equity, shall be brought in connection with any such claim, dispute or other matter later than thirty (30) days after the date on which the ENGINEER has rendered such written decision in respect thereof. Failure to bring an action within said thirty (30) day period shall result in ENGINEER's decision being final and binding upon the OWNER and the CONTRACTOR. In no event may any such action be brought after the time at which instituting such proceedings would be otherwise barred by the applicable statute of limitations."

SC-10.01.C & SC-10.01.D Add the following new paragraphs after paragraph 10.01.B of the General Conditions:

10.01.C At anytime, ENGINEER may request a quotation from CONTRACTOR for a proposed change in the Work. Within seven (7) calendar days after receipt of a request for a quotation for a proposed change, the CONTRACTOR shall submit a written and detailed proposal for an increase or decrease in the Contract Price or Contract Time for the proposed change. ENGINEER shall have twenty-one (21) calendar days after receipt of the detailed proposal to respond in writing. The proposal shall include an itemized estimate of all costs and time for performance that will result directly or indirectly from the proposed change. Unless otherwise directed, itemized estimates shall be in accordance with Articles 11 and 12 of the General Conditions and in sufficient detail to permit an analysis by ENGINEER of all material,

labor, equipment, subcontract, and overhead costs and fees and shall cover all Work involved in the change, whether such Work was deleted, added, changed, or impacted. Any amount claimed for subcontracts shall be similarly supported. Itemized schedule adjustments shall be in sufficient detail to permit an analysis of impact as required in Section 01310: Progress Schedules. Notwithstanding the request for quotation, the CONTRACTOR shall carry on the Work and maintain the progress schedule. Delays in the submittal of the written and detailed quotation will be considered a non-prejudicial delay as defined in the Supplementary Conditions.

10.01.D The adjustment in Contract Price and/or Contract Time stated in a Change Order shall comprise the total price and/or time adjustment due or owed the CONTRACTOR for the Work or changes defined in the Change Order. By executing the Change Order, the CONTRACTOR acknowledges and agrees that the stipulated price and/or time adjustments include the costs and delays for all Work contained in the Change Order, including costs and delays associated with the interruption of schedules, extended overheads, delay, acceleration and cumulative impacts or ripple effect on all other non-affected Work under this contract. Signing of the Change Order constitutes full and mutual accord and satisfaction for the adjustment in the Contract Price or Contract Time as a result of increases or decreases in costs and time of performance caused directly and indirectly from the change, subject to the current scope of the entire Work as set forth in the Contract Documents. Acceptance of the Change Order constitutes an agreement between OWNER and CONTRACTOR that the Change Order represents an equitable adjustment to the Contract Documents, and that the CONTRACTOR will waive all rights to file a claim on this Change Order after it is properly executed.

SC-10.05 Add the following new paragraphs after paragraph 10.05.F of the General Conditions:

10.05.G. This Project is a "Public Work" under Chapter 255, Florida Statutes. No liens may be filed against OWNER. Any Clamant may apply to the OWNER for a copy of this Contract and the Public Construction Bond. The Claimant shall have a right of action against the CONTRACTOR and surety for the amount due him. Such action shall not involve the OWNER in any expense claims against the CONTRACTOR or the surety are subject to timely prior notice to both the CONTRACTOR

and the Surety as specified in Section 255.05 Florida Statutes. The CONTRACTOR shall insert the following in all subcontracts hereunder.

"NOTICE: Claims for labor, materials, and supplies are not assertable against the OWNER and are subject to proper prior notice to the CONTRACTOR and the Surety pursuant to Chapter 255 of the Florida Statutes. This paragraph shall be insert in every subcontract hereunder."

SC-12.02 Delete paragraph 12.02 of the General Conditions in its entirety and insert the following in its place:

12.02.A The Contract Time may be changed only by a Change Order. Any claim for an extension or shortening in the Contract Time shall be based on written notice delivered to the OWNER and ENGINEER within fifteen (15) days from detection or the beginning of any event or circumstance giving rise to an Excusable or Compensable Delay and setting forth the general nature of the cause of delay. Within thirty (30) days of any such detection or beginning of event, the CONTRACTOR shall provide the analysis and documentation required to ascertain the facts, as specified in Section 01310: Progress Schedules and shall provide a written statement that the adjustment claimed is the entire adjustment to which the CONTRACTOR has reason to believe it is entitled as a result of the occurrence of said event. No claim by the CONTRACTOR under this provision shall be allowed unless the CONTRACTOR has given the notice and the analysis and documentation required in this paragraph, or if asserted after final payment.

12.02.B No forfeiture due to delay shall be made because of any Excusable and Prejudicial Delays in the completion of the entire Work or a specified part thereof. Any such delays shall not entitle the CONTRACTOR to any change in Contract Price. The sole remedy of the CONTRACTOR shall be an extension of the Contract Time pursuant to this Article and the provisions of Section 01310: Progress Schedules.

12.02.C No forfeiture due to delay shall be made because of any Compensable and Prejudicial Delays in the completion of the Work or a specified part thereof. Any such delays will entitle the CONTRACTOR solely to an extension of the Contract Time pursuant to this Article and the provisions of Section 01310: Progress Schedules, of the General Requirements.

12.02.D No extensions of Contract Time or increases in Contract Price shall be granted for Nonprejudicial Delays of any type or for Inexcusable Delays, unless otherwise agreed to by the OWNER at his sole discretion.

SC-13.03 B Delete Paragraph 13.03.B and sub-paragraphs 13.03.B.1, 13.03.B.2 and 13.03.B.3 in their entirety and insert the following:

13.03.B Payment of testing and laboratory services is specified in Section 01410; Testing and Laboratory Services for inspections and tests required by the Contract Documents. In addition to the requirements specified in Section 01410, CONTRACTOR shall pay for all inspections, tests or approvals covered by paragraph 13.03.C.

SC-13.06 Add a new paragraph 13.06.C as follows:

"The CONTRACTOR shall not be entitled to an extension of Contract Time or increase in Contract Cost for removing or correcting defective work."

SC-13.07.A Add a new paragraph 13.07.A.5:

"When deemed necessary by OWNER, CONTRACTOR shall furnish and install at no cost to OWNER, such temporary equipment and material necessary to maintain functionality of the Work while defective Work is being corrected or replaced."

SC-13.07.B Revise the first (1st) sentence of paragraph 13.07.B as follows:

"…, or in an emergency where delay would cause risk of loss, damage, present a threat to OWNER or the public, the environmental or cause or present a threat of violation of any Laws and Regulations, OWNER may…"

SC-14.02 Add a new paragraph 14.02.A.4 as follows:

"Applications for payment shall be in accordance with Section 01027."

SC-14.02 Delete subparagraph 14.02.C of the General Conditions and replace it with the following sentence:

"Thirty (30) days after presentation of the Application for Payment to OWNER with ENGINEER's recommendation, the amount recommended will (subject to the provisions of the last sentence of paragraph 14.02.B) become due and payable by OWNER to CONTRACTOR."

SC-14.04.A Delete the first sentence of paragraph 14.04.A of the General Conditions and replace it with the following sentences:

"After all requirements of Section 01700: Contract Closeout have been met with respect to Substantial Completion, then when CONTRACTOR considers the entire Work ready for its intended use CONTRACTOR shall notify OWNER and ENGINEER in writing that the entire Work is substantially complete (except for items specifically listed by CONTRACTOR as incomplete) and request that ENGINEER issue a certificate of Substantial Completion."

SC-14.06.A Amend 14.06.A to read as follows:

"After all requirements of Section 01700: Contract Closeout have been met with respect to Final Inspection Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies. Contractor shall not request a Final Inspection until CONTRACTOR has achieved Substantial Completion."

SC-14.07.A Add the following subparagraphs after Paragraph 14.07.A.3 of the General Conditions:

14.07.A.4 Notwithstanding any provision of the Contract Documents to the contrary, the OWNER shall not be deemed to have accepted the Work or waived claims against the CONTRACTOR until (i) payment of all remaining amounts of the Contract Price as provided under Paragraph 5.3. of the Agreement, (ii) all Record Drawings, specifications, addenda, modifications and shop drawings are delivered to and accepted by the ENGINEER, and (iii) the CONTRACTOR has met all conditions of General Condition 13.07 - Correction Period.

SC-15.01 Add a new subparagraph immediately after paragraph 15.01.A of the General Conditions to read as follows:

15.01.B Notwithstanding this paragraph 15.01, if the OWNER stops Work under paragraph 13.05 or suspends the CONTRACTOR's services under paragraph 13.06 of the General Conditions, or suspends the Work or any portion thereof because of the CONTRACTOR's failure to prosecute the Work without endangering persons and property, the CONTRACTOR shall not be entitled to an extension of Contract Time or increase in Contract Price.

SC-16.01 Add a new paragraph 16.01.D as follows:

"The CONTRACTOR shall carry on the Work and maintain the progress schedule during any dispute, regardless of how resolved, unless otherwise mutually agreed in writing. Venue for any litigation, at law or equity or arbitration, shall lie exclusively in the place of the OWNER's choosing. This Contract, or any provision hereof, shall be construed and interpreted, and any litigation arising therefrom, shall be governed by the laws of the State of Florida."

SC-17.01 Add the following after paragraph 17.01.A.2:

"3. Delivered by an independent carrier than can substantiate delivery with a tracking number and name of an individual or member of the firm accepting receipt."

SC-17.07 & SC-17.08 Add the two paragraphs immediately after paragraph 17.06 of the General Conditions which are to read as follows:

17.07 The form of all submittals, notices, change orders and other documents permitted or required to be used or transmitted under the Contract Documents shall be determined by the ENGINEER.

17.08 All representations, warranties and guarantees made in the Contract Documents shall survive final payment and termination or completion of the Agreement. Also, the obligation of the CONTRACTOR to maintain the Work until Substantial Completion shall service final payment and termination or completion of the Agreement.

END OF SECTION

SECTION 00843

CHANGE ORDER FORM

Project: **City of Crestview**

CHANGE ORDER NO._____

DATE OF ISSUANCE: _____ CONTRACTOR:_____

EFFECTIVE DATE:_____ ENGINEER:_____

OWNER'S CONTRACT NO.:_____

The following changes are hereby made to the Contract Documents:

CHANGE IN CONTRACT PRICE:	CHANGE IN CONTRACT TIMES:
Original Contract Price $_____	Original Contract Times Substantial Completion:_____ Ready for final payment:_____ days or dates
Net changes from previous Change Orders No.___to No. ___ $_____	Net change from previous Change Orders No. ___ to No. ___ _____ days
Contract Price prior to this Change Order $_____	Contract Times prior to this Change Order Substantial Completion:_____ Ready for final payment:_____ days or dates
Net Increase (~~decrease~~) of this Change Order $_____	Net Increase (decrease) of this Change Order _____ days
Contract Price with all approved Change Orders $_____	Contract Times with all approved Change Orders Substantial Completion:_____ Ready for final payment:_____ days or dates

CHANGES ORDERED:

I. GENERAL This change order is necessary to cover changes in the work to be performed under this Contract. The General Conditions, Supplementary Conditions, Specifications and all parts of the Project Manual listed in Article 1, Definitions, of the General Conditions apply to and govern all work under this change order.

Change Order No._____

II. REQUIRED CHANGES: _____

III. JUSTIFICATION:_____

IV. PAYMENT: _____

V. APPROVAL AND CHANGE AUTHORIZATION: _____

_____

_____

_____

_____

_____

_____

_____

Acknowledgments:

The aforementioned change, and work affected thereby, is subject to all provisions of the original contract not specifically changed by this Change Order; and,

It is expressly understood and agreed that the approval of the Change Order shall have no effect on the original contract other than matters expressly provided herein.

Change Order Request by:_____

Change(s) Ordered by: _____

RECOMMENDED BY:

_____
(Engineer)

By:_____ _____
(Authorized Signature) (Date)

_____
(Title)

ACCEPTED BY:

_____
(Contractor)

_____ _____
(Authorized Signature) (Date)

_____
(Title)

APPROVED BY:

City of Crestview, Florida
(Owner)

By:_____ _____
(Authorized Signature) (Date)

END OF SECTION

SECTION 00844

APPLICATION AND CERTIFICATE FOR PAYMENT FORM

Application No._____ Progress_____ Final_____

Engineer's Project No.: _____

Project: **City of Crestview**

Contractor:_____ Contract Date:_____

Contract for:_____

Application Date:_____ For Period Ending_____

Change Order Summary			
Change Orders approved in previous months by OWNER TOTAL		ADDITIONS	DEDUCTIONS
Approved this month			
Number	Date Approved		
	TOTALS		
Net Change by Change Orders			

1.	ORIGINAL CONTRACT SUM	$_____
2.	Net Change by Change Order	$_____
3.	CONTRACT SUM TO DATE (Line 1 and 2)	$_____
4.	TOTAL COMPLETED AND STORED TO DATE	$_____
5.	RETAINAGE: (Column I & N, Forms 00845 and 00846)	
	a. _____% of Completed Work	$_____
	b. _____% of Stored Material	$_____
	Total Retainage (Line 5a and 5b)	$_____
6.	TOTAL EARNED LESS RETAINAGE (Line 4 less Line 5 Total)	$_____
7.	LESS PREVIOUS CERTIFICATES FOR PAYMENT (Line 6 from prior Certificate)	$_____
8.	AMOUNT DUE THIS APPLICATION	$_____
9.	BALANCE TO FINISH, PLUS RETAINAGE (Line 3 less Line 6)	$_____

Contractor's Certification

The undersigned Contractor hereby swears under penalty of perjury that (1) all previous progress payments received from the Owner on account of Work performed under the contract referred to above have been applied by the undersigned to discharge in full all obligations of the undersigned incurred in connection with Work covered by prior Applications for Payment numbered 1 through _____ inclusive; and (2) all materials and equipment incorporated in said Project or otherwise listed in or covered by this Application for Payment are free and clear of all liens, claims, security interest and encumbrances; (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and not defective as that term is defined in the Contract Documents.

Dated _____, 20__

_____
(Contractor)

By:_____
(Name)

_____
(Title)

COUNTY OF_____

STATE OF_____

Before me on this _____ day of _____, 20__, personally appeared _____, known to me, who being duly sworn, deposes and says that (s)he is the _____ of the Contractor above mentioned; that(s) he executed the above Application for Payment and statement on behalf of said Contractor; and that all of the statements contained therein are true, correct and complete.

_____
Notary Public
My Commission Expires_____

Engineer's Recommendation

Payment of the above AMOUNT DUE THIS APPLICATION is recommended.

By:_____ Date:_____
(Authorized Signature)

Owner's Approval By:_____

_____
(Title)

Acct. No._____ Date:_____

END OF SECTION

SECTION 00845
SCHEDULE OF VALUES

Pay Estimate No. ____________________ Project ____
For Period Ending ___________________ Prepared by _______________________________ Page ____ of ____

A	B	C	D	E	F	G		H		I
Item	Description	Bid Quantity	Units	Unit Price	Bid Amount	Complete Through Last Period		Complete Through This Period		Value of Items Completed
						Qty.	%	Qty.	%	
						Subtotals				

SECTION 00849

CONTRACTOR'S FINAL RELEASE OF LIEN

Before me the undersigned authority in said County and State, appeared _____ who, being first duly sworn, deposes and says that he is _____ of_____, a company and/or corporation authorized to do business under the laws of Florida, which is the Contractor on the Contract described as: City of Crestview dated the _____ day of _____, 20_____, that the said deponent is duly authorized to make this affidavit by resolution of the Board of Directors of said company and/or corporation; that deponent knows of his own knowledge that said Contract has been complied with in every particular by said Contractor and that all parts of the work have been approved by the Owner's Engineers; that there are no bills remaining unpaid for labor, material, or otherwise, in connection with said Contract and work, and that there are no suits pending against the undersigned as Contractor or anyone in connection with the work done and materials furnished or otherwise under said Contract. Deponent further says that the final estimate which has been submitted to the owner simultaneously with the making of the affidavit constitutes all claims and demands against the Owner on account of said Contract or otherwise, and the acceptance of the sum specified in said final estimate will operate as a full and final release and discharge of the Owner from any further claims, demands or compensation by Contractor under the above Contract. Deponent further agrees that all guarantees under this Contract shall be in full force from the date of this release as spelled out in the Contract Documents.

Sworn to and subscribed to before me this _____ day of _____, 20_____.

_____
Notary Public

My Commission Expires_____

We, the _____ having heretofore executed a Performance Bond for the above-mentioned Contractor covered Project and Section as described above in the sum of_____dollars ($_____), hereby agree that the Owner may make full payment of the final estimate, including the retained percentage, to said Contractor.

It is fully understood that the granting of the right to the Owner to make payment of the final estimate to said Contractor and/or his assigns, shall in no way relieve the surety company of its obligations under its bond, as set forth in the Specifications, Contract and Bond pertaining to the above Project.

IN WITNESS WHEREOF, the _____ has caused this instrument to be executed on its behalf by its _____ and/or its duly authorized attorney in fact, and its corporate seal to be hereunto affixed, all of this _____ day of _____, A.D., 20_____.

_____
Surety Company

_____
Attorney in Fact

(Power of Attorney must be attached if executed by Attorney in Fact)

STATE OF FLORIDA

COUNTY OF _____

Before me the undersigned authority, personally appeared to me well known as the person described in and who executed the foregoing instrument in the name of _____ and/or _____ purpose therein expressed and that he had due and legal authority to execute the same on behalf of said _____, a corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal at _____ this _____ day of _____, 20_____.

_____
Notary Public

END OF SECTION

TECHNICAL

SPECIFICATIONS

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

A. The completed Work will provide Owner with a new Biosolids Dewatering Facility, two additional sludge digesters, as well as other improvements all as enumerated as follows:

1. A new Biosolids Dewatering Building including the following:
   a. A covered truck loading bay and process building.
   b. A single new 2-meter BFP, plus space allocations for an additional BFP in the future.
   c. A polymer feed system including allocated space for polymer barrel storage, activation system, and polymer dosing pumps for the initially installed BFP.
   d. Space allocation for an additional polymer feed system for the future BFP.
2. BFP feed pumps to transfer sludge from the digestors to be dewatered at the new Dewatering Building.
3. Two new 60-foot diameter prestressed concrete digestors equipped with 75-hp surface aerators and telescoping decant valves.
4. Sludge transfer pumps to allow for transfer or sludge from the new digestors to the existing digestors.
5. New electrical components to power and control the new equipment.
6. Replacement and supplementation of WWTP security access control and security lighting.
7. Demolition of two existing sludge drying beds.
8. Miscellaneous site/civil improvements to provide access to new facilities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 PROPOSAL REQUESTS

A. Owner may, in anticipation of ordering an addition, deletion, or revision to the Work, request Contractor to prepare a detailed proposal of cost and times to perform contemplated change.

B. Proposal request will include reference number for tracking purposes and detailed description of and reason for proposed change, and such additional information as appropriate and as may be required for Contractor to accurately estimate cost and time impact on Project.

C. Proposal request is for information only; Contractor is neither authorized to execute proposed change nor to stop Work in progress as result of such request.

D. Contractor's written proposal shall be transmitted to Engineer promptly, but not later than 14 days after Contractor's receipt of Owner's written request. Proposal shall remain firm for a maximum period of 45 days after receipt by Engineer.

E. Owner's request for proposal or Contractor's failure to submit such proposal within the required time period will not justify a Claim for an adjustment in Contract Price or Contract Times (or Milestones).

1.02 CLAIMS

A. Include, at a minimum:

1. Specific references including (i) Drawing numbers, (ii) Specification section and article/paragraph number, and (iii) Submittal type, Submittal number, date reviewed, Engineer's comment, as applicable, with appropriate attachments.
2. Stipulated facts and pertinent documents, including photographs and statements.
3. Interpretations relied upon.
4. Description of (i) nature and extent of Claim, (ii) who or what caused the situation, (iii) impact to the Work and work of others, and (iv) discussion of claimant's justification for requesting a change to price or times or both.
5. Estimated adjustment in price claimant believes it is entitled to with full documentation and justification.
6. Requested Change in Contract Times: Include at least (i) Progress Schedule documentation showing logic diagram for request, (ii) documentation that float times available for Work have been used, and (iii) revised activity logic with durations including sub-network logic revisions, duration changes, and other interrelated schedule impacts, as appropriate.
7. Documentation as may be necessary as set forth below for Work Change Directive, and as Engineer may otherwise require.

1.03 WORK CHANGE DIRECTIVES

A. Procedures:

1. Engineer will:
   a. Initiate, including a description of the Work involved and any attachments.
   b. Affix signature, demonstrating Engineer's recommendation.
   c. Transmit five copies to Owner for authorization.
2. Owner will:
   a. Affix signature, demonstrating approval of the changes involved.
   b. Return four copies to Engineer, who will retain one copy, send one copy to the Resident Project Representative or other field representative, and forward two copies to Contractor.
3. Upon completion of Work covered by the Work Change Directive or when final Contract Times and Contract Price are determined, Contractor shall submit documentation for inclusion in a Change Order.
4. Contractor's documentation shall include but not be limited to:
   a. Appropriately detailed records of Work performed to enable determination of value of the Work.
   b. Full information required to substantiate resulting change in Contract Times and Contract Price for Work. On request of Engineer, provide additional data necessary to support documentation.
   c. Support data for Work performed on a unit price or Cost of the Work basis with additional information such as:
      1) Dates Work was performed, and by whom.
      2) Time records, wage rates paid, and equipment rental rates.
      3) Invoices and receipts for materials, equipment, and subcontracts, all similarly documented.

B. Effective Date of Work Change Directive: Date of signature by Owner, unless otherwise indicated thereon.

1.04 CHANGE ORDERS

A. Procedure:

1. Engineer will prepare six copies of proposed Change Order and transmit such with Engineer's written recommendation and request to Contractor for signature.
2. Contractor shall, upon receipt, either: (i) promptly sign copies, retaining one for its file, and return remaining five copies to Engineer for Owner's signature, or (ii) return unsigned five copies with written justification for not executing Change Order.
3. Engineer will, upon receipt of Contractor signed copies, promptly forward Engineer's written recommendation and partially executed five copies for Owner's signature, or if Contractor fails to execute the Change Order, Engineer will promptly so notify Owner and transmit Contractor's justification to Owner.

4. Upon receipt of Contractor-executed Change Order, Owner will promptly either:
   a. Execute Change Order, retaining one copy for its file and returning four copies to Engineer; or
   b. Return to Engineer unsigned copies with written justification for not executing Change Order.
5. Upon receipt of Owner-executed Change Order, Engineer will transmit two copies to Contractor, one copy to Resident Project Representative or other field representative, and retain one copy, or if Owner fails to execute the Change Order, Engineer will promptly so notify Contractor and transmit Owner's justification to Contractor.
6. Upon receipt of Owner-executed Change Order, Contractor shall:
   a. Perform Work covered by Change Order.
   b. Revise Schedule of Values to adjust Contract Price and submit with next Application for Payment.
   c. Revise Progress Schedule to reflect changes in Contract Times, if any, and to adjust times for other items of Work affected by change.
   d. Enter changes in Project record documents after completion of change related Work.

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

1. Stipulated compensation (Contract Price or Contract Times, or both) set forth includes payment for (i) the Cost of the Work covered by the Change Order, (ii) Contractor's fee for overhead and profit, (iii) interruption of Progress Schedule, (iv) delay and impact, including cumulative impact, on other Work under the Contract Documents, and (v) extended overheads.
2. Change Order constitutes full mutual accord and satisfaction for the change to the Work.
3. Unless otherwise stated in the Change Order, all requirements of the original Contract Documents apply to the Work covered by the Change Order.

1.05 COST OF THE WORK

A. In determining the supplemental costs allowed in paragraph 13.01.B.5 of the General Conditions for rental equipment and machinery, the following will apply.

B. Rental of construction equipment and machinery and the parts thereof having a replacement value in excess of $1,000, whether owned by Contractor or rented or leased from others, shall meet the following requirements:

1. Full rental costs for leased equipment shall not exceed rates listed in the Rental Rate Blue Book published by Equipment Watch, as adjusted to the regional area of the Project. Owned equipment costs shall not exceed the single shift rates established in the Cost Reference Guide (CRG) published by Equipment Watch. The most recent published edition in effect at commencement of actual equipment use shall be used.

2. Rates shall apply to equipment in good working condition. Equipment not in good condition, or larger than required, may be rejected by Engineer or accepted at reduced rates.
3. Leased Equipment: For equipment leased or rented in arm's length transactions from outside vendors, maximum rates shall be determined by the following actual usage/Payment Category:
   a. Less than 8 hours: Hourly rate.
   b. 8 or more hours but less than 7 days: Daily rate.
   c. 7 or more days but less than 30 days: Weekly rate.
   d. 30 days or more: Monthly rate.
4. Arm's length rental and lease transactions are those in which the firm involved in the rental or lease of equipment is not associated with, owned by, have common management, directorship, facilities and/or stockholders with the firm renting the equipment.
5. Financial arrangements associated with rental and lease transactions that provide Contractor remuneration or discounts not visible to the Owner must be disclosed and integrated with charged rates.
6. Leased Equipment in Use: Actual equipment use time documented by Engineer shall be the basis that equipment was on and utilized at the Project Site. In addition to the leasing rate above, equipment operational costs shall be paid at the estimated hourly operating cost rate set forth in the Rental Rate Blue Book if not already included in the lease rate. Hours of operation shall be based upon actual equipment usage to the nearest quarter hour, as recorded by Engineer.
7. Leased Equipment, When Idle (Standby): Idle or standby equipment is equipment onsite or in transit to and from the Work Site and necessary to perform the Work under the modification, but not in actual use. Idle equipment time, as documented by Engineer, shall be paid at the leasing rate determined above, excluding operational costs.
8. Owned and Other Equipment in Use: Equipment rates for owned equipment or equipment provided in other than arm's length transaction shall not exceed the single shift total hourly costs rate developed in accordance with the CRG and as modified herein for multiple shifts. This total hourly rate will be paid for each hour the equipment actually performs work. Hours of operation shall be based upon actual equipment usage as recorded by Engineer. This rate shall represent payment in full for Contractor's direct costs.
9. Owned and Other Equipment, When Idle (Standby): Equipment necessary to be onsite to perform the Work on single shift operations, but not utilized, shall be paid for at the ownership hourly expense rate developed in accordance with the CRG, provided its presence and necessity onsite has been documented by Engineer. Payment for idle time of portions of a normal workday, in conjunction with original contract Work, will not be allowed. In no event shall idle time claimed in a day for a particular piece of equipment exceed the normal Work or shift schedule established for the Project. It is agreed that this rate shall represent payment in full for Contractor's direct costs. When Engineer determines that the equipment is not needed to continuously remain at the Work Site, payment will be limited to actual hours in use.

10. Owned and Other Equipment, Multiple Shifts: For multiple shift operations, the CRG single shift total hourly costs rate shall apply to the operating equipment during the first shift. For subsequent shifts, up to two in a 24-hour day, operating rate shall be the sum of the total hourly CRG operating cost and 60 percent of the CRG ownership and overhaul expense. Payment for idle or standby time for second and third shifts shall be 20 percent of the CRG ownership and overhaul expense.
11. When necessary to obtain owned equipment from sources beyond the Project limits, the actual cost to transfer equipment to the Site and return it to its original location will be allowed as an additional item of expense. Move-in and move-out allowances will not be made for equipment brought to the Project if the equipment is also used on original Contract or related Work.
12. If the move-out destination is not to the original location, payment for move-out will not exceed payment for move-in.
13. If move is made by common carrier, the allowance will be the amount paid for the freight. If equipment is hauled with Contractor's own forces, rental will be allowed for the hauling unit plus the hauling unit operator's wage. If equipment is transferred under its own power, the rental will be 75 percent of the appropriate total hourly costs for the equipment, without attachments, plus the equipment operator's wage.
14. Charges for time utilized in servicing equipment to ready it for use prior to moving and similar charges will not be allowed.
15. When a breakdown occurs on any piece of owned equipment, payment shall cease for that equipment and any other owned equipment idled by the breakdown.
16. If any part of the Work is shut down by Owner, standby time will be paid during nonoperating hours if diversion of equipment to other Work is not practicable. Engineer reserves the right to cease standby time payment when an extended shutdown is anticipated.
17. If a rate has not been established in the CRG for owned equipment, Contractor may:
    a. If approved by Engineer, use the rate of the most similar model found, considering such characteristics as manufacturer, capacity, horsepower, age, and fuel type, or
    b. Request Equipment Watch to furnish a written response for a rate on the equipment, which shall be presented to Engineer for approval; or
    c. Request Engineer to establish a rate.

1.06 FIELD ORDER

A. Engineer will issue Field Orders, with three copies to Contractor.

B. Effective date of the Field Order shall be the date of signature by Engineer, unless otherwise indicated thereon.

C. Contractor shall acknowledge receipt by signing and returning one copy to Engineer.

D. Field Orders will be incorporated into subsequent Change Orders, as a no-cost change to the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Schedule of Values: Submit on Contractor's standard form.
2. Schedule of Estimated Progress Payments:
   a. Submit with initially acceptable Schedule of Values.
   b. Submit adjustments thereto with Application for Payment.
3. Application for Payment.
4. Final Application for Payment.

1.02 SCHEDULE OF VALUES

A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement.

B. Upon request of Engineer, provide documentation to support the accuracy of the Schedule of Values.

C. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.

D. Lump Sum Work:

1. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and contract closeout separately.
   a. Mobilization includes, at minimum, items identified in Section 01 50 00, Temporary Facilities and Controls.
   b. Include item(s) for monthly progress schedule update
2. Break down by Division 02 through 49 with appropriate subdivision of each specification for each Project facility.

E. An unbalanced or front-end loaded schedule will not be acceptable.

F. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.

G. Submit Schedule of Values on a CD in a spreadsheet format compatible with latest version of MSExcel.

1.03 SCHEDULE OF ESTIMATED PROGRESS PAYMENTS

A. Show estimated payment requests throughout Contract Times aggregating initial Contract Price.

B. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

1.04 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.

B. Use detailed Application for Payment Form suitable to Owner.

C. Provide separate form for each schedule as applicable.

D. Include accepted Schedule of Values for each schedule or portion of lump sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.

E. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.

F. Preparation:

1. Round values to nearest dollar.
2. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Engineer.

1.05 PAYMENT

A. Payment for all Lump Sum Work shown or specified in Contract Documents is included in the Contract Price. Payment will be based on a percentage complete basis for each line item of the accepted Schedule of Values.

B. Payment for Lump Sum Work covers all Work specified or shown within the limits or Specification sections.

1.06 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Defective Work not accepted by Owner.
6. Material remaining on hand after completion of Work.

1.07 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and preliminary operation and maintenance data is acceptable to Engineer.

B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational:

1. Statement of Qualification (SOQ) for land surveyor or civil engineer.
2. Photographs:
   a. Digital Images: Submit two copies of DVD disc containing images within 5 days of being taken. Each image is to have a minimum file size of 1.4 Mb (1,400 Kb) so viewed resolution is high quality. The production of larger file sizes with higher resolution is encouraged.
3. Video Recordings: Submit two copies within 5 days of being taken.

1.02 RELATED WORK AT SITE

A. General:

1. Other work that is either directly or indirectly related to scheduled performance of the Work under these Contract Documents, listed henceforth, is anticipated to be performed at Site by others.
2. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.
3. Include sequencing constraints specified herein as a part of Progress Schedule.

1.03 UTILITY NOTIFICATION AND COORDINATION

A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.

1.04 PROJECT MILESTONES

A. General: Include the Milestones specified herein as a part of the Progress Schedule required under Section 01 32 00, Construction Progress Documentation.

1.05 WORK SEQUENCING/CONSTRAINTS

A. Include the following work sequences in the Progress Schedule:

1. Continuous unobstructed operation of the Crestview WWTP is required. This may require the addition of temporary bypass pumping of process flows and sewer flows as specified in Section 01 57 28, Temporary Flow Control.
2. Provide temporary plugs or caps on interconnecting piping as needed to maintain the indicated existing facilities in service and to preclude the entry of wastewater or process flow into the new facilities prior to their acceptance.

1.06 FACILITY OPERATIONS

A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.

B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner's operations.

C. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner's facility.

D. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.

E. Process or Facility Shutdown:

1. The existing and/or proposed facilities may only be shut down after approval installation and activation of bypass pumping facilities such that normal flow is maintained into and through the Crestview WWTP.
2. Provide 7 days advance written request for approval of need to shut down a process or facility to Owner and Engineer.
3. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.

F. Install and maintain bypass facilities and temporary connections required to keep Owner's operations on line. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.

G. Do not proceed with Work affecting a facility's operation without obtaining Owner's and Engineer's advance approval of the need for and duration of such Work.

H. Relocation of Existing Facilities:

1. During construction, it is expected that minor relocations of Work will be necessary.
2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.07 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs and Article Audio Video Recordings**.**
2. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.08 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
2. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.
3. Digital Images: No post-session electronic editing of images is allowed. Stored image shall be actual image as captured without cropping or other edits.

B. Preconstruction and Post-Construction:

1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take a minimum of 48 photographs of Site and property adjacent to perimeter of Site.
2. Particular emphasis shall be directed to structures both inside and outside the Site.
3. Format: Digital, minimum resolution of 1680 by 2240 pixels and 24-bit, millions of color.

C. Construction Progress Photos:

1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
2. Weekly: Take 48 photographs using digital, minimum resolution of 1680 by 2240 pixels and 24-bit, millions of color.
3. Monthly: Take 50 photographs using digital, minimum resolution of 1680 by 2240 pixels and 24-bit, millions of color.

D. Documentation:

1. Digital Images:
   a. Electronic image shall have date taken embedded into image.
   b. Archive using a commercially available photo management system that provides listing of photographs including date, keyword description, and direction of photograph.
   c. Label each disk with Project and Owner’s name, and month and year images were produced.

1.09 AUDIO-VIDEO RECORDINGS

A. Prior to beginning the Work on Site or of a particular area of the Work, and again within 10 days following date of Substantial Completion, videograph Site and property adjacent to Site.

B. In the case of preconstruction recording, no work shall begin in the area prior to Engineer's review and approval of content and quality of video for that area.

C. Particular emphasis shall be directed to physical condition of existing vegetation, structures, and pavements within and areas adjacent to and within the right-of-way or easement, and on Contractor storage and staging areas.

D. Engineer shall have right to select subject matter and vantage point from which videos are to be taken.

E. Video Format and Quality:

1. DVD format, with sound.
2. Video:
    a. Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections.
    b. Electronically, and accurately display the month, day, year, and time of day of the recording.
3. Audio:
    a. Audio documentation shall be done clearly, precisely, and at a moderate pace.
    b. Indicate date, project name, and a brief description of the location of recording, including:
        1) Facility name.
        2) Street names or easements.
        3) Addresses of private property.
        4) Direction of coverage, including engineering stationing, if applicable.

F. Documentation:

1. DVD Label:
    a. DVD number (numbered sequentially, beginning with 001).
    b. Project name.
    c. Date and time of coverage.
2. Project Video Log: Maintain an ongoing log that incorporates above noted label information for DVDs on Project.

1.10 REFERENCE POINTS AND SURVEYS

A. Location and elevation of bench marks are shown on Drawings.

B. Contractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Notify Engineer at least 3 working days in advance of time when grade and line to be provided by Owner will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
5. Retain professional land surveyor or civil engineer registered in state of Florida who shall perform or supervise engineering surveying necessary for additional construction staking and layout.
6. Maintain complete accurate log of survey work as it progresses as a Record Document.
7. On request of Engineer, submit documentation.
8. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to check layout, survey, and measurement work performed by others.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SALVAGE OF MATERIALS

A. Salvage materials for Owner's use as directed by the Owner. Before removing or demolishing existing fencing, gates, lighting, valves, or other materials deemed salvageable, request Owner's direction whether they desire such materials to be salvaged.

1. Remove material with care so as not to damage for future use.
2. Store materials where instructed by Owner onsite.

3.02 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of Engineer and Owner before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
2. Weather-resistant or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Refinish entire assemblies.
3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.

D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on Drawings.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

A. Engineer will schedule physical arrangements for meetings throughout progress of the Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

A. Contractor shall be prepared to discuss the following subjects, as a minimum:

1. Required schedules.
2. Status of Bonds and insurance.
3. Sequencing of critical path work items.
4. Progress payment procedures.
5. Project changes and clarification procedures.
6. Use of Site, access, office and storage areas, security and temporary facilities.
7. Major product delivery and priorities.
8. Contractor’s safety plan and representative.

B. Attendees will include:

1. Owner’s representatives.
2. Contractor’s office representative.
3. Contractor’s resident superintendent.
4. Contractor’s quality control representative.
5. Subcontractors’ representatives whom Contractor may desire or Engineer may request to attend.
6. Engineer’s representatives.
7. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 00, Construction Progress Documentation.

1.04 PROGRESS MEETINGS

A. Engineer will schedule regular progress meetings at Site, conducted monthly to review the Work progress, Progress Schedule, Schedule of Submittals, Application for Payment, contract modifications, and other matters needing discussion and resolution.

B. Attendees will include:

1. Owner's representative(s), as appropriate.
2. Contractor, Subcontractors, and Suppliers, as appropriate.
3. Engineer's representative(s).
4. Others as appropriate.

1.05 QUALITY CONTROL MEETINGS

A. In accordance with Section 01 45 16.13, Contractor Quality Control.

B. Scheduled by Engineer on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of the Work and work of other Contractors.

C. Attendees will include:

1. Contractor.
2. Contractor's designated quality control representative.
3. Subcontractors and Suppliers, as necessary.
4. Engineer's representatives.

1.06 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) COORDINATION MEETINGS

A. Engineer will schedule up to four meetings at Site, conducted to review specific requirements of PICS work.

B. Attendees will include:

1. Contractor.
2. Owner.
3. PICS Subcontractor/Installer.
4. Engineer's representatives.

1.07 PREINSTALLATION MEETINGS

A. When required in individual Specification sections, convene at Site prior to commencing the Work of that section.

B. Require attendance of entities directly affecting, or affected by, the Work of that section.

C. Notify Engineer 4 days in advance of meeting date.

D. Provide suggested agenda to Engineer to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

1.08 FACILITY STARTUP MEETINGS

A. Schedule and attend a minimum of three facility startup meetings. The first of such meetings shall be held prior to submitting Facility Startup Plan, as specified in Section 01 91 14, Equipment Testing and Facility Startup, and shall include preliminary discussions regarding such plan.

B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.

C. Attendees will include:

1. Contractor.
2. Contractor's designated quality control representative.
3. Subcontractors and equipment manufacturer's representatives whom Contractor deems to be directly involved in facility startup.
4. Engineer's representatives.
5. Owner's operations personnel.
6. Others as required by Contract Documents or as deemed necessary by Contractor.

1.09 OTHER MEETINGS

A. In accordance with Contract Documents and as may be required by Owner and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Preliminary Progress Schedule: Submit at least 7 days prior to preconstruction conference.
2. Detailed Progress Schedule:
   a. Submit initial Detailed Progress Schedule within 90 days after Effective Date of the Agreement.
   b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
3. Submit with Each Progress Schedule Submission:
   a. Contractor's certification that Progress Schedule submission is actual schedule being used for execution of the Work.
   b. Electronic file compatible with latest version of Microsoft Project, unless otherwise approved by Engineer.
   c. Progress Schedule: Four legible copies.
   d. Narrative Progress Report: Same number of copies as specified for Progress Schedule.

1.02 PRELIMINARY PROGRESS SCHEDULE

A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 90 days, and a summary of balance of Project through Final Completion.

B. Show activities including, but not limited to the following:

1. Notice to Proceed.
2. Permits.
3. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
4. Early procurement activities for long lead equipment and materials.
5. Initial Site work.
6. Earthwork.
7. Specified Work sequences and construction constraints.
8. Contract Milestone and Completion Dates.
9. Owner-furnished products delivery dates or ranges of dates.
10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.

11. System startup summary.
12. Project close-out summary.
13. Demobilization summary.

C. Update Preliminary Progress Schedule monthly as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.

D. Format: In accordance with Article Progress Schedule—Bar Chart.

1.03 DETAILED PROGRESS SCHEDULE

A. In addition to requirements of General Conditions, submit Detailed Progress Schedule beginning with Notice to Proceed and continuing through Final Completion.

B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.

C. When accepted by Engineer, Detailed Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.

D. Format: In accordance with Article Progress Schedule—Bar Chart.

1.04 PROGRESS SCHEDULE—BAR CHART

A. General: Comprehensive bar chart schedule, generally as outlined in Associated General Contractors of America (AGC) 580, “Construction Project Planning and Scheduling Guidelines.” If a conflict occurs between the AGC publication and this specification, this specification shall govern.

B. Format:

1. Unless otherwise approved, white paper, 11-inch by 17-inch sheet size.
2. Title Block: Show name of Project and Owner, date submitted, revision or update number, and name of scheduler.
3. Identify horizontally, across the top of the schedule, the time frame by year, month, and day.
4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
5. Legend: Describe standard and special symbols used.

C. Contents: Identify, in chronological order, those activities reasonably required to complete the Work, including as applicable, but not limited to:

1. Obtaining permits, submittals for early product procurement, and long lead time items.
2. Mobilization and other preliminary activities.
3. Initial Site work.
4. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s).
5. Subcontract Work.
6. Major equipment design, fabrication, factory testing, and delivery dates.
7. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, Summary of Work.
8. Sitework.
9. Concrete Work.
10. Structural steel Work.
11. Architectural features Work.
12. Conveying systems Work.
13. Equipment Work.
14. Mechanical Work.
15. Electrical Work.
16. Instrumentation and control Work.
17. Interfaces with Owner-furnished equipment.
18. Other important Work for each major facility.
19. Equipment and system startup and test activities.
20. Project closeout and cleanup.
21. Demobilization.

1.05 PROGRESS OF THE WORK

A. Updated Progress Schedule shall reflect:

1. Progress of Work to within 5 working days prior to submission.
2. Approved changes in Work scope and activities modified since submission.
3. Delays in Submittals or resubmittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.
7. Report of changed logic.

B. Produce detailed sub-schedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

C. If an activity is not completed by its latest scheduled completion date and this failure is anticipated to extend Contract Times (or Milestones), submit, within 7 days of such failure, a written statement as to how nonperformance will be corrected to return Project to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.

D. Owner may order Contractor to increase plant, equipment, labor force, or working hours if Contractor fails to:

1. Complete a Milestone activity by its completion date.
2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

1.06 SCHEDULE ACCEPTANCE

A. Engineer's acceptance will demonstrate agreement that:

1. Proposed schedule is accepted with respect to:
   a. Contract Times, including Final Completion and all intermediate Milestones, are within the specified times.
   b. Specified Work sequences and constraints are shown as specified.
   c. Specified Owner-furnished Equipment or Material arrival dates, or range of dates, are included.
   d. Access restrictions are accurately reflected.
   e. Startup and testing times are as specified.
   f. Submittal review times are as specified.
   g. Startup testing duration is as specified and timing is acceptable.
2. In all other respects, Engineer's acceptance of Contractor's schedule indicates that, in Engineer's judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

B. Unacceptable Preliminary Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, including updating schedule on a monthly basis to reflect actual progress and occurrences to date.

C. Unacceptable Detailed Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.

D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer's acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

1.07 ADJUSTMENT OF CONTRACT TIMES

A. Reference General Conditions and Section 01 26 00, Contract Modification Procedures.

B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.

C. Schedule Contingency:

1. Contingency, when used in the context of the Progress Schedule, is time between Contractor's proposed Completion Time and Contract Completion Time.
2. Contingency included in Progress Schedule is a Project resource available to both Contractor and Owner to meet Contract Milestones and Contract Times. Use of Schedule contingency shall be shared to the proportionate benefit of both parties.
3. Use of schedule contingency suppression techniques such as preferential sequencing and extended activity times is prohibited.
4. Pursuant to Contingency sharing provisions of this specification, no time extensions will be granted, nor will delay damages be paid until a delay occurs which (i) consumes all available contingency time, and (ii) extends Work beyond the Contract Completion date.

D. Claims Based on Contract Times:

1. Where Engineer has not yet rendered formal decision on Contractor's Claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, reflect an interim adjustment in the Progress Schedule as acceptable to Engineer.
2. It is understood and agreed that such interim acceptance will not be binding on either Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.
3. Revise Progress Schedule prepared thereafter in accordance with Engineer's formal decision.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval.

B. Deferred Submittal: Information submitted by Contractor for portions of design that are to be submitted to permitting agency for approval prior to installation of that portion of the Work, along with Engineer's review documentation that submittal has been found to be in general conformance with Project's design.

C. Informational Submittal: Information submitted by Contractor that requires Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract.

1.02 PROCEDURES

A. Direct submittals to Engineer at the following, unless specified otherwise.

1. To be determined at the preconstruction conference.

B. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format.

1. Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.
2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
3. PDF files shall be set to open "Bookmarks and Page" view.
4. Add general information to each PDF file, including title, subject, author, and keywords.
5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
6. Submit new electronic files for each resubmittal.
7. Include a copy of the Transmittal of Contractor's Submittal form, located at end of section, with each electronic file.

8. Engineer will reject submittal that is not electronically submitted, unless specifically accepted.
9. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
10. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

C. Transmittal of Submittal:

1. Contractor shall:
   a. Review each submittal and check for compliance with Contract Documents.
   b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
      1) Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
      2) Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form attached at end of this section.
3. Identify each submittal with the following:
   a. Numbering and Tracking System:
      1) Sequentially number each submittal.
      2) Resubmission of submittal shall have original number with sequential alphabetic suffix.
   b. Specification section and paragraph to which submittal applies.
   c. Project title and Engineer's project number.
   d. Date of transmittal.
   e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
4. Identify and describe each deviation or variation from Contract Documents.

D. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual Specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in Specification.

3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
4. Index with labeled tab dividers in orderly manner.

E. Timeliness: Schedule and submit in accordance Schedule of Submittals and requirements of individual Specification sections.

F. Processing Time:

1. Time for review shall commence on Engineer's receipt of submittal.
2. Engineer will act upon Contractor's submittal and transmit response to Contractor not later than 30 days after receipt, unless otherwise specified. For submittals in excess of 50 pages, Engineer's response will be within 45 days after receipt.
3. Resubmittals will be subject to same review time.
4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.

G. Resubmittals: Clearly identify each correction or change made.

H. Incomplete Submittals:

1. Engineer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
2. When any of the following are missing, submittal will be deemed incomplete:
    a. Contractor's review stamp; completed and signed.
    b. Transmittal of Contractor's Submittal; completed and signed.
    c. Clear evidence that the Contractor has performed the required review.
    d. Substantive components of a submittal.

I. Submittals not required by Contract Documents:

1. Will not be reviewed and will be returned stamped "Not Subject to Review".
2. Engineer will keep one copy and return submittal to Contractor.

1.03 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings:

1. Identify and Indicate:
   a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
   b. Equipment and Component Title: Identical to title shown on Drawings.
   c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
   d. Project-specific information drawn accurately to scale.
2. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.
3. Product Data: Provide as specified in individual Specifications.
4. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

C. Samples:

1. Copies: Two, unless otherwise specified in individual Specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
   a. Manufacturer name.
   b. Model number.
   c. Material.
   d. Sample source.
3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
4. Full-size Samples:
   a. Size as indicated in individual Specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

D. Action Submittal Dispositions: Engineer will review, comment, stamp, and distribute as noted:

1. Approved:
   a. Contractor may incorporate product(s) or implement Work covered by submittal.

b. Distribution: Electronic.

2. Approved as Noted:
   a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
   b. Distribution: Electronic.
3. Partial Approval, Resubmit as Noted:
   a. Make corrections or obtain missing portions, and resubmit.
   b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
   c. Distribution: Electronic.
4. Revise and Resubmit:
   a. Contractor may not incorporate product(s) or implement Work covered by submittal.
   b. Distribution: Electronic.

E. Back charges for Review of Resubmittals: Where a resubmittal is returned as "Partially Approved, Resubmit as Noted" or "Revise and Resubmit", Contractor shall be subject to charges from the Owner for reimbursement of Engineer's charges associated with review of the 2nd and subsequent resubmittals at a cost of $250 each for submittal of less than 30 pages or 10 Drawings, and $500 for any larger submittals.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Copies: Submit three copies, unless otherwise indicated in individual Specification section.
2. Refer to individual Specification sections for specific submittal requirements.
3. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward copy to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will retain one copy and return remaining copy with review comments to Contractor, and require that submittal be corrected and resubmitted.

B. Certificates:

1. General:
   a. Provide notarized statement that includes signature of entity responsible for preparing certification.
   b. Signed by officer or other individual authorized to sign documents on behalf of that entity.

2. Welding: In accordance with individual Specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual Specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual Specification sections.
6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.
7. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers' Field Services.

C. Construction Photographs Video: In accordance with Section 01 31 13, Project Coordination, and as may otherwise be required in Contract Documents.

D. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.

E. Contractor-design Data (related to temporary construction):

1. Written and graphic information.
2. List of assumptions.
3. List of performance and design criteria.
4. Summary of loads or load diagram, if applicable.
5. Calculations.
6. List of applicable codes and regulations.
7. Name and version of software.
8. Information requested in individual Specification section.

F. Deferred Submittals: See Drawings for list of deferred submittals.

1. Contractor-design data related to permanent construction:
    a. List of assumptions.
    b. List of performance and design criteria.
    c. Summary of loads or load diagram, if applicable.
    d. Calculations.
    e. List of applicable codes and regulations.
    f. Name and version of design software.
    g. Factory test results.
    h. Informational submittals requested in individual Specification section.

2. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit calculations and test results of Contractor-designed components for review by Engineer.

G. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual Specification section.

H. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.

I. Payment:

1. Application for Payment: In accordance with Section 01 29 00, Payment Procedures.
2. Schedule of Values: In accordance with Section 01 29 00, Payment Procedures.
3. Schedule of Estimated Progress Payments: In accordance with Section 01 29 00, Payment Procedures.

J. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.

K. Schedules:

1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00, Construction Progress Documentation.
   a. Show for each, at a minimum, the following:
      1) Specification section number.
      2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
      3) Estimated date of submission to Engineer, including reviewing and processing time.
   b. On a monthly basis, submit updated Schedule of Submittals to Engineer if changes have occurred or resubmittals are required.
2. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.

L. Special Guarantee: Supplier's written guarantee as required in individual Specification sections.

M. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.

N. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Promptly submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to Engineer for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.

O. Test, Evaluation, and Inspection Reports:

1. General: Shall contain signature of person responsible for test or report.
2. Factory:
    a. Identification of product and Specification section, type of inspection or test with referenced standard or code.
    b. Date of test, Project title and number, and name and signature of authorized person.
    c. Test results.
    d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
    e. Provide interpretation of test results, when requested by Engineer.
    f. Other items as identified in individual Specification sections.
3. Field:
    a. As a minimum, include the following:
        1) Project title and number.
        2) Date and time.
        3) Record of temperature and weather conditions.
        4) Identification of product and Specification section.
        5) Type and location of test, Sample, or inspection, including referenced standard or code.
        6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
        7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
        8) Provide interpretation of test results, when requested by Engineer.
        9) Other items as identified in individual Specification sections.

P. Testing and Startup Data: In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

Q. Training Data: In accordance with Section 01 43 33, Manufacturers' Field Services.

1.05 SUPPLEMENTS

A. The supplement listed below, following "End of Section", is part of this specification.

1. Form: Transmittal of Contractor's Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

JACOBS

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO: _____ _____ _____ _____ _____ **FROM**: _____ Contractor _____ _____ _____	Submittal No.: _____ ☐ New Submittal ☐ Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ **(Cover only one section with each transmittal)** Schedule Date of Submittal: _____

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational
	☐ Deferred		

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: _____

Contractor (Authorized Signature)

SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual Specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor’s personnel, Subcontractors, Owner, and Engineer.

1.02 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association
34.	BHMA	Builders Hardware Manufacturers' Association

35.	CBM	Certified Ballast Manufacturer
36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America
40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	EIA	Electronic Industries Alliance
47.	EJCDC	Engineers Joint Contract Documents' Committee
48.	ETL	Electrical Test Laboratories
49.	FAA	Federal Aviation Administration
50.	FCC	Federal Communications Commission
51.	FDA	Food and Drug Administration
52.	FEMA	Federal Emergency Management Agency
53.	FIPS	Federal Information Processing Standards
54.	FM	FM Global
55.	Fed. Spec.	Federal Specifications (FAA Specifications)
56.	FS	Federal Specifications and Standards (Technical Specifications)
57.	GA	Gypsum Association
58.	GANA	Glass Association of North America
59.	HI	Hydraulic Institute
60.	HMI	Hoist Manufacturers' Institute
61.	IBC	International Building Code
62.	ICBO	International Conference of Building Officials
63.	ICC	International Code Council
64.	ICEA	Insulated Cable Engineers' Association
65.	IFC	International Fire Code
66.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
67.	IESNA	Illuminating Engineering Society of North America
68.	IFI	Industrial Fasteners Institute
69.	IGMA	Insulating Glass Manufacturer's Alliance
70.	IMC	International Mechanical Code
71.	INDA	Association of the Nonwoven Fabrics Industry
72.	IPC	International Plumbing Code
73.	ISA	International Society of Automation
74.	ISO	International Organization for Standardization
75.	ITL	Independent Testing Laboratory

76.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
77.	MIA	Marble Institute of America
78.	MIL	Military Specifications
79.	MMA	Monorail Manufacturers' Association
80.	MSS	Manufacturer's Standardization Society
81.	NAAMM	National Association of Architectural Metal Manufacturers
82.	NACE	NACE International
83.	NBGQA	National Building Granite Quarries Association
84.	NEBB	National Environmental Balancing Bureau
85.	NEC	National Electrical Code
86.	NECA	National Electrical Contractor's Association
87.	NEMA	National Electrical Manufacturers' Association
88.	NESC	National Electrical Safety Code
89.	NETA	InterNational Electrical Testing Association
90.	NFPA	National Fire Protection Association
91.	NHLA	National Hardwood Lumber Association
92.	NICET	National Institute for Certification in Engineering Technologies
93.	NIST	National Institute of Standards and Technology
94.	NRCA	National Roofing Contractors Association
95.	NRTL	Nationally Recognized Testing Laboratories
96.	NSF	NSF International
97.	NSPE	National Society of Professional Engineers
98.	NTMA	National Terrazzo and Mosaic Association
99.	NWWDA	National Wood Window and Door Association
100.	OSHA	Occupational Safety and Health Act (both Federal and State)
101.	PCI	Precast/Prestressed Concrete Institute
102.	PEI	Porcelain Enamel Institute
103.	PPI	Plastic Pipe Institute
104.	PS	Product Standards Section-U.S. Department of Commerce
105.	RMA	Rubber Manufacturers' Association
106.	RUS	Rural Utilities Service
107.	SAE	SAE International
108.	SDI	Steel Deck Institute
109.	SDI	Steel Door Institute
110.	SJI	Steel Joist Institute
111.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
112.	SPI	Society of the Plastics Industry
113.	SSPC	The Society for Protective Coatings

114.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
115.	SWI	Steel Window Institute
116.	TEMA	Tubular Exchanger Manufacturers' Association
117.	TCA	Tile Council of North America
118.	TIA	Telecommunications Industry Association
119.	UBC	Uniform Building Code
120.	UFC	Uniform Fire Code
121.	UL	formerly Underwriters Laboratories Inc.
122.	UMC	Uniform Mechanical Code
123.	USBR	U.S. Bureau of Reclamation
124.	WCLIB	West Coast Lumber Inspection Bureau
125.	WI	Wood Institute
126.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02 SUBMITTALS

A. Informational Submittals:

1. Training Schedule: Submit, in accordance with requirements of this Specification, not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual Specification section.

B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services, when required by an individual Specification section, to meet the requirements of this section.

B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.

C. Schedule manufacturer' services to avoid conflict with other onsite testing or other manufacturers' onsite services.

D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.

E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.

F. When specified in individual Specification sections, manufacturer's onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Providing, on a daily basis, copies of manufacturers' representatives field notes and data to Engineer.
4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
6. Assistance during functional and performance testing, and facility startup and evaluation.
7. Training of Owner's personnel in the operation and maintenance of respective product as required.

3.02 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.

B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

3.03 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.

2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01 32 00, Construction Progress Documentation, and Section 01 91 14, Equipment Testing and Facility Startup.

C. Prestartup Training:

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
2. Complete at least 14 days prior to beginning of facility startup.

D. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is part of this specification.

1. Manufacturer's Certificate of Proper Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

SECTION 01 45 16.13
CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.02 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.03 SUBMITTALS

A. Informational Submittals:

1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
2. CQC Report: Submit, weekly, an original and one copy in report form.

1.04 OWNER'S QUALITY ASSURANCE

A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:

1. Relieve Contractor of responsibility for providing adequate quality control measures;
2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance;
3. Constitute or imply acceptance; or
4. Affect the continuing rights of Owner after acceptance of the completed Work.

C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.

D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.

E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.

B. Maintain complete inspection records and make them available at all times to Owner and Engineer.

C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.

B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor’s management and control with the Owner’s Quality Assurance.

C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
2. CQC System Manager may perform other duties on the Project.
3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
4. CQC System Manager shall report to the Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
6. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.

B. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:

1. Preparatory Phase:
   a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
   b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
   c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
   d. Perform prior to beginning Work on each definable feature of Work:
      1) Review applicable Contract Specifications.
      2) Review applicable Contract Drawings.

3) Verify that all materials and/or equipment have been tested, submitted, and approved.
4) Verify that provisions have been made to provide required control inspection and testing.
5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
7) Review the appropriate activity hazard analysis to verify safety requirements are met.
8) Review procedures for constructing the Work, including repetitive deficiencies.
9) Document construction tolerances and workmanship standards for that phase of the Work.
10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.

2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Owner at least 48 hours in advance of beginning the initial phase.
      2) Perform prior to beginning Work on each definable feature of Work:
         a) Review minutes of the preparatory meeting.
         b) Check preliminary Work to verify compliance with Contract requirements.
         c) Verify required control inspection and testing.
         d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
         e) Resolve all differences.
         f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
      3) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3. Follow-up Phase:
   a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
   b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
   c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
   a. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager,

including authority to stop Work which is not in compliance with the Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.

b. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.

c. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.

d. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.

e. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

f. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

A. As a minimum, prepare a CQC report for every 7 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.

B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.

C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:

1. Contractor/subcontractor and their areas of responsibility.
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability and storage.
6. Identify submittals reviewed, with Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. List instructions given/received and conflicts in Drawings and/or Specifications.
10. Contractor's verification statement.
11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
12. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

3.07 SUBMITTAL QUALITY CONTROL

A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Perform the following activities and record the following data:
   a. Verify testing procedures comply with contract requirements.

b. Verify facilities and testing equipment are available and comply with testing standards.
c. Check test instrument calibration data against certified standards.
d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
e. Documentation:
    1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
    2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
    3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
    4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
    5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

3.09 COMPLETION INSPECTION

A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.

B. Punchlist:

1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.

3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of Nurserymen (AAN): American Standards for Nursery Stock.
2. Federal Emergency Management Agency (FEMA).
3. National Fire Prevention Association (NFPA): 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
5. U.S. Department of Agriculture (USDA): Urban Hydrology for Small Watersheds.
6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.

1.02 SUBMITTALS

A. Informational Submittals:

1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
2. Temporary Construction Submittals:
   a. Parking area plans.
   b. Contractor’s field office, storage yard, and storage building plans, including gravel surfaced area.
   c. Fencing and protective barrier locations and details.
   d. Staging area location plan.
   e. Plan for maintenance of existing plant operations.

1.03 MOBILIZATION

A. Mobilization includes, but is not limited to, these principal items:

1. Obtaining required permits.
2. Moving Contractor’s field office and equipment required for first month operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.

4. Providing onsite Internet service to Contractor's field offices.
5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
6. Arranging for and erection of Contractor's work and storage yard.
7. Posting OSHA required notices and establishing safety programs and procedures.
8. Having Contractor's superintendent at Site full time.

B. Use area designated for Contractor's temporary facilities as shown on Drawings.

1.04 PROTECTION OF WORK AND PROPERTY

A. Comply with Owner's safety rules while on Owner's property.

B. Keep Owner informed of serious onsite accidents and related claims.

C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

PART 2 PRODUCTS

2.01 PROJECT SIGN

A. Provide and maintain one, 8-foot wide by 4-foot high sign constructed of 3/4-inch exterior high-density overlaid plywood. Sign shall bear name of Project, Owner, Contractor, Engineer, and other participating agencies. Lettering shall be blue applied on white background by an experienced sign painter. Include Owner's and agency's logos in full color. Provide exterior type enamel paint. Information to be included and logo graphic will be provided by Engineer.

2.02 CONTRACTORS FIELD OFFICE

A. Prefabricated or mobile units with serviceable finishes temperature controls, and foundations adequate for normal loading.

B. Provide on-site facilities for Contractor and subcontractors as appropriate to the stage and demands of the work.

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power:

1. Determine type and amount available and make arrangements for obtaining temporary electric power service, metering equipment, and pay all costs for electric power used during contract period, except portions of the Work designated in writing by Engineer as substantially complete. as needed.
2. Cost of electric power will be borne by Contractor.

B. Lighting: Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.

C. Water:

1. Contractor shall make temporary connections for construction water at Site at locations as coordinated with the Owner. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed notify fire department before obtaining water from fire hydrants.
2. Water as reasonably necessary for prosecution of the work shall be provided at no cost to Contractor. If, in the opinion of the Engineer the Contractor’s water use is excessive or wasteful, Engineer may require the Contractor to install an acceptable metering devise and pay for water used at Owner’s current rate.

D. Sanitary and Personnel Facilities:

1. Provide and maintain facilities for Contractor’s employees, Subcontractors, and other onsite employers’ employees. Service, clean, and maintain facilities and enclosures.
2. Use of Owner’s existing sanitary facilities by construction personnel will not be allowed.

E. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

3.02 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. No residence or business shall be cut off from vehicular traffic unless special arrangements have been made.
3. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made. See Section 01 31 13, Project Coordination for additional coordination requirements.
4. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform work to their satisfaction.
5. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
6. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
7. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
8. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
9. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
10. Maintain original Site drainage wherever possible.

B. Site Security: Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.

C. Trees and Plantings:

1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on Drawings to remain undisturbed.
    a. Where practical, tunnel beneath trees when on or near line of trench.
    b. Employ hand excavation as necessary to prevent tree injury.
    c. Do not stockpile materials within drip lines of trees.
    d. Provide and maintain temporary barricades around trees.
    e. Water vegetation as necessary to maintain health.
    f. Cover temporarily exposed roots with wet burlap, and keep burlap moist until soil is replaced around roots.
    g. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of Engineer.
    h. Dispose of removed trees in a legal manner off the Site.
2. Balling and burlapping of trees indicated for replacement shall conform to recommended specifications set forth in the American Standards for Nursery Stock, published by American Association of Nurserymen. Balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by ball and not by top.
3. In event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.
4. Replace each plant that dies as a result of construction activities.

D. Existing Structures:

1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor’s operations, obtain approval of property owner and Engineer.
2. Replace items removed in their original location and a condition equal to or better than original.

E. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

F. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

G. Archaeological Finds: Should finds of an archaeological or paleontological nature be made within Site limits, immediately notify Owner and Engineer and proceed in accordance with General Conditions. Continue the Work in other areas without interruption.

H. Endangered and Threatened Species:

1. Take precautions necessary and prudent to protect native endangered and threatened flora and fauna.
2. Notify Engineer of construction activities that might threaten endangered and threatened species or their habitats.
3. Engineer will mark areas known as habitats of endangered and threatened species prior to commencement of onsite activities.
4. Additional areas will be marked by Engineer as other habitats of endangered and threatened species become known during construction.

3.03 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

B. Noise Control:

1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
2. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:

1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Engineer's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewatering pump discharges.
3. Comply with Section 01 57 13, Temporary Erosion and Sedimentation Control, for stormwater flow and surface runoff.
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 13, Temporary Erosion and Sedimentation Control, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.04 STORAGE YARDS AND BUILDINGS

A. Coordinate requirements with Section 01 61 00, Common Product Requirements, Owner, and Engineer to establish Temporary Storage Area.

B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.

3.05 ACCESS ROADS

A. Construct access roads as shown and within easements, rights-of-way, or Project limits. Use existing roads where shown.

B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

C. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.

D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

E. Upon completion of construction, restore ground surface disturbed by access road construction to original grade.

3.06 PARKING AREAS

A. Contractor may park up to two vehicles at the construction trailer. All other vehicle parking shall be restricted to designated areas as coordinated with the Owner and Engineer.

B. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.

3.07 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Ensure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

D. Notify fire department and police department before closing street or portion thereof. Notify said departments when streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without written permission from fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish Contractor's night emergency telephone numbers to police department.

3.08 CLEANING DURING CONSTRUCTION

A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.

B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up and dispose of debris.

C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least weekly, dispose of such waste materials, debris, and rubbish offsite.

D. At least weekly, brush sweep entry drive, roadways, and other streets and walkways affected by the Work and where adjacent to the Work.

END OF SECTION

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section covers work necessary for stabilization of soil to prevent erosion during and after construction and land disturbing activities. The work shall include the furnishing of all labor, materials, tools, and equipment to perform the work and services necessary as herein specified and as indicated on the Drawings. This shall include installation, maintenance, and final removal of all temporary soil erosion and sediment control measures.

B. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. The right is reserved to modify the use, location, and quantities of soil erosion and sediment control measures based on activities of the Contractor and as the Engineer considers to be to the best interest of the Owner.

C. See additional information noted on the Drawings.

1.02 GENERAL

A. See Conditions of the Contract and Division 1, General Requirements, which contain information and requirements that apply to the Work specified herein and are mandatory for this project.

B. All activities shall conform to the National Pollutant Discharge Elimination System per Part IV, Chapter 373, Florida Statute, as administered by the Florida Department of Environmental Protection (FDEP). Best practices and erosion control measures shall conform to the Drawings and the Florida Stormwater Erosion and Sedimentation Control Inspector’s Manual, latest edition. In the event of a conflict, the more stringent requirement shall apply.

C. Contractor shall prepare and obtain approval for a Generic Permit for Stormwater Discharge from Large and Small Construction Activities (FDEP Document 62-621.300[4][a]). The Contractor shall prepare and submit the supporting Generic Permit documentation including a site specific Stormwater Pollution Prevent Plan, Notice of Intent (FDEP Form 62-621.300[4][b]), and processing fee.

D. Soil erosion stabilization and sedimentation control consist of the following elements:

1. Maintenance of existing permanent or temporary storm drainage piping and channel systems, as necessary.
2. Construction of new permanent and temporary storm drainage piping and channel systems, as necessary.
3. Construction of temporary erosion control facilities such as silt fences, check dams, etc.
4. Topsoil and Seeding:
    a. Placement and maintenance of Temporary Seeding on all areas disturbed by construction.
    b. Placement of permanent topsoil, fertilizer, and seed, etc., in all areas not occupied by structures or pavement, unless shown otherwise.
5. Soil Stabilization Seeding: Placement of fertilizer and seed, etc., in areas as specified hereinafter.

E. The Contractor shall be responsible for phasing Work in areas allocated for his exclusive use during this Project, including any proposed stockpile areas, to restrict sediment transport. This will include installation of any temporary erosion control devices, ditches, or other facilities.

F. The areas set aside for the Contractor's use during the Project may be temporarily developed to provide satisfactory working, staging, and administrative areas for his exclusive use. Preparation of these areas shall be in accordance with other requirements contained within these Specifications and shall be done in a manner to both control all sediment transport away from the area.

G. All permanent stockpiles shall be seeded with soil stabilization seed and protected by construction of silt fences.

H. Sediment transport and erosion from working stockpiles shall be controlled and restricted from moving beyond the immediate stockpile area by construction of temporary toe-of-slope ditches and accompanying silt fences, as necessary. The Contractor shall keep these temporary facilities in operational condition by regular cleaning, regrading, and maintenance. Stockpiles remaining in place longer than 14 calendar days shall be considered permanent stockpiles for purposes of erosion and sediment control.

I. The Contractor shall maintain all elements of the Soil Erosion Stabilization and Sedimentation Control systems and facilities to be constructed during this Project for the duration of his activities on this Project. Formal inspections made jointly by the Contractor and the Field Engineer shall be conducted every 2 weeks to evaluate the Contractor's conformance to the requirements of both these Specifications and FDEP Regulations.

J. All silt traps shall be cleaned of collected sediment after every storm or as determined from the biweekly inspections. Cleaning shall be done in a manner that will not direct the sediment into the storm drain piping system. Removed sediment shall be taken to an area selected by the Owner.

K. Replacement or repair of failed or overloaded silt fences, check dams, or other temporary erosion control devices shall be accomplished by the Contractor immediately upon discovery.

L. Unpaved earth drainage ditches shall be regraded as needed to maintain original grade and remove sediment buildup. If a ditch becomes difficult to maintain, the Contractor shall cooperate with the Engineer and install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by the Engineer.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures.

B. In addition, the Contractor shall provide the following specific information:

1. Certificates of inspection of seed by state or federal authorities and copies of delivery invoices or other proof of quantities of fertilizer.
2. Manufacturer’s certificate of compliance attesting that the geotextile meets the requirements of these Specifications.

PART 2 PRODUCTS

2.01 PERMANENT SEED

A. All permanent grass seed shall be in accordance with Section 32 92 00, Turf and Grasses. Permanent seeds shall be Bahia grass seed and have a minimum pure seed content of 95 percent with a minimum germination of 80 percent.

2.02 SOIL STABILIZATION AND TEMPORARY SEED

A. All temporary grass seed shall be in accordance with Section 32 92 00, Turf and Grasses. Temporary seed for erosion control shall be annual type ryegrass seed with a minimum pure seed content of 95 percent with a minimum germination of 95 percent.

2.03 FERTILIZER

A. Fertilizer shall be commercial, chemical type, uniform in composition, free-flowing, conforming to state and federal laws, and suitable for application with equipment designed for that purpose.

B. Fertilizer shall be as specified under Section 32 92 00, Turf and Grasses.

2.04 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds, or clean salt hay.

B. Straw mulch shall be as specified under Section 32 92 00, Turf and Grasses.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall install erosion and sediment control measures and maintain in accordance with the Drawings and in accordance with the Florida Stormwater Erosion and Sedimentation Control Inspector's Manual, latest edition.

B. The Contractor shall provide and maintain temporary seeding at all times.

3.02 SEEDING

A. General:

1. The Contractor shall give at least 3 days notice to the Engineer prior to seeding to allow the Owner to inspect the prepared areas. The Contractor shall rework any areas not approved for seeding to the Owner's satisfaction.
2. The Contractor shall keep the Engineer advised of schedule of operations.
3. Seeding application shall be as specified under Section 32 92 00, Turf and Grasses.

B. Soil Stabilization and Temporary Seeding:

1. Hydroseeding will be permitted as an alternative method of applying seed and associated soil conditioning agents described above. Should the Contractor elect to apply soil stabilization seeding by hydroseeding methods, he shall submit his operational plan and methods to the Engineer.

2. Temporary Seeding is to be placed and maintained over all disturbed areas prior to Permanent Seeding. Maintain Temporary Seeding until such time as areas are approved for Permanent Seeding. As a minimum, maintenance shall include the following:
   a. Fix-up and reseeding of bare areas or redisturbed areas.
   b. Mowing for stands of grass or weeds exceeding 6 inches in height.

C. Topsoil and Permanent Seeding:

1. Topsoil is to be placed over all disturbed areas that are not surfaced with concrete, asphalt, or pavers.
2. Preparation:
   a. After rough grading is completed and reviewed by the Engineer, Contractor shall spread topsoil as hereinbefore specified over all areas to receive Permanent Seeding to a minimum compacted depth of 4 inches with surface elevations as shown. Loosen the finished surface to a depth of 2 inches and leave in smooth condition, free from depressions or humps, ready for seeding.
   b. Finish Grading:
      1) Contractor shall rake the topsoiled area to a uniform grade, so that all areas drain as indicated on the grading plan.
      2) Contractor shall remove all trash and stones exceeding 1 inch in diameter from area to a depth of 2 inches.
3. Maintenance:
   a. Maintenance Period: Contractor shall begin maintenance immediately after each portion of permanent grass is planted and continue for 8 weeks after all planting is completed.
   b. Maintenance Operations: Contractor shall water to keep surface soil moist. Repair washed out areas by filling with topsoil, liming, fertilizing, and seeding. Replace mulch on banks when washed or blown away. Mow to 2 inches after grass reaches 3 inches in height, and mow frequently enough to keep grass from exceeding 3-1/2 inches. Weed by local spot application of selective herbicide only after first planting season when grass is established.
4. Guarantee:
   a. If, at the end of the 8-week maintenance period, a satisfactory stand of grass has not been produced, the Contractor shall renovate and reseed the grass or unsatisfactory portions thereof immediately.
   b. A satisfactory stand is defined as grass or section of grass that has a substantial establishment of new grass, strongly rooted, and uniformly green in appearance from a distance of 50 feet. No noticeable thin or bare areas as determined by the Engineer.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.02 DESIGN REQUIREMENTS

A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions as indicated on the Drawings, with the Occupational Safety and Health Administration, and with all other applicable state and local agency requirements.

1. Refer to Design Criteria on Structural General Notes Drawings.
2. Refer to individual Specification sections and to Drawings for additional design criteria.

B. Where Contractor design is specified; installation, systems, equipment, and components shall be designed by a qualified professional Engineer registered in the State of Florida.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 230 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 10 degrees F to 105 degrees F.

1.04 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

C. Extra Materials, Special Tools, Test Equipment, and Expendables:

1. Furnish as required by individual Specifications.
2. Schedule:
    a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
    b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.
3. Packaging and Shipment:
    a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
    b. Prominently displayed on each package, the following:
        1) Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
        2) Applicable equipment description.
        3) Quantity of parts in package.
        4) Equipment manufacturer.
4. Deliver materials to site or other area as designated by the Contractor.
5. Notify Engineer, Owner, and Construction Manager upon arrival for transfer of materials.
6. Replace extra materials and special tools found to be damaged or otherwise inoperable at the time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer. Upon receipt of manufacturer's advance notice of shipment, promptly notify Engineer of anticipated date and place of delivery.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.05 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.06 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, Temporary Facilities and Controls. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.

E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.

G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.

H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

I. Authority Having Jurisdiction (AHJ):

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

J. Equipment Finish:

1. Provide manufacturer’s standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with finish as approved by Owner.

K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

M. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.

B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Do not cut or notch any structural member or building surface without specific approval of Engineer.

F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.

G. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.04 FIELD FINISHING

A. In accordance with Section 09 90 00, Painting and Coating, and individual Specification sections.

3.05 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.06 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

3.07 SUPPLEMENTS

A. The supplement listed below, following "End of Section", is part of this specification.

1. Form: Manufacturer's Certificate of Compliance.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

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

Date of Execution: _____, 20___

Manufacturer: _____

Manufacturer's Authorized Representative *(print)*: _____

_____

(Authorized Signature)

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Special bonds, Special Guarantees, and Service Agreements.
   c. Consent of Surety to Final Payment: As required in General Conditions.
   d. Releases or Waivers of Liens and Claims: As required in General Conditions.
   e. Releases from Agreements.
   f. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
   g. Extra Materials: As required by individual Specification sections.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
4. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents in electronic format for Contractor's printing and use.
2. Print one full size set of contract drawings for "Record Drawing" markup.
3. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
4. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Engineer.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by "cloud" drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.

c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.

5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
   b. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner and Engineer.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touchup marred surfaces to specified finish and match adjacent surfaces.
4. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.
6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Remove snow and ice from access to buildings.
10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
11. Leave water courses, gutters, and ditches open and clean.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

1.02 DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Engineer's review.

B. Final Data: Engineer-accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03 SEQUENCING AND SCHEDULING

A. Equipment and System Data:

1. Preliminary Data:
   a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
   b. Submit prior to shipment date.
2. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to installation of equipment or system. Submit Compilation Formatted and Electronic Media Formatted data prior to Substantial Completion of Project.

B. Materials and Finishes Data:

1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
2. Final Data: Submit within 10 days after final inspection.

1.04 DATA FORMAT

A. Prepare preliminary and final data in the form of an instructional manual. Prepare final data on electronic media.

B. Instructional Manual Format:

1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
2. Size: 8-1/2 inches by 11 inches, minimum.
3. Cover: Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
    a. Project title.
    b. Designate applicable system, equipment, material, or finish.
    c. Identity of separate structure as applicable.
    d. Identify volume number if more than one volume.
    e. Identity of equipment number and Specification section.
4. Spine:
    a. Project title.
    b. Identify volume number if more than one volume.
5. Title Page:
    a. Contractor name, address, and telephone number.
    b. Subcontractor, Supplier, installer, or maintenance contractor’s name, address, and telephone number, as appropriate.
        1) Identify area of responsibility of each.
        2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
    a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
    b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
7. Paper: 20-pound minimum, white for typed pages.
8. Text: Manufacturer’s printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Electronic Media Format:

1. Portable Document Format (PDF):
    a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.
    b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.
    c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.

2. Manufacturers' standard electronic format.

1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit two copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
   a. Submit three copies for Engineer's review.
   b. If data meets conditions of the Contract:
      1) One copy will be returned to Contractor.
      2) One copy will be forwarded to Resident Project Representative.
      3) One copy will be retained in Engineer's file.
   c. If data does not meet conditions of the Contract:
      1) All copies will be returned to Contractor with Engineer's comments (on separate document) for revision.
      2) Engineer's comments will be retained in Engineer's file.
      3) Resubmit two copies revised in accordance with Engineer's comments.
3. Final Data: Submit two copies in format specified herein.

1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content For Each Unit (or Common Units) and System:

1. Product Data:
   a. Include only those sheets that are pertinent to specific product.
   b. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
   c. Function, normal operating characteristics, and limiting conditions.
   d. Performance curves, engineering data, nameplate data, and tests.
   e. Complete nomenclature and commercial number of replaceable parts.
   f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
   g. Spare parts ordering instructions.

h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).

2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.
4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
   a. Format:
      1) Provide reinforced, punched, binder tab; bind in with text.
      2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
      3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
      4) Identify Specification section and product on Drawings and envelopes.
   b. Relations of component parts of equipment and systems.
   c. Control and flow diagrams.
   d. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
5. Instructions and Procedures: Within text, as required to supplement product data.
   a. Format:
      1) Organize in consistent format under separate heading for each different procedure.
      2) Provide logical sequence of instructions for each procedure.
      3) Provide information sheet for Owner's personnel, including:
         a) Proper procedures in event of failure.
         b) Instances that might affect validity of guarantee or Bond.
   b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
   c. Operating Procedures:
      1) Startup, break-in, routine, and normal operating instructions.
      2) Test procedures and results of factory tests where required.
      3) Regulation, control, stopping, and emergency instructions.
      4) Description of operation sequence by control manufacturer.
      5) Shutdown instructions for both short and extended duration.
      6) Summer and winter operating instructions, as applicable.
      7) Safety precautions.
      8) Special operating instructions.
   d. Maintenance and Overhaul Procedures:
      1) Routine maintenance.
      2) Guide to troubleshooting.

3) Disassembly, removal, repair, reinstallation, and re-assembly.

6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards:
3. Electrical service.
4. Control requirements and interfaces.
5. Communication requirements and interfaces.
6. List of electrical relay settings, and control and alarm contact settings.
7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
8. As-installed control diagrams by control manufacturer.
9. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Startup and shutdown sequences, normal and emergency.
   c. Safety precautions.
   d. Special operating instructions.
10. Maintenance Procedures:
    a. Routine maintenance.
    b. Guide to troubleshooting.
    c. Adjustment and checking.
    d. List of relay settings, control and alarm contact settings.
11. Manufacturer’s printed operating and maintenance instructions.
12. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.

C. Maintenance Summary:

1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.

2. Format:
    a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
    b. Each Maintenance Summary may take as many pages as required.
    c. Use only 8-1/2-inch by 11-inch size paper.
    d. Complete using typewriter or electronic printing.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
    a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
    b. "Unit" is the unit of measure for ordering the part.
    c. "Quantity" is the number of units recommended.
    d. "Unit Cost" is the current purchase price.

1.07 DATA FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
    a. Catalog number, size, and composition.
    b. Color and texture designations.
    c. Information required for reordering special-manufactured products.
2. Instructions for Care and Maintenance:
    a. Manufacturer's recommendation for types of cleaning agents and methods.
    b. Cautions against cleaning agents and methods that are detrimental to product.
    c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
    a. Applicable standards.
    b. Chemical composition.
    c. Details of installation.
2. Instructions for inspection, maintenance, and repair.

1.08 SUPPLEMENTS

A. The supplement listed below, following "End of Section", is part of this Specification.

1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

   a. Name_____ Telephone No. _____

   b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01 88 15
ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the Florida Building Code 7th Edition (2020), for wind, gravity, soil, and operational loads.

1.02 REFERENCES

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

1. American Concrete Institute 318-14 (ACI): Building Code requirements for Structural Concrete.
2. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
3. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
4. Design Criteria noted on General Structural Notes.
5. Florida Building Code 7th Edition (2020).
6. International Code Council (ICC): International Building Code (IBC).

1.03 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Florida.

2. Design anchorage into concrete including embedment in accordance with ACI 318-14; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.
   a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, wind, and operational loading.
5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
6. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
7. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
8. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
9. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
3. Operational:
   a. For loading supplied by equipment manufacturer for IBC required load cases.
   b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
   c. Locate braces to minimize vibration to or movement of structure.

d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
   b. Manufacturers' engineered hardware product data.
   c. Attachment assemblies' drawings; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
   d. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include Florida Building Code and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer's specific criteria used for design; sealed by an engineer registered in the State of Florida.
2. Manufacturer's hardware installation requirements.

C. Deferred Submittals: Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

1.06 SOURCE QUALITY CONTROL

A. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

B. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.

B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

D. Do not use powder-actuated fasteners or sleeve anchors for anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 horsepower.

PART 3 EXECUTION

3.01 GENERAL

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

B. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

C. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

D. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.

E. Calculations shall limit anchor bolt concrete edge distance to a maximum of 4 inches or as required to provide sufficient anchor bolt capacity to resist the applied loads.

3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. In accordance with Section 05 50 00, Metal Fabrications and Section 05 05 19, Post-Installed Anchors.

B. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.

C. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.

D. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as a pump station.

E. Facility Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Unit Process Startup Form for each unit process.
4. Completed Facility Performance Demonstration/Certification Form.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:

1. Step-by-step instructions for startup of each unit process and the complete facility.
2. Unit Process Startup Form (sample attached), to minimally include the following:
    a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
    b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
    c. Startup requirements for each unit process, including water, power, chemicals, etc.
    d. Space for evaluation comments.
3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
    a. Description of unit processes included in the facility startup.
    b. Sequence of unit process startup to achieve facility startup.
    c. Description of computerized operations, if any, included in the facility.
    d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
    e. Signature spaces for Contractor and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.

B. Contractor's Testing and Startup Representative:

1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.

D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.

E. Owner will:

1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
2. Operate process units and facility with support of Contractor.

3.02 EQUIPMENT TESTING

A. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
    a. Owner/Project Name.
    b. Equipment or item tested.
    c. Date and time of test.
    d. Type of test performed (Functional or Performance).
    e. Test method.
    f. Test conditions.
    g. Test results.
    h. Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking: Prior to beginning functional testing:
    a. Calibrate testing equipment in accordance with manufacturer's instructions.
    b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
    c. Lubricate equipment in accordance with manufacturer's instructions.
    d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
    e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.

f. Check power supply to electric-powered equipment for correct voltage.
g. Adjust clearances and torque.
h. Test piping for leaks.

6. Ready-to-test determination will be by Engineer based at least on the following:
   a. Acceptable Operation and Maintenance Data.
   b. Notification by Contractor of equipment readiness for testing.
   c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
   d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
   e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
   f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
   g. Equipment and electrical tagging complete.
   h. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
3. Prepare Equipment Test Report summarizing test method and results.
4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.

B. Make adjustments, repairs, and corrections necessary to complete unit process startup.

C. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.

D. Significant Interruption: May include any of the following events:

1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
2. Failure to meet specified functional operation.
3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
5. As determined by Engineer.

E. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

3.04 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility including its computer system, until all unit processes are operable and under control of computer system.

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic and computerized operation.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are a part of this Specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification Form.

END OF SECTION

UNIT PROCESS STARTUP FORM

OWNER:_____ **PROJECT:**_____

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):_____

Evaluation Comments:_____

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:_____ **PROJECT:**_____

Unit Processes Description (List unit processes involved in facility startup):

_____

_____

_____

_____

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

_____

_____

_____

_____

_____

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ **Date:** _____**, 20____**

Engineer: _____ **Date:** _____**, 20____**

(Authorized Signature)

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
3. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
4. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
    a. Part 61—National Emission Standards for Hazardous Air Pollutants.
    b. Part 82—Protection of Stratospheric Ozone.
    c. Part 273—Standards for Universal Waste Management.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.

E. Renovation: Altering a facility or one or more facility components in any way.

F. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

G. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

H. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.
3. Copies of reports and other documentation required for abandoning wells.
4. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped.
5. Submit a shipping receipt or bill of lading for all universal waste shipped.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor's safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this demolition project to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.

1.05 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation;
2. The Contractor's planned sequence of operations, including coordination with other work in progress;
3. Disconnection schedule of utility services.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor's Demolition/Renovation Plan has been approved by Engineer.

B. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.

1.07 USE OF EXPLOSIVES

A. Not allowed.

1.08 ENVIRONMENTAL PROTECTION

A. Sequence and coordinate all demolition to be in concert with the proposed construction. Maintain in service the existing facility and its ability to continuously accept and treat raw sewage.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Structures:

1. Existing above-grade structures indicated on the Drawings shall be removed in their entirety.
2. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

B. Substructure: Remove any substructure base material until native soils is reached.

C. Utilities and Related Equipment:

1. Coordinate with Owner and Engineer or appropriate utilities to turn off affected services at least 48 hours before starting demolition activities.
2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
3. When utility lines are encountered that are not indicated on the Drawings, notify Owner and Engineer prior to further work in that area.
4. Remove meters and related equipment and deliver to a location as determined by the Owner.
5. Excavate and remove utility lines serving structures to be demolished at the outside perimeter of the demolition.

6. Provide a permanent leak-proof closure for water and gas lines.
7. Plug sewer lines with concrete to a minimum plug length of three feet to prevent groundwater infiltration.

D. Paving and Slabs:

1. Remove concrete and asphaltic concrete paving and slabs as required for the prosecution of the work where it is to be replaced. Remove to its full depth where not scheduled to be replaced.
2. Provide neat sawcuts at limits of pavement removal as indicated.

E. Concrete:

1. Core drill corners of new opening to avoid overcutting adjacent reinforcing in existing concrete to remain. Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the remaining concrete is sound.
2. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Repair exposed rebar ends and embeds as shown on Drawings.
3. Where new concrete adjoins existing concrete, thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 3/16 inch. Rebar and small embeds at existing concrete may be required to be left to engage new concrete. Saturate surface with water for 24 hours prior to placing new concrete. The new Work shall tie into the existing construction as shown on Drawings.

F. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
3. Patching shall be as specified and indicated, and shall include: Fill holes and depressions left as a result of removals in existing structures with an approved patching material, applied in accordance with the manufacturer’s printed instructions.

G. Cylinders and Canisters: Remove all fire suppression system cylinders and canisters and dispose as specified in Paragraph Ozone Depleting Substances (ODS).

H. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.
3. Rework existing circuits, or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
12. Provide new typewritten panelboard circuit directory cards.

I. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

3.02 PROTECTION

A. Dust and Debris Control:

1. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.
2. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

B. Existing Work:

1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.
2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
5. Do not overload pavements to remain.

C. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

D. Facilities:

1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

E. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner's personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner's personnel and the general public to occupied portions of the structure.

3.03 BURNING

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

3.04 RELOCATIONS

A. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.05 BACKFILL

A. Do not use demolition debris as backfill material.

B. Fill excavations, open basements and other hazardous openings to existing ground level or foundation level of new construction in accordance with Section 31 23 23, Fill and Backfill.

3.06 TITLE TO MATERIALS

A. All salvaged equipment and materials will remain the property of Owner.

B. Salvage equipment and materials as directed by the Owner.

C. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Engineer of Contractor's Demolition/Renovation Plan, and the resulting authorization by Engineer to begin demolition.

3.07 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment listed in Article Title To Materials to be reused or relocated to prevent damage, and reinstall as the Work progresses.

B. Properly store and maintain equipment and materials in same condition as when removed.

C. Store equipment and material designated to be reused in a location designated by Owner.

D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

E. Engineer will determine condition of equipment and materials prior to removal.

3.08 UNSALVAGEABLE MATERIAL

A. All unsalvageable materials, except concrete permitted to remain in place, shall be disposed of offsite by the Contractor.

B. Universal Waste Lamps and Thermostats: Dispose of in strict accordance with 40 CFR 273.

3.09 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 GENERAL

A. Unless otherwise specified, Work shall conform to requirements of Section 1 through Section 5 of ACI 301-16, Specifications for Structural Concrete.

1. Environmental concrete structures are included in the scope of Work.

1.02 REFERENCES

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

1. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.

1.03 DEFINITIONS

A. Unless otherwise specified, definitions shall be in accordance with ACI 301 and Section 03 30 00, Cast-in-Place Concrete.

1.04 SUBMITTALS

A. Unless otherwise specified, submittals shall be in accordance with ACI 301.

B. Action Submittals: Manufacturer’s product data literature for each type of form tie.

C. Informational Submittals:

1. Shoring and Backshoring Procedure.
2. Shop Drawings for Shoring, Reshoring, and Backshoring.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified, in accordance with ACI 301.

B. Formwork Accessories:

1. Form Snap-Ties:
   a. Material: Unless otherwise specified: Steel.
   b. Spreader Inserts:
      1) Conical or spherical type.
      2) Design to maintain positive contact with forming material.
      3) Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
   c. Wire ties not permitted.
   d. Form Snap-Ties without Water Stop for structures other than hydraulic structures, basements, pipe galleries and accessible spaces below finish grade.
   e. Form Snap-Ties with Water Stop for hydraulic structures, basements, pipe galleries, and accessible spaces below finish grade:
      1) Neoprene water stop 3/16-inch thick and 15/16-inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.
         (1) Orient waterstop perpendicular to tie and symmetrical about center of tie.
         (2) Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
2. Formwork Release Agents:
   a. Shall not impair subsequent treatments of concrete surfaces when applied to forms.
   b. Ready-to-use water-based material formulated to reduce or eliminate surface imperfections.
   c. Contain no mineral oil or organic solvents.
      1) Manufacturers and Products:
         a) Master Builders Solutions US, Shakopee, MN; MasterFinish RL 211.
         b) Cresset Chemical Company; Crete-Lease 20-VOC-Xtra.
         c) Euclid Chemical, Cleveland, OH; FORMSHIELD WB.
3. Other Embedded Items: Unless otherwise specified, in accordance with ACI 301.

C. Performance and Design Requirements: Unless otherwise noted, in accordance with ACI 301, to provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete, and within specified tolerances.

D. Earth cuts shall not be used as forms for vertical surfaces.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, execution shall be in accordance with ACI 301.

B. Form Tolerances:

1. Unless otherwise specified, provide forms in accordance with ACI 117 and ACI 301, and the following tolerances for finishes specified:
   a. See the Schedule of Concrete Finishes in Section 03 30 00, Cast-in-Place Concrete, for beam, column, and wall types related to required form tolerances.
   b. Comply with tolerance limits required by equipment manufacturers. Coordinate tolerance requirements with equipment manufacturers.
   c. The most restrictive tolerance shall govern.
   d. Wall Tolerances:
      1) Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
      2) Wall Type W-A:
         a) Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high.
         b) Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in all directions.
      3) Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      4) Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/4 inch.

3.02 CONSTRUCTION AND ERECTION OF FORMWORK

A. In accordance with ACI 301.

3.03 FORM SURFACE PREPARATION

A. Prior to coating surface, thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants.

B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by manufacturer.

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

3.04 ERECTION

A. General: In accordance with ACI 301, unless otherwise specified.

B. Beveled Edges (Chamfer):

1. Form 3/4-inch bevels at concrete edges exposed to view in final construction, unless otherwise noted.
2. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Engineer's approval of size prior to placement of beveled edge.

C. Wall Forms:

1. Do not reuse forms with damaged surfaces.
2. Locate form ties and joints in uninterrupted uniform pattern.
3. Inspect form surfaces prior to installation to ensure conformance with specified tolerances.

3.05 FORM REMOVAL

A. Nonsupporting forms, sides of beams, walls, columns, and similar parts of Work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:

1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
2. Curing and protection operations are maintained.

B. Elevated Structural Slabs or Beams: In accordance with ACI 318-14 and at such time as concrete has reached compressive strength equal to 80 percent of specified 28-day compressive strength as determined by test cylinders.

C. Form Ties: Remove conical inserts and plug holes as specified in Section 03 30 00, Cast-in-Place Concrete.

3.06 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. C920, Specification for Elastomeric Joint Sealants.
   d. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   e. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
   f. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
   g. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
   h. D1171, Standard Guide for Evaluating Nonwoven Fabrics.
   i. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   j. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   k. D2240, Standard Test Method for Rubber Property – Durometer Hardness.
2. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
   b. Construction Joints: Include joints locations showing additional required joint locations and any proposed alternate locations.

2. Product Data:
   a. Waterstops.
   b. Bond breaker.
   c. Premolded joint fillers.
   d. Pourable joint fillers.
   e. Preformed control joints.
   f. Roofing felt.
   g. Accessories not specified in other sections.
3. Samples:
   a. PVC waterstop with grommets.
   b. PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.

B. Informational Submittals:

1. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
   a. Waterstops.
   b. Premolded joint fillers.
   c. Pourable joint fillers (sealant proportions not required as products used only as a filler).
   d. Preformed control joints.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer's product data sheets prior to unloading and storing onsite.

B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 PLASTIC WATERSTOP

A. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.

B. Specific Gravity: Approximately 1.37.

C. Shore Durometer Type A Hardness: Approximately 80.

D. Performance Requirements: COE Specification CRD-C-572.

E. Type Required: 6 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center, as indicated on Drawings.

F. Corrugated or tapered type waterstops are not acceptable.

G. Thickness: Constant from bulb edge (or center of waterstop) to outside stop edge.

H. Minimum Weight per Foot of Waterstop: 1.60 pounds for 3/8 inch by 6 inches.

I. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

J. Manufacturers and Products for Center Bulb Type:

1. Use same manufacturers for flat ribbed profile:
   a. Vinylex Corp., St Louis, MO.; No. RB638H (6 inches by 3/8 inch.
   b. Greenstreak, St. Louis, MO; Style 732 (6 inches by 3/8 inch.
   c. Durajoint, Garrettsville, OH.; Type 9 (6 inches by 3/8 inch).
   d. BoMetals, Carrollton, GA.: No. RCB-638LB (6 inches by 3/8 inch).
   e. Dacon Plastics LLC, Jacksonville, TX; No. RCB17 (6 inches by 3/8 inch).

2.02 HYDROPHILIC WATERSTOP

A. For use at construction joints only, where new concrete is placed against existing concrete and as shown on Drawings.

B. Material shall be a nonbentonite hydrophilic rubber compound.

C. Manufacturers and Products:

1. Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
2. Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.

2.03 BOND BREAKER

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

2.04 BONDING AGENT

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

2.05 PREMOLDED JOINT FILLER

A. Bituminous Type: ASTM D994 or ASTM D1751.

B. Sponge Rubber:

1. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum. Use in joints for potable and nonpotable water containment structures.
2. Manufacturer and Product: Monmouth Rubber and Plastics, Corp, Long Branch, NJ; Durafoam DK5151.

2.06 BUILDING PREFORMED CONTROL JOINT

A. One-Piece, Flexible, Polyvinyl Chloride Joint Former:

1. Manufacturer and Product: WR Meadows, Inc., Hampshire, IL; Keyway.

B. One-Piece Galvanized Steel Strip with Preformed Groove:

1. Manufacturer and Product: BoMetals, Inc. Carrollton, GA; QuickKey or ProKey Joint.

C. Furnish in full-length, unspliced pieces.

2.07 POURABLE JOINT FILLERS

A. General: Although product is a sealant, it is being specified as a filler to prevent debris accumulation and allow expansion and contraction under shrinkage and thermal loads. It does not need to meet proportional sealant geometry requirements.

B. Filler for Water Containment Structures:

1. Multicomponent sealant, self-leveling or nonsag as required for level, sloping, or vertical joints.
2. Color: White.
3. Manufacturer and Product: Sika Corp., Lyndhurst, NJ; Sikaflex-2c.

2.08 ACCESSORIES

A. Joint Sealant: Polyurethane as specified in Section 07 92 00, Joint Sealants.

B. Roofing Felt: ASTM D226, Type II, 30-pound asphalt-saturated or equal weight of ASTM D227 coal-tar saturated felt.

C. Steel Reinforcement: As specified in Section 03 21 00, Steel Reinforcement.

D. Nails: Galvanized, as required for securing premolded joint filler.

E. Ties for PVC Waterstop: Grommets for each edge at 12-inch maximum spacing.

PART 3 EXECUTION

3.01 GENERAL

A. Commence concrete placement after joint preparation is complete.

B. Time Between Concrete Pours: As specified in Section 03 30 00, Cast-in-Place Concrete.

3.02 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface.

1. Remove laitance and spillage from steel reinforcement and dowels.
2. Roughen surface to minimum of 1/4-inch amplitude:
   a. Sandblast after concrete has fully cured.
   b. Water blast after concrete has partially cured.
   c. Green cut fresh concrete with high-pressure water and hand tools.
3. Perform cleaning so as not to damage waterstop, if one is present.

B. Construction Joint with Hydrophilic Waterstop:

1. Follow hydrophilic waterstop manufacturer’s written instructions.
2. Clean debris, dirt, dust, and foreign material from concrete surface. Concrete surface must be smooth, clean, and dry. Grind concrete as required.

3.03 INSTALLATION OF WATERSTOPS

A. General:

1. Continuous waterstop shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
2. Join waterstop at intersections to provide continuous seal.
3. Center waterstop on joint.
4. Secure waterstop in correct position. Tie waterstop to steel reinforcement using grommets and tiewire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
5. Repair or replace damaged waterstop.
6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
7. Joints in Footings and Slabs:
    a. Ensure that space beneath horizontal waterstop is completely filled with concrete.
    b. During concrete placement, make visual inspection of waterstop area.
    c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, then place remaining concrete to full height of slab.

B. Plastic Waterstops:

1. Install in accordance with manufacturer’s written instructions.
2. Splice in accordance with waterstop manufacturer’s written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees F.
    a. Allow at least 10 minutes before new splice is pulled or strained in any way.
    b. Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.
    c. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
    d. Field splice permitted only for straight butt welds.

C. Hydrophilic Waterstop:

1. Install in accordance with manufacturer’s written instructions.
2. Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.

3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
4. Lap ends of waterstop strip together at splices and corners and join with sealant.
5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.
6. Lap hydrophilic waterstop 2 feet minimum with intersecting plastic waterstops.

3.04 PREFORMED CONTROL JOINTS

A. Do not use in water-holding basins.

B. Locate slightly below top of slab.

C. Install in accordance with manufacturer's written instructions in straight, full-length pieces.

D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement using only approved stakes and other secondary installation materials.

3.05 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

3.06 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. SP-66, Detailing Manual.
2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
3. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. A1064/A1064M, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. Concrete Reinforcing Steel Institute (CRSI):
   a. Placing Reinforcing Bars.
   b. Manual of Standard Practice.
5. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66:
   a. Bending lists.
   b. Placing drawings.
2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
   a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
   b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer's published methods.
   c. Manufacturer's instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60.

B. Mechanical Splices and Connections:

1. Metal Sleeve Splice:
   a. Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
   b. Manufacturer and Product: Erico Products, Inc., Cleveland, OH; Cadweld T-Series.

C. Welded Wire Fabric:

1. ASTM A1064, using wire of 75 ksi minimum tensile strength.
2. Furnish flat sheets only, rolled sheets not permitted.

2.02 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Plastic Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 1 Reinforcement Supports.
2. Stainless Steel Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 2 Reinforcement Supports, except legs shall be made wholly from stainless steel wire.
3. Precast Concrete Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Cementitious (Precast) Reinforcement Supports.
   a. Precast concrete bar supports shall have equal or greater strength than the surrounding concrete.
   b. Precast concrete bar supports shall be four square inches minimum, in plan.
   c. Precast concrete bar supports shall have tie wires.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.

3.02 PLACING REINFORCING STEEL

A. Unless otherwise specified, in accordance with ACI 301.

B. Accessories:

1. Bar Supports in Contact with Ground: Provide precast concrete block supports.
   a. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.
2. Bar Supports in Contact with Forms: Unless otherwise noted, bar supports shall be plastic protected wire bar supports, stainless steel protected wire bar supports, or precast concrete block bar supports.
   a. Use stainless steel protected wire bar supports or precast concrete block bar supports at formed surfaces that will receive abrasive blasting, hydro-blasting, or grinding.
3. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports, and location of reinforcement remains within tolerance throughout work.

C. Splices and Laps:

1. Lap Splice Reinforcing: Refer to Structural General Notes on Drawings for additional information.
2. Tie splices with annealed wire as specified in CRSI Standard.

D. Mechanical Splices and Connections:

1. Provide mechanical splices and connections where shown on Drawings.
2. Install assembly in accordance with manufacturer's written instructions and in accordance with ICC Evaluation Services Report or equivalent code agency report.
3. Maintain minimum edge distance and concrete cover.

E. Tying Reinforcing Bars:

1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

F. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.

G. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.

H. Unless permitted by Engineer, do not cut reinforcing bars in field.

3.03 WELDED WIRE FABRIC INSTALLATION

A. Use only where specifically shown.

B. Extend fabric to within 2 inches of edges of slab and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.

C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.

D. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.

E. Do not use fabric that has been rolled. Install flat sheets only.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 24 00
FIBROUS REINFORCEMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C78, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   b. C1116, Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
   c. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.

1.02 DEFINITIONS

A. Aspect Ratio: The ratio of length to diameter of the fiber.

B. Fibrillated Fibers: Fibers in bundles that, when added to concrete during mixing, separate into uniformly distributed angular fibrils (fiber strands) which act as secondary concrete reinforcement.

C. Micro-Fibers: Shorter length, low dose, typically 0.1 percent by volume fibers designed to control plastic shrinkage cracking.

D. Monofilament Fiber: Single filament fiber.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements: 2-hour fire resistance rating when tested under ASTM E119 on Series 700, Series 800, and Series 900 composite metal deck assemblies.

1.04 SUBMITTALS

A. Action Submittals:

1. Product data for fibrillated fibers.
2. Fiber reinforced concrete mix design.

B. Informational Submittals:

1. Manufacturer's written instructions for mixing and batching of fibrillated fibers.
2. Fiber manufacturer's Certificate of Compliance.
3. Manufacturer's written test procedure for the residual strength index of fiber reinforced concrete.
4. Certificate of Compliance from concrete supplier as to type, brand name, and amount of fibers added to mix.
5. Fiber manufacturer's certification of registration as proof of ISO 9002 Fiber Manufacturing Facility Certification.

PART 2 PRODUCTS

2.01 MATERIALS

A. Micro-Synthetic Fiber Reinforcement:

1. 100 percent virgin polypropylene self-fibrillating fibers.
2. Fibrillated bundles to allow uniform distributed angular fibrils (fiber strands) when mixed into concrete.
3. Multidesign gradation.
4. Specific Gravity: 0.91 minimum.
5. Minimum residual strength index of 50 psi.
6. Type III fibers conforming to ASTM C1116, Part 4.1.3.
7. Fiber Length: 0.50 inch to 1.0 inch
8. Manufacturers and Products:
   a. Euclid Chemical Company, Cleveland OH; Fiberstrand F.
   b. Propex Concrete Systems Corporation, Chattanooga, TN; Fibermesh 300.

B. Concrete: Components shall conform to Section 03 30 00, Cast-in-Place Concrete.

2.02 CONCRETE MIX DESIGN AND CONCRETE MIXING

A. In accordance with Section 03 30 00, Cast-in-Place Concrete.

B. Add 1.5 pounds minimum per cubic yard at the time concrete is batched.

PART 3 EXECUTION

3.01 PLACING, PROTECTING, CURING, AND FINISHING

A. In accordance with Section 03 30 00, Cast-in-Place Concrete.

B. Mix fibers into concrete in accordance with fiber manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

A. Test as specified in Section 03 30 00, Cast-in-Place Concrete.

B. Test fiber reinforced concrete with a modified version of ASTM C78 test using the printed test procedure provided by Fibermesh.

C. Test minimum of two beam Samples prior to casting the concrete.

D. Test minimum of two additional Samples for each 25 cubic yards or any portion thereof used on the Project.

3.03 MANUFACTURER'S SERVICE

A. Provide the services of a technical representative to instruct the concrete supplier in proper batching and mixing of materials.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 GENERAL

A. Unless otherwise specified, Work must be in accordance with ACI 301, Specifications for Structural Concrete.

1.02 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete.
   b. 305.1, Specification for Hot Weather Concreting.
   c. 306.1, Standard Specification for Cold Weather Concreting.
   d. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
   e. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.
2. ASTM International (ASTM): C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
3. National Ready Mixed Concrete Association (NRMCA).

1.03 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

B. Defective Area:

1. Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections.

2. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.
3. Cold joints.

C. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained. Surfaces must be considered exposed concrete, even if covered by paint, sealers, or similar applications.

D. Hot Weather: As defined in ACI 305.1.

E. Hydraulic Structure: Liquid containment structure.

F. New Concrete: Less than 60 days old.

1.04 SUBMITTALS

A. Action Submittals:

1. Mix Designs:
   a. Indicate concrete mix design number CMD# provided in Supplements at the end of this section for mix design requirements for each class of concrete used on Project.
   b. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   c. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   d. Manufacturer's Certificate of Compliance for the following:
      1) Portland cement.
      2) Fly ash.
      3) Slag cement.
      4) Silica Fume.
      5) Aggregates, including specified class designation for coarse aggregate.
      6) Admixtures.
      7) Concrete producer has verified compatibility of constituent materials in design mix.
   e. Test Reports:
      1) Cement: Chemical analysis report.
      2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
      3) Aggregates:
         a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.

b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.

4) Water-Soluble Chloride-Ion Content in Hardened Concrete: One of the following:
   a) Test report in accordance with ASTM C1218/ C1218M at an age between 28 days and 42 days.
   b) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
   c) Or all of the following:
      (1) Manufacturer's Certificate of Compliance that each admixture does not intentionally add chlorides and/or that the chloride content of each admixture does not exceed trace amounts.
      (2) Verification that potable water is used in the concrete mix or test data documenting the chloride content of the water.
      (3) Letter from the concrete supplier stating that fine and coarse aggregates are from sources that are not known to be susceptible to chlorides in the aggregates.
   d) Alkali Aggregate Reactivity: Where required, in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
   e) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.

2. Product Data:
   a. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
   b. Specified ancillary materials.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details must include, but not be limited to, the following:
   a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
   b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   c. Methods for temperature protection during placement.

d. Types of covering, insulation, housing, or heating to be provided.
e. Curing methods to be used during and following protection period.
f. Use of strength accelerating admixtures.
g. Methods for verification of in-place strength.
h. Procedures for measuring and recording concrete temperatures.
i. Procedures for preventing drying during dry, windy conditions.

4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
   a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   b. Use of retarding admixture.
   c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
   d. Types of shading and wind protection to be provided.
   e. Curing methods, including use of evaporation retardant.
   f. Procedures for measuring and recording concrete temperatures.
   g. Procedures for preventing drying during dry, windy conditions.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer’s application instructions for bonding agent and bond breaker.
3. Manufacturer’s Certificate of Compliance to specified standards:
   a. Bonding agent.
   b. Bond breaker.
   c. Repair Materials.
4. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
5. Field test reports.
6. Recorded temperature data from concrete placement where specified.

7. Liquid Tightness test results.
8. Concrete Delivery Tickets:
    a. For each batch of concrete before unloading at Site.
    b. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.
    c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.
    d. Indicate concrete mix design number CMD# provided in Supplements at the end of this section for mix design requirements for each class of concrete used on Project.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher.
4. Testing Agency: Unless otherwise permitted, an independent agency, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
    a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1.
    b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

B. Preinstallation Conference:

1. Required Meeting Attendees:
    a. Contractor, including pumping, placing and finishing, and curing subcontractors.
    b. Ready-mix producer.
    c. Admixture representative.
    d. Steel reinforcement installer.

e. Testing and sampling personnel.
f. Owner and/or Owner's designee.

2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda must include:
   a. Admixture types, dosage, performance, and redosing at Site.
   b. Mix designs, test of mixes, and Submittals.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finish, curing, and water retention.
   f. Steel reinforcement details.
   g. Protection procedures for weather conditions.
   h. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 19, Project Meetings.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, Work must be in accordance with ACI 301.

2.02 MATERIALS

A. Cementitious Materials:

1. Cement:
   a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
   b. Blended Hydraulic Cement:
      1) Unless otherwise specified, excluding Type IS (greater than 70), conforming to ASTM C595/C595M, and having (MS) designation.
      2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
   c. Furnish from one source.
2. Supplementary Cementitious Materials (SCM):
   a. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
      1) When air-entrainment is specified, fly ash shall comply with uniformity requirements of Table 3 of ASTM C618.

b. Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.
c. Silica Fume: ASTM C1240.

B. Aggregates: Furnish from one source for each aggregate type used in a mix design.

1. Aggregates:
   a. In accordance with ASTM C33/C33M, except as modified herein.
      1) Class Designation: 4S unless otherwise specified.
   b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c. Alkali Silica Reactivity: See Article, Concrete Mix Design.
2. Fine Aggregates:
   a. In accordance with ASTM C33/C33M, except as modified herein.
   b. In the event manufactured sand is included in the mix design, the material shall be from the same source as the coarse aggregate.
   c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
      1) Limit material finer than 75-µm (No. 200) sieve to 5 percent mass of total sample.
      2) Limit coal and lignite to 1.0 percent.
3. Coarse Aggregate:
   a. Crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
   b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

C. Admixtures: Unless otherwise permitted, furnish from one manufacturer.

1. Characteristics:
   a. Compatible with other constituents in mix.
   b. Contain at most, only trace amount chlorides in solution.
   c. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
2. Air-Entraining Admixture: ASTM C260/C260M.
3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
4. Retarding Admixture: ASTM C 494/C 494M, Type B.
5. Accelerating Admixture: ASTM C 494/C 494M, Type C.

6. High Range Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
7. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
8. Shrinkage Reducing Admixture:
    a. Manufacturers and Products:
        1) Master Builders Solutions US, Shakopee, MN; Tetraguard AS20.
        2) Euclid Chemical Co., Cleveland, OH; Eucon SRA Series.
        3) W. R. Grace & Co., Cambridge, MA; Eclipse Series.
9. Do not use calcium chloride as an admixture.

D. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water.

2.03 ANCILLARY MATERIALS

A. Bonding Agent: Unless otherwise specified, in accordance with the following:

1. ASTM C881/C881M, Type V.
2. Two-component, moisture insensitive, 100 percent solids epoxy.
3. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
4. Manufacturers and Products:
    a. Master Builders Solutions US, Shakopee, MN; Concresive Standard LVI.
    b. Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
    c. Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
    d. Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.
2. Manufacturers and Products:
    a. Dayton Superior Corporation, Kansas City, KS; EDOCO Clean Lift Bond Breaker.
    b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.

C. Repair Material:

1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.

3. Obtain Manufacturer's Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be Site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
6. Manufacturers and Products:
   a. Master Builders Solutions US, Shakopee, MN; MasterEmaco S Series products.
   b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop Series.

2.04 CONCRETE MIX DESIGN

A. General:

1. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
2. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
3. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
4. Use water-reducing admixture or water-reducing admixture and high-range water-reducing admixture, or plasticizing admixture in:
   a. Pumped concrete.
   b. Concrete with a water-cementitious materials ratio below 0.50.
   c. Concrete that is part of a liquid-containment structure, below grade occupied structures and pipe galleries.
   d. Columns, piers, pilasters, and walls.
5. Use water-reducing admixture or high-range water-reducing admixture, or plasticizing admixture:
   a. To achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
   b. When anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
6. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.

B. Potential alkali-aggregate reactivity of concrete:

1. Do not use aggregates susceptible to alkali-carbonate reaction (ACR).
2. Resistance to alkali-silica reaction: Unless otherwise specified, or unless members are designated as being dry in service and not in contact with ground, or assigned to Exposure Class W0, use one of the three following options for qualifying concrete mixtures to reduce the potential of alkali-silica reaction.
3. Option (c) shall not be used with natural pozzolan or fly ash that has a CaO content greater than 18 percent, or for aggregate with expansion at 1 year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293. Fly ash with an alkali content greater than 4.0 percent shall not be used in option (b) or (c).
    a. For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 shall not exceed 0.04 percent at 1 year.
    b. For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 shall not exceed 0.10 percent at an age of 16 days. Submit supporting data for each aggregate showing expansion in excess of 0.10 at 16 days when tested in accordance with ASTM C1260.
    c. Alkali content in concrete (LBA), excluding that from supplementary cementitious materials and pozzolan and slag cement in blended cements, shall not exceed 4 lb/yd^3 for aggregate with expansion greater than or equal to 0.04 percent and less than 0.12 percent or not exceed 3 lb/yd^3 for aggregate with expansion greater than or equal to 0.12 percent and less than 0.24 percent. Reactivity shall be determined by testing in accordance with ASTM C1293. Alkali content in concrete (LBA) shall be calculated as follows:
        1) LBA = (cement content, lb/yd^3) x (equivalent alkali content of portland cement in percent/100 percent).

C. Proportions:

1. Design mix to meet aesthetic, durability, and strength requirements.
2. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.

D. Concrete Shrinkage Limits: Where shrinkage limits are specified, design mix for following shrinkage limits and test in accordance with ASTM C157/C157M, with the following modifications:

1. Prisms shall be moist cured for 7 days prior to 28-day drying period.
2. Comparator reading at end of 7-day moist cure shall be used as initial length in length change calculation.
3. Reported results shall be average of three prisms.
4. If shrinkage of a specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
5. Unless otherwise specified, results at end of 28-day drying period shall not exceed 0.040 percent if 3-inch prisms are used, or exceed 0.038 percent if 4-inch prisms are used. Aggregate will be rejected if test values exceed these limits.

E. Slump Range at Site:

1. Unless otherwise specified, and prior to submitting mix design, select a target slump at the point of delivery for concrete mixtures used for Work. Selected target slump shall not exceed 9 inch. Concrete shall not show visible signs of segregation. The target slump indicated on the submittal shall be used as the basis for acceptance during the project. Determine the slump by ASTM C143/C143M.
2. Slump tolerance shall meet requirements of ACI 117.

2.05 CONCRETE MIXING

A. General: In accordance with ACI 301, except as modified herein.

2.06 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Engineer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in this section.

PART 3 EXECUTION

3.01 PLACING CONCRETE

A. Preparation: Meet requirements ACI 301, except as modified herein.

B. Inspection: Notify Engineer and Special Inspector at least 1 full working day in advance before starting to place concrete.

C. Placement into Formwork:

1. Limit free fall to prevent segregation.
2. Where vapor retarder or barrier is required, coordinate subgrade preparation with requirements in Division 7, Thermal and Moisture Protection of Specifications.
3. Reinforcement: Secure in position before placing concrete.
4. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs which shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
5. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
6. Use placement devices, for example chutes, pouring spouts, and pumps as required to prevent segregation.
7. Do not use aluminum conveying devices.
8. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
9. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
10. Cure concrete as specified in Section 03 39 00, Concrete Curing.

D. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
4. Conveyor Belts:
    a. Approved by Engineer.
    b. Wipe clean with device that does not allow mortar to adhere to belt.
    c. Cover conveyor belts and chutes.

E. Retempering: Not permitted for concrete where cement has partially hydrated.

F. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

G. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate control, and contraction joints where shown on Drawings.
3. Construction Joints: Unless otherwise shown or permitted, locate construction joints as follows:
    a. Locate construction joints as shown on Drawings or where approved in joint location submittal required in Section 03 15 00, Concrete Joints and Accessories.
    b. Provide vertical construction joints in walls and slabs at maximum spacing of 60 feet, unless shown or approved otherwise.
4. Consider beams, brackets, and haunches as part of floor or roof system and place monolithically with floor or roof system.
5. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

H. Minimum Time between Adjacent Placements:

1. Construction or Control Joints: 7 days unless otherwise specified.
2. Construction joint between top of footing or slab, and column or wall: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
3. Contraction Joints: 1 day.
4. If continuous placement of beams, girders, or slabs with columns or walls is indicated in Contract Documents, do not place horizontal elements until the underlying concrete is consolidated and bleed water is not on the surface of the supporting member, unless otherwise specified.

I. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.
3. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
4. Vibrate concrete in vicinity of joints to obtain impervious concrete.

J. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
   a. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
   b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
2. Concrete Curing: As specified in Section 03 39 00, Concrete Curing.

K. Cold Weather Placement:

1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
   a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
   b. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.
   c. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
   d. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
   e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.

f. Cure concrete as specified in Section 03 39 00, Concrete Curing.
   1) Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3500 psi.

2. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.
3. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.
4. Maintain curing conditions as specified in Section 03 39 00, Concrete Curing.

3.02 CONCRETE BONDING

A. Construction Joints in New Concrete Members: Prepare surface of construction joint as specified in Section 03 15 00, Concrete Joints and Accessories.

B. Construction Joints at Existing Concrete:

1. Thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 1/4 inch.
2. Saturate surface with water for 24 hours prior to placing new concrete.

3.03 REPAIRING CONCRETE

A. Repair defective areas of concrete.

1. Cut edges perpendicular to surface at least 1/2-inch deep. Do not feather edges. Soak area with water for 24 hours.
2. Patch with specified repair material.
3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Engineer prior to use.
4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.

5. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.
7. Repair structural cracks, in accordance with Section 03 64 23, Epoxy Resin Injection Grouting.
8. Repair leaking cracks in accordance with Section 03 64 24, Polyurethane Injection Grouting.

B. Tie Holes: Unless otherwise specified, fill with specified repair material.

1. Demonstrate patching of holes at minimum of 6 locations.

C. Alternate Form Ties, Through-Bolts:

1. Demonstrate patching of holes at minimum of six locations.
2. Mechanically roughen entire interior surface of through hole.
3. Dry pack entire hole from both sides of plug with nonshrink grout, as specified in Section 03 62 00, Grouting.
4. Use only enough water to dry pack grout.
5. Dry pack while bonding agent is still tacky.
6. If bonding agent has dried, remove bonding agent by mechanical means and reapply new coat of bonding agent.
7. Compact grout using steel hammer and steel tool to drive grout to high density.
8. Cure grout with water.

D. Exposed Metal Objects:

1. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair area of chipped-out concrete as specified for defective areas.

E. Blockouts at Pipes or Other Penetrations: Where shown install in accordance with requirements of Drawings.

3.04 CONCRETE WALL FINISHES

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

1. Patch tie holes.
2. Knock off projections.
3. Repair defective areas.
4. Inject cracks.

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

1. Patch tie holes.
2. Grind off fins and other projections.
3. Repair defective areas to provide smooth uniform appearance.
4. Inject cracks.

C. Type W-5 (Finish for Painting): In accordance with requirements for Type W-2 except as follows: Leave surface ready for painting as specified in Section 09 90 00, Painting and Coating.

3.05 CONCRETE SLAB FINISHES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Finish slab in accordance with specified slab finish.
4. Do not dust surfaces with dry materials nor add water to surfaces.
5. Cure concrete as specified in Section 03 39 00, Concrete Curing.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
2. Wood float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand steel trowel concrete to produce smooth, smooth dense surface, free from trowel marks.
5. Provide light steel-troweled finish (two trowelings) at air-entrained slabs. Provide hard steel-troweled finish (ringing sound from the trowel) for nonair-entrained slabs.

6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
    a. Approved power machine may be used in lieu of or in addition to hand finishing in accordance with directions of machine manufacturer.
    b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.
    c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):

1. Finish slab to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.
2. Wood float finish to compact and seal surface.
3. Remove laitance and leave surface clean.
4. Coordinate with other finish procedures.

D. Type S-3 (Underside Elevated Slab Finish): When forming is removed, grind off projections on underside of slab and repair defective areas, including small shallow air pockets where schedule of concrete finishes requires: Prepare surfaces to match Type W-2 (Smooth Wall Finish).

E. Type S-5 (Broomed Finish):

1. Finish as specified for Type S-1 floor finish, except use only a light-steel troweled finish, and then finish surface by drawing fine-hair broom lightly across surface.
2. Broom in same direction and parallel to expansion joints, or, in case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

F. Type S-6 (Sidewalk Finish):

1. Slope walks down 1/4 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float with wood or cork float to true plane, then flat steel trowel before brooming.
3. Broom surface at right angles to direction of traffic or as shown.
4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with grooving tool.

3.06 CONCRETE SLAB TOLERANCES

A. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Slab Type S-A: Steel gauge block 5/16-inch thick.
4. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
5. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

3.07 BEAM FINISHES

A. Type B-1: Match wall Type W-1.

B. Type B-2: Match wall Type W-2.

3.08 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.09 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.

3. When concrete is pumped, for each concrete mixture, sampling and testing at point of delivery and at point of placement will be as follows:
    a. Air content: For first load of the day, test will be at point of delivery and at point of placement. Provided results for first load at point of placement are within specified limits, testing will only be performed at point of delivery for every fourth truck except that testing will be performed at point of placement every 4 hours.
    b. Slump: For first load of the day test at point of delivery and at point of placement. Provided results for first load at point of placement are within specified limits, testing will only be performed at point of delivery for every truck except that testing should be performed at point of placement every 4 hours.
    c. Frequency of test cylinders: Concrete will be sampled for making test specimens at point for placement. One composite sample for every 100 cubic yards or one composite sample minimum per day if total quantity is less than 100 cubic yards.
4. Evaluation will be in accordance with ACI 301 and Specifications.
5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
6. Frequency of testing may be changed at discretion of Engineer.
7. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified in Section 03 39 00, Concrete Curing, by seven additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.

C. Cold Weather Placement Tests:

1. During cold weather concreting, cylinders will be cast for field curing as follows. Use method that will produce greater number of specimens:
   a. Six extra test cylinders from last 100 cubic yards of concrete.
   b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens will be in addition to those cast for lab testing.
3. Test cylinders will be protected from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Field test cylinders will be kept in same protective environment as parts of structure they represent to determine if specified strength has been obtained.
5. Cylinders will be tested in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Subcontractor shall use test results to determine specified strength gain prior to falsework removal or for prestressing.

D. Tolerances:

1. Walls: Measure and inspect walls for compliance with tolerances specified in Section 03 10 00, Concrete Forming and Accessories.
2. Slab Finish Tolerances and Slope Tolerances:
   a. Make floor flatness measurements day after floor is finished and before shoring is removed to eliminate effects of shrinkage, curing, and deflection.
   b. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
   c. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

E. Liquid Tightness Tests:

1. Purpose: To determine integrity and liquid-tightness of finished exterior and interior concrete surfaces of liquid containment structures.
2. Test the following structure for liquid-tightness:
   a. 20 – Aerobic Digesters #3 and #4, test elevation 241.79.
3. Water for tightness test shall be provided by Contractor.
4. After testing has been completed, dispose of test water in a manner approved by Owner.

5. Liquid-Tightness Test Requirement:
    a. Rate of filling shall not exceed 4 feet/hour.
    b. Structure shall be filled to test level indicated for minimum of 3 days prior to commencing visual inspection and test measurements.
    c. Minimum test duration shall be as follows:
        1) Water depth up to 15 feet: 5 days.
        2) Water depth up to 20 feet: 4 days.
        3) Water depth greater than 20 feet: 3 days.
    d. Perform tightness tests in accordance with ACI 350.1 and as specified herein.
    e. Do not place backfill or proceed with other work that will cover concrete surfaces until tightness testing has been completed and approved.
    f. Measure evaporation, precipitation, and temperature as specified.
6. Measure water surface at two points 180 degrees apart when possible where attachments, such as ladders exist, at 24-hour intervals.
7. Acceptance Criteria:
    a. Acceptance of the containment structure shall be based on criteria for both Part 1 and Part 2. Containment structures shall be retested until they meet the required Part 1 and Part 2 criteria.
    b. Part 1, Qualitative: If any water is observed on the containment structure surfaces, exterior to the contained liquid, where moisture can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the test.
    c. Part 2, Quantitative:
        1) Volume loss shall not exceed 0.050 percent of contained liquid volume per 24-hour period, adjusted for evaporation, precipitation, and temperature.
        2) Acceptance that structure has passed Part 2 of the liquid tightness test shall be based on volume loss per 24 hour period during specified test period.
8. Repairs When Test Fails:
    a. Dewater structure; fill leaking cracks as specified in Section 03 64 24, Polyurethane Injection Grouting.
    b. Patch areas of damp spots previously recorded and repeat water leakage test in its entirety until structure successfully passes test.

3.10 MANUFACTURER'S SERVICES

A. Provide representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Concrete Producer Representative:
    a. Observe how concrete mixes are performing.
    b. Be present during first placement of each type of concrete mix.
    c. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
    d. Establish control limits on concrete mix designs.
    e. Provide equipment for control of concrete redosing for air entrainment or high range water reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.
2. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
3. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.11 PROTECTION OF INSTALLED WORK

A. After curing as specified in Section 03 39 00, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage as a result of other construction work.

B. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.12 SCHEDULE OF CONCRETE FINISHES

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

B. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
Exterior Wall Surfaces		
Above grade/exposed (above point 6" below finish grade)	W-2	W-B
Above grade/covered with brick veneer or other finish material	W-1	W-A
Backfilled/waterproofed (below point 6" below finish grade)	W-1	W-A
Backfilled/not waterproofed (below point 6" below final grade)	W-1	W-A
Interior Wall Surfaces		
Open top water-holding tanks and basins/not painted or coated	W-2	W-A
Covered water-holding tanks and basins/not painted or coated	W-1	W-A
Water-holding tanks, channels, and basins/painted or coated	W-5	W-A
Buildings, pipe galleries, and other dry areas/not painted or coated	W-2	W-A
Buildings, pipe galleries, and other dry areas/painted or coated	W-5	W-A
Exterior Slabs		
Roof slab/exposed	S-5	S-B
Roof slab/covered with roofing material	S-1	S-A
Water-holding tanks and basins/top of wall	S-5	S-B
Top of footing	S-2	S-A
Other water-holding tanks and basins	S-1	S-A
Stairs and landings	S-5	S-B
Sidewalks	S-6	S-B
Other exterior slabs	S-5	S-A

Area	Type of Finish	Required Form Tolerances
Interior Slabs		
Buildings, pipe galleries, and other dry areas	S-1	S-B
Slabs to receive mortar setting bed for tile	S-2	S-A
Slabs to receive resilient flooring or carpet	S-1	S-A
Hydraulic channels	S-1	S-A
Underside of elevated slabs	S-3	S-A
Beams		
Beams/coated	B-3	B-A
Beams/not coated	B-2	B-A

3.13 SUPPLEMENT

A. Requirements of concrete mix designs following "End of Section," are a part of this Specification and supplement requirements of Parts 1 through 3 of this section:

1. Concrete Mix Design CMD1, Class 4500F2S1W1C1.
2. Concrete Mix Design CMD2, Class 4500F2S1W0C1.
3. Concrete Mix Design CMD3, Class 3500F1S1W0C1.
4. Concrete Mix Design CMD4, Class CF00F1S1W0C1.

END OF SECTION

CONCRETE MIX DESIGN CMD1, CLASS 4500F2S1W1C1:

A. Locations where mix shall be used: Liquid-containment structure, below grade occupied structures and pipe galleries

B. Exposure Categories and Classifications: F2S1W1C1

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
2. Minimum concrete compressive strength (f'c) shall be 4,500 psi at 28 days.
3. Concrete mix shall be designed to conform to shrinkage limits.
4. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
   a. Slabs to receive hard-troweled finish.
   b. Slabs to receive dry shake floor hardener.
   c. Slabs to receive topping placed monolithically as two-course floor on top of plastic concrete.
5. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

* Tolerance of air content is $\pm 1\frac{1}{2}$ percent.

§ Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

6. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in mix design, as follows:
   a. Fly Ash and other Pozzolans: 25 percent.
   b. Slag Cement: 50 percent.
   c. Silica Fume: 10 percent.
   d. Combined Fly Ash and other Pozzolans, Slag Cement, and Silica Fume: 50 percent, with fly ash and other pozzolans not exceeding 25 percent, and silica fume not exceeding 10 percent.
   e. Combined Fly Ash and other Pozzolans and Silica Fume: 35 percent, with fly ash and other pozzolans not exceeding 25 percent, and silica fume not exceeding 10 percent.
   f. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
      1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
      2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
      3) Silica fume, ASTM C1240, present in blended cement.
7. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
   c. ASTM C595/C595M Type IS (greater than 70).
8. Unless otherwise permitted, minimum cementitious materials content in mix design shall be as follows:
   a. 515 pounds per cubic yard for concrete with 1-1/2-inch nominal maximum size aggregate.
   b. 535 pounds per cubic yard for 1-inch nominal maximum size aggregate.
   c. 560 pounds per cubic yard for 3/4-inch nominal maximum size aggregate.
   d. 580 pounds per cubic yard for 1/2-inch nominal maximum size aggregate.
   e. 600 pounds per cubic yard for 3/8-inch nominal maximum size aggregate.
   f. Unless otherwise permitted, limit cementitious materials content to 100 pounds per cubic yard greater than specified minimum cementitious materials content in mix design.

9. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

CONCRETE MIX DESIGN CMD2, CLASS 4500F2S1W0C1:

A. Locations where mix shall be used: Typical, unless otherwise specified.

B. Exposure Categories and Classifications: F2S1W0C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 4,500 psi at 28 days.
   a. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
      1) Slabs to receive a hard-troweled finish.
      2) Slabs to receive a dry shake floor hardener.
      3) Slabs to receive a topping placed monolithically as a two-course floor on top of plastic concrete.
   b. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

* Tolerance of air content is ±1-1/2 percent.

§ Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.

3. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
      3) ASTM C595/C595M Type IS (greater than 70).
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

CONCRETE MIX DESIGN CMD3, CLASS 3500F1S1W0C1:

A. Locations where mix shall be used:

1. Electrical duct banks.
2. Pipe encasements that are not cast monolithically with concrete base mats or slabs.

B. Exposure Categories and Classifications: F1S1W0C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 3,500 psi at 28 days.
3. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	6.0
1/2	5.5
3/4	5.0
1	4.5
1-1/2	4.5
2§	4.0
3§	3.5

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

* Tolerance of air content is ±1-1/2 percent.

§ Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

4. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
      3) ASTM C595/C595M Type IS (greater than 70).
5. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

CONCRETE MIX DESIGN CMD4, CLASS CF00F1S1W0C1:

A. Locations where mix shall be used: Where noted as Fiber Reinforced Concrete Fill (FRCF) on Drawings.

B. Exposure Categories and Classifications: F1S1W0C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 3,500 psi at 28 days.
3. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
3/8	6.0
1/2	5.5
3/4	5.0
1	4.5
1-1/2	4.5
2§	4.0
3§	3.5

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

* Tolerance of air content is ±1-1/2 percent.

§ Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

4. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.

c. ASTM C595/C595M Type IS (greater than 70).
   1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

5. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
6. Fiber Reinforcement:
   a. Where required, provide polypropylene micro-fibers in design mix in accordance with Section 03 24 00, Fibrous Reinforcing.
   b. Add fiber-reinforcement to mix in concrete plant.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

END OF SUPPLEMENT

SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI): 301, Specification for Structural Concrete.
2. ASTM International (ASTM):
   a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
   a. Evaporation retardant.
   b. Curing compound.
   c. Penetrating water repellent sealer.
   d. Clear liquid densifier.
2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
   a. Curing compound showing moisture retention requirements.
   b. Retardants for exposed aggregate finish.

PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM Type I, Class A.

2. Manufacturers and Products:
    a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
    b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
    c. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
    d. Dayton Superior; Safe Cure and Seal 1315 EF.
    e. Master Builders Solutions US, Shakopee, MN; MasterKure CC 200WB.
    f. Euclid Chemical Co., Cleveland, OH; EucoCure VOX.
    g. Euclid Chemical Co., Cleveland, OH; Kurez VOX White Pigmented.

B. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
    a. Master Builders Solutions US, Shakopee, MN; MasterKure ER 50.
    b. Euclid Chemical Co., Cleveland, OH; Eucobar.

C. Penetrating Water Repellent Sealer: Water based, ready to use, single component, silane/siloxane, penetrating, clear water repellant sealer.

1. Viscosity: 50 cps.
2. Flash Point: 200 degrees F.
3. NCHRP No. 244 Reduction in Chloride Content:
    a. Average: 82 percent.
    b. Minimum Required: 75 percent.
4. NCHRP No. 244 Reduction in Weight Gain:
    a. 21 Days: 85 percent.
    b. VOCs: 50 g/l.
    c. Depth of Penetration: 1/4 inch.
5. Manufacturers and Products:
    a. BASF Construction Chemicals, Shakopee MN; MasterProtect H 400.
    b. Euclid Chemical Co.; Baracade WB 244.

D. Clear Liquid Densifier:

1. Colorless, aqueous solution of magnesium fluorosilicate.
2. Each gallon of solution shall contain a minimum of 2 pounds of fluorosilicate compound.

3. Manufacturers and Products:
   a. Master Builders Solutions US, Shakopee, MN; MasterKure HD 300WB.
   b. Euclid Chemical Co., Cleveland, OH; Surfhard.

E. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION

3.01 CONCRETE CURING

A. General:

1. Cure all concrete in accordance with project specifications and ACI 301.
2. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures. Refer to Interior Finish Schedule for surfaces to receive coatings.
3. Use only water curing on potable water structures.
4. Where curing compound cannot be used, water curing as described below or special methods using moisture shall be agreed upon by Engineer prior to placing concrete.
5. As required in Section 03 30 00, Cast-in-Place Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

B. Use one of the following methods as approved by Engineer:

1. Vertical Surfaces
   a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
   b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
   c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.
2. Horizontal Surfaces:
   a. Method 1: Protect surface by water ponding for 7 days.
   b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 7 days.
   c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
   d. Method 4: Continuously sprinkle exposed surface for 7 days.
   e. Method 5: Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.

3.02 EVAPORATION RETARDANT APPLICATION

A. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface.

B. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.

C. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.03 PRESTRESSED TANK CONCRETE CURING

A. Keep concrete surfaces and form continuously wet for 7 days where portland cement is used, or 3 days where high-early-strength cement is used.

B. Begin curing immediately after initial concrete set has occurred.

C. Do not use curing compounds.

3.04 PENETRATING WATER REPELLENT SEALER APPLICATION

A. Apply where indicated on Interior Finish Schedule.

B. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

C. Concrete to receive penetrating sealer shall be dry for a minimum 24 hours immediately prior to application.

D. Apply per manufacturer’s recommendations utilizing low pressure airless spray equipment.

1. Actual coverage and number of coats to be determined by field test sample application and water absorption testing. Final approval by Owner is required.

E. Apply at a coverage rate of 125 square feet per gallon to 200 square feet per gallon. Cure penetrating sealer on slabs for the minimum time recommended by manufacturer prior to allowing foot or vehicular traffic.

3.05 CLEAR LIQUID DENSIFIER APPLICATION

A. Apply where indicated in Interior Finish Schedule.

B. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

C. Apply liquid densifier evenly, using three coats, allowing 24 hours between coats.

1. First coat 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength, mix with water.
2. Apply each coat so as to remain wet on surface for 15 minutes.
3. Apply approved liquid densifier in accordance with manufacturer's instructions.
4. After final coat is completed and dry, remove surplus liquid densifier from surface by scrubbing and mopping with water.

3.06 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

B. Provide penetrating water repellent sealer manufacturer's representative to demonstrate proper application of product.

C. Provide clear liquid densifier manufacturer's representative to demonstrate proper mixing and application of product.

D. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

END OF SECTION

SECTION 03 62 00
GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   b. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   c. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   d. C579, Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   e. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   f. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   g. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   h. C1181, Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   i. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing nonshrink grout.
3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer’s Written Instructions:
   a. Adding fiber reinforcing to batching.
   b. Mixing of grout.

2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements.
   a. Grout free from chlorides and other corrosion-causing chemicals.
   b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Manufacturer's Certificate of Proper Installation.
5. Statements of Qualification: Grout manufacturer's representative.
6. Test Reports:
   a. Test report for 24-hour evaluation of nonshrink grout.
   b. Test results and service report from demonstration and training session.
   c. Field test reports and laboratory test results for field-drawn Samples.
7. List of Contractor's equipment installation staff trained by grout manufacturer's representative in: Nonshrink grout installation and curing.

1.03 QUALIFICATIONS

A. Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Provide independent testing laboratory test results for testing conducted within last 18 months.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT SCHEDULE

A. Furnish nonshrink grout category as indicated in the following schedule:

Application	Grout Category
Blockouts for gate guides	II
Precast joints	II
Column baseplates single-story	II
Machine bases 25 hp or less	II

Application	Grout Category
Bases for precast wall sections	II
Baseplates for columns over one story	II
Precast base joints higher than one story	II
Form Tie-Through bolt openings	II
Machine bases 26 hp and up	III
Baseplates and/or soleplates with vibration, thermal movement, etc.	III

2.02 NONSHRINK GROUT

A. Category II:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. Master Builders Solutions US., Shakopee, MN; MasterFlow 928.
   b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
   c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
   d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.
   e. US MIX Co., Denver, CO; US SPEC MP Grout.

B. Category III:

1. Metallic and nongas-liberating.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.

4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturer and Product:
   a. Master Builders Solutions US., Shakopee, MN; MasterFlow 885.
   b. Euclid Chemical Co, Cleveland, OH; Hi-Flow Metallic Grout.

PART 3 EXECUTION

3.01 GROUT

A. General: Mix, place, and cure grout in accordance with grout manufacturer's representative's training instructions.

B. Form Tie-Through Bolt Holes: Provide nonshrink grout, Category II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with X- plug in Section 03 10 00, Concrete Forming and Accessories, and bonding agent in Section 03 30 00, Cast-in-Place Concrete.

C. Form Snap-Tie Hole: Fill tie hole in accordance with requirements of Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.

3.02 GROUTING MACHINERY FOUNDATIONS

A. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.

B. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.

C. Sandblast to bright metal all metal surfaces in contact with grout in accordance with manufacturer's written instructions.

D. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

E. Form with watertight forms at least 2 inches higher than bottom of plate.

F. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

G. If grout cannot be placed from one edge and flowed to the opposite edge, air vents shall be provided through the plate to prevent air entrapment.

H. Radius all corners of grout pad.

3.03 TANK FOUNDATIONS

A. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.

B. Clean metal surfaces of all paint, oil, grease, loose rust and other foreign material that will be in contact with grout.

C. Set tank in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

D. Form with watertight forms at least 2 inches higher than bottom of plate.

E. Fill space between bottom of tank base and original concrete in accordance with manufacturer's representative's training instructions.

3.04 FIELD QUALITY CONTROL

A. General:

1. Performed by Project representative's inspection staff.
2. Perform the following quality control inspections. The grout manufacturer's representative shall accompany the Project representative's inspection staff on the first installation of each size and type of equipment.

B. Evaluation and Acceptance of Nonshrink Grout:

1. Inspect the surface preparation of concrete substrates onto which nonshrink grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
2. Inspect preparation and application of nonshrink grout form work for conformance to the manufacturer's recommendations.
3. Conduct a final review of completed nonshrink grout installation for conformance to these Specifications.

4. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
5. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
6. For large grout applications, make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
7. Consistency: As specified in Article Nonshrink Grout. Flow cone test in accordance with ASTM C939. Grout with consistencies outside range requirements shall be rejected.
8. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
9. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
10. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
11. Perform bleeding test in accordance with ASTM C940 to demonstrate grout will not bleed.
12. Store cubes at 70 degrees F.
13. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.
14. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

3.05 MANUFACTURER'S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer's representative. Allow 2-week notice to grout manufacturer's representative for scheduling purposes.
2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of grout.
3. Necessary equipment and materials shall be available for demonstration.
4. Conduct training prior to equipment mount installation work on equipment pads.
5. Training for each type of grout shall be not less than 4 hours' duration.

B. Nonshrink Grout Training:

1. Training is required for Type II and Type III grout installations.
2. Provide nonshrink grout installation training by the qualified grout manufacturer's representative for Contractor's workers that will be installing nonshrink grout for baseplates and equipment mounts. Schedule training to allow Engineer's attendance.
3. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and form tie-through bolt holes to provide actual on-the-job training.
4. Use minimum of two bags for each grout Category. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.
5. Include recommended grout curing methods in the training.
6. Mix and demonstrate patching through-bolt holes and blockouts for gate guides, and similar items.
7. Transport test cubes to independent test laboratory and obtain test reports.
8. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.

3.06 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is part of this Specification.

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

_____
(Test Lab Name)

_____
(Address)

_____
(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain three bags of each type of grout.

1. From intended grout supplier for Project.
2. Three bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A.	Product data and warranty information contained in company literature and data?	Yes_____ No_____
B.	Literature and bag information meet specified requirements?	Yes_____ No_____
C.	Manufacturer guarantees grout as specified in Article Guarantee?	Yes_____ No_____
D.	Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas?	Yes_____ No_____
E.	Water demands and limits printed on bag?	Yes_____ No_____
F.	Mixing information printed on the bag?	Yes_____ No_____
G.	Temperature restrictions printed on bag?	Yes_____ No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____
2. List expiration date. _____
3. Weigh bags and record weight. _____

Owner's Representative will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of three bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10-gallon pail.
2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
3. Use maximum water allowed per water requirements listed in bag instructions.
4. Mix grout to maximum time listed on bag instructions.
5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. _____ seconds
6. Add water to attain 20- to 30-second flow in accordance with ASTM C939.
7. Record time of grout through cone at new water demand. _____ seconds
8. Record total water needed to attain 20- to 30-second flow. _____ pounds
9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
3. Cover top of both cans with glass or plastic plate preventing evaporation.
4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.

5. Visually check for bleeding of water at 15-minute intervals for 2 hours.
6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3-gallon cans. Place the cans into the 40-degree F and 90-degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4 inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.
2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take a ASTM C939 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 degrees F and 90 degrees F.
    a. 20 min _____, sec. @ 40 degrees F.
    b. 40 min _____, sec. @ 40 degrees F.
    c. 60 min _____, sec. @ 40 degrees F.
    d. 20 min _____, sec. @ 90 degrees F.
    e. 40 min _____, sec. @ 90 degrees F.
    f. 60 min _____, sec. @ 90 degrees F.

All Category II and Category III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

_____ _____

Qualified Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.
2. Store cubes at 70 degrees F for 24 hours.
3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

_____ _____

Signature of Independent Testing Laboratory Date Test Conducted

SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. International Code Council (ICC):
   a. 2018 International Building Code (IBC).
   b. Evaluation Services Reports.
4. Florida Building Code, 7th Edition (2020).

1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s catalog information.

B. Informational Submittals:

1. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
2. Manufacturer’s written letter of certification identifying installer’s qualifications to install products.
3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: At least three similar projects with same products within last 3 years.
2. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Store adhesive components in accordance with manufacturer's written instructions.

C. Dispose of when:

1. Shelf life has expired.
2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to 2018 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
2. Suitable for long-term loads as well as for wind loads.
3. Meet requirements of ASTM C881/C881M.
4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
5. Disposable, Self-Contained Cartridge System:
   a. Capable of dispensing both components in proper mixing ratio.
   b. Fit into manually or pneumatically operated caulking gun.
6. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD (ESR-2322) or HIT-HY 200 (ESR-3187) Adhesive Anchors.
   b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System (ESR-3298).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508).

B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

C. Reinforcing Dowels: As specified in Section 03 21 00, Steel Reinforcement.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes:
   a. Electric or pneumatic rotary type with medium or light impact.
   b. Hollow drills with flushing air systems are preferred.
2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.

C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.

D. Doweling:

1. Install per details shown on Drawings and in accordance with adhesive manufacturer's instructions.
2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement or other obstruction is likely, slant drill to address edge distance or to clear obstruction. If drill must be slanted more than indicated in the manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

E. Adhesive:

1. Install in accordance with written manufacturer's instructions.
2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 64 23
EPOXY RESIN INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C882, Standard Specification for Test Method for Bond Strength of Epoxy Resin System Used with Concrete by Slant Shear.
   b. D570, Standard Test Method for Water Absorption of Plastics.
   c. D638, Standard Test Method for Tensile Properties of Plastics.
   d. D648, Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. Hydraulic Structure: Liquid containment structure and/or structure designed to mitigate liquid infiltration.

D. Injection: Method of bonding together, addressing or eliminating leakage through cracks or joints by installing resin under pressure to fill the void in crack or joint.

E. Joint: A planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements and may contain embedded waterstops.

F. Leak or Leakage: Crack or joint exhibiting presence of moisture, sign of efflorescence, intermittently wet to touch, or continuous flow of liquid.

G. Narrow Cracks: Width equal to or less than 0.015 inch.

H. Wide Cracks: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for epoxy resin.
2. Technical data for metering, mixing, and injection equipment.
3. Depth of penetration, length, material used, and procedures where epoxy is approved for use.
4. Marked up drawings of proposed epoxy injection repair crack locations, widths, and lengths and direction on structure.
5. Sample bottle.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for epoxy resins.
2. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements.
3. Statements of Qualification for Epoxy Resin:
   a. Manufacturer's Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
4. Sample of epoxy resin two component ratio and injection pressure test records for concrete crack repair work.
5. Installation instructions for repairing core holes with repair mortar.
6. Epoxy resin two component ratio and injection pressure test records for concrete crack repair work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staffs:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of epoxy injection process for concrete structure.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.
   c. Experienced in operation, maintenance, and troubleshooting of application equipment.

2. Injection Crew and Job Foreman:
    a. Provide written and verifiable evidence showing compliance with the following requirements:
        1) Licensed or certified by epoxy resin material manufacturer.
        2) Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection, including 2,000 linear feet of wet crack injection to stop water leakage.

1.05 PERFORMANCE REQUIREMENTS

A. Injected Epoxy Resin: Fill cracks and joints with minimum resin depth penetration no less than 90 percent of:

1. Full thickness of concrete section for cracks or joints.
2. Depth between waterstop and inside face of structure for joints with an embedded waterstop.

B. Injected cracks and joints which leak shall be considered deficient work irrespective of depth of penetration. Reinjection of deficient work or, with approval of Engineer, provide other repairs to eliminate leakage.

C. Bond Strength Test for Epoxy Resin:

1. Concrete failure before resin failure.
2. 1,500 psi minimum bond strength per ASTM C882 test requirements with no failure of either concrete or epoxy resin.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Package resin material in new sealed containers and label with following information:
    a. Manufacturer's name.
    b. Product name and lot number.

B. Storage and Protection: Store epoxy resin material containers in accordance with manufacturer's printed instructions and at ambient temperatures below 110 degrees F and above 45 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials and accessories specified in this section shall be products of:

1. Master Builders Solutions, US, Shakopee, MN; MasterInject series products that meet properties below.
2. Sika Corp., Lyndhurst, NJ; Sikadur Series products that meet properties below.
3. Euclid Chemical Co., Cleveland, OH; Euco Series (#452) products that meet properties below.

2.02 EPOXY INJECTION RESIN

A. Two-component A and B structural epoxy resin for injection into cracks or joints or other voids in concrete structures for bonding or grouting.

B. Uncured Resin Properties:

1. When mixed in ratio specified on resin container label:

	Test Method	**Wide Cracks or Joints**	**Narrow Cracks or Joints**
Pot Life (60-gram mass) @ 77, plus or minus 4 deg F	As specified in Article Source Quality Control	13 to 25 minutes	15 to 30 minutes
Pot Life (60-gram mass) @ 100, plus or minus 4 deg F	As specified in Article Source Quality Control	3 to 10 minutes	10 to 20 minutes
Viscosity @ 40, plus or minus 3 deg F	Brookfield RVT Spindle No. 4 @ 20 rpm	4,400 cps	600 cps
Viscosity @ 75 to 77 deg F	Brookfield RVT Spindle No. 2 @ 20 rpm	375 to 350 cps	175 to 140 cps

C. Epoxy Resin Properties: When cured for 7 days at 77 degree F, plus or minus 3 degrees F and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

	Test Method	**Wide Cracks or Joints**	**Narrow Cracks or Joints**
Ultimate Tensile Strength, psi	ASTM D368	8,000 min.	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	4.2 max.	3.0 max.
Flexural Strength, psi	ASTM D790	10,000 min.	10,000 min.
Flexural Modulus, psi	ASTM D790	5.5×10^5 min.	4.5×10^5 min.
Compressive Yield Strength, psi	ASTM D695*	15,000 min.	12,000 min.
Compressive Modulus, psi	ASTM D695*	4.0×10^5 min.	4.0×10^5 min.
Heat Deflection Temperature	ASTM D648*	130 deg F min.	140 deg F min.
Cured 3 days @ 40 deg F – Wet Concrete		3,500 psi min.	3,500 psi min.
Cured 1 day @ 77 deg F – Dry Concrete		5,000 psi min.	5,000 psi min.
Cured 3 days @ 77 deg plus or minus 3 deg F		5,000 psi min.	5,000 psi min.
*Cure test specimens so that peak exothermic temperature of resin does not exceed 100 degrees F. Note: See referenced specifications for preparation method of test specimens.			

2.03 SURFACE SEAL

A. Sufficient strength and adhesion for holding injection fittings firmly in place and to resist pressures preventing leakage during injection.

B. Capable of removal after injection resin has cured.

2.04 WATER

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

2.05 SAMPLE BOTTLE

A. Five-inch natural wide mouth HDPE bottle or 4-ounce clear PVC cylinder bottle; supplied with caps.

2.06 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of epoxy resin.

B. Pot Life Test:

1. Condition Component A and Component B to required temperature.
2. Measure components in ratio of Component B as stated on manufacturer's label into an 8-fluid ounce paper cup.
3. Mix components for 60 seconds using non-metallic stirring instrument. Scrape sides and bottom of cup periodically.
4. Probe mixture once with non-metallic stirring instrument every 30 seconds, starting 2 minutes prior to minimum specified pot life.
5. Pot Life Definition: Time at which a soft stringy mass forms in center of cup.

C. Slant Shear Test: Prepare specimens and perform tests in accordance with ASTM C882.

PART 3 EXECUTION

3.01 GENERAL

A. Unless permitted otherwise, structurally repair cracks or joints listed below: Cracks considered to be defective as defined in Section 03 30 00, Cast-in-Place Concrete.

B. Do not proceed with injection work until submittals have been reviewed and approved by Engineer.

C. Perform cracks or joints injection work after removing defective surface materials and after performing surface preparation, but prior to applying surface repair material unless otherwise noted. See Section 03 30 00, Cast In Place Concrete for concrete surface repair system.

D. The width of cracks may vary along length and through thickness of concrete section.

E. Remove all excess, unused epoxy resin materials on concrete surfaces exposed to view prior to end of Work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two epoxy resin components and inject mixture into cracks or joints.

B. Pumps:

1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.
3. Capable of immediate compensation for changes in resins.
4. Do not use batch mix pumps.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed epoxy resin at pressures in accordance with epoxy resin manufacturer's printed instruction and able to maintain pressure.

D. Automatic Shutoff Control: Provide sensors on both Component A and Component B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: Maintain epoxy resin manufacturer's prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:

1. Two independent valve nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
2. Pressure gauge capable of sensing pressure behind each valve.

3.03 PREPARATION

A. Free cracks or joints from loose matter, dirt, laitance, oil, grease, efflorescence, salt, and other contaminants.

B. Clean cracks or joints in accordance with epoxy resin manufacturer's instructions.

C. Clean surfaces adjacent to cracks or joints from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instructions.

D. Do not use acids and corrosives for cleaning, other than those specified herein unless neutralized prior to injecting epoxy resin.

E. During installation and curing of materials, if ambient temperature is expected to drop below manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

G. Dry out cracks or joints if required by manufacturer's instructions.

3.04 APPLICATION

A. All liquid is to be removed from hydraulic structure prior to commencing with epoxy injection, unless approved otherwise.

B. Entry Ports:

1. Establish openings for epoxy resin entry in surface seal along crack.
2. Determine space between entry ports equal to thickness of concrete member to allow epoxy resin to penetrate to the full thickness of the member.
3. Drill injection holes at an angle between 45 degrees and 60 degrees from surface of concrete and perpendicular to alignment of cracks or joints, to intersect crack or joint at midpoint of concrete section.
4. Locate drill holes on alternate sides of crack or joint where possible, unless orientation of crack or joint is known or has been verified by non-destructive testing techniques or core drilling.
5. Drill Hole Spacing: Do not exceed concrete thicknesses or 12 inches maximum, except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack or joint.
7. Take measures to prevent drilling holes for injection too shallow or too deep, or damaging waterstop in joints.
8. Remove dust and debris in drill holes and on surface of structure resulting from drilling operation, by flushing with water prior to installing the injection packers or ports.
9. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
    a. Cracks or joints extend entirely through concrete element.
    b. Backfill of walls on one side.
    c. Slab-on-grade.
    d. Difficult to excavate behind wall to seal both surfaces of crack.

10. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling or other one-way ball or check valve, to permit testing for watertightness cracks and joints.

C. Application of Surface Seal along Cracks and Joints:

1. Apply surface seal in accordance with manufacturer's instructions to designated cracks and joints face prior to injection. Seal surface of cracks or joints to contain and prevent escape of injection epoxy.
2. Cure surface seal in accordance with manufacturer's printed instructions before commencing inject work.

D. Epoxy Injection:

1. Ensure zerk coupling is not installed in ports or packers next to the one being injected.
2. Start injection into each crack or joint at lowest elevation entry port or packer along vertical or diagonal crack or joint, and at one end of horizontal crack or joint.
3. Where injection entry ports or packers are used, continue injection at first port or packer until resin begins to flow out of port or packer at next highest elevation. Plug first port or packer and start injection at second port or packer until resin flows from next port or packer.
4. Inject entire crack or joint with same sequence.
5. At no time inject more than 6 feet length of first vertical crack or joint before verifying resin in sample bottle has start to set and cure.
6. Prior to commencing injection work along a horizontal crack or joint in structure when processed using ports or packers with zerk couplings are used, remove zerk couplings from injection ports or packers except for two ports or packers located where injection work will commence. Commence injection work in first two ports or packers. Once clean resin is vented from third injection port or packer, cease injection at first port or packer, and install zerk coupling and commence injection at third port or packer. Repeat process for fourth and subsequent ports or packers until full length of crack or joint has been injected.
7. The injected epoxy resin shall fill the cracks and joints, and in no case shall the depth of penetration of the injection material be less than ninety percent (90 percent) of:
    a. The full thickness of the concrete section for cracks or joints; and
    b. The depth between the waterstop and the inside face of the structure for joints with an embedded waterstop.

8. Injected crack sand joints found to exhibit leakage shall be deemed as deficient work irrespective of the depth of penetration. Carry out re-injection of deficient work as required , at no cost to the Owner.

E. Finishing:

1. Allow epoxy resin to cure in accordance with manufacturer's instruction after cracks or joints have been completely injected to allow surface seal removal without draining or runback of uncured epoxy resin material from cracks or joints.
2. Remove surface seal and injection packers or ports from cured injection resin along crack.
3. Finish crack or joint faces flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports, packers, drill holes, or damage from removal of surface seal is not acceptable.
5. Grind off protrusions and patch indentations and holes from injection packers and entry ports with a suitable patch material to satisfaction of Engineer.
6. Remove surplus surface seal material splatters and injection resin material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Epoxy Resin Two Component Ratio Tests:

1. Disconnect mixing head and pump two resin components simultaneously through ratio check device.
2. Adjust discharge pressure to 160 psi for both resin components.
3. Simultaneously discharge both resin components into separate calibrated containers.
4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work has stopped for more than 1 hour.
7. Document and maintain complete accurate records of ratios and pressure checks.

B. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect two resin component delivery lines to pressure check device.

2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure test for each injection equipment unit:
   a. Beginning and end of each injection work day.
   b. When injection work stops for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Bottled Sample Tests:

1. During injection operation, provide at least one sample of mixed epoxy resin for each injection pump per shift per injection work day in a sample bottle.
2. Provide sufficient sample to demonstrate sample material epoxy resin will set and cure correctly.
3. Label each bottled sample with Contractor's name, date, and time sample was taken, and location in structure where sample was taken. Record details of bottle sample tests.
4. Place filled sample bottle upright in a container and allow sample to cure.
5. After sample has been allowed to cure, cut bottled sample open and visually inspect contents to verify that epoxy resin material has completely reacted and cured.
6. Evaluation and Assessment of Test:
   a. Should bottled sample(s) indicate a problem; such as epoxy resin not cured or foreign liquid in sample bottle, take verifying core sample immediately from cracks or joints, where material was used.
   b. Should above-referenced bottle sample(s) and core sample(s) indicate a problem with epoxy resin, arrange to have a Technical Representative of the epoxy resin manufacturer come to Site to review bottled sample(s) and core drilled sample(s) with Engineer and provide technical advice on corrective measures.
   c. Carry out further investigation work or corrective measures recommended by Technical Representative of epoxy resin manufacturer.

D. Core Sample Tests:

1. When required by Engineer.
2. Initial Cores:
   a. 4-inch diameter for full crack depth along cracks or joints or to waterstop in joints taken from Engineer selected locations.
   b. Take three cores in first 100 linear feet of crack repaired and one core sample for each 500 linear feet thereafter.
   c. Label each core with core number, location, and date when core was obtained.
3. Provide suitable containers for storage, curing, and transportation of test specimens.
4. Methods of Testing Cores:
   a. Penetration: Visual examination.
   b. Bond Strength/Compression Test: Concrete failure prior to resin failure.
5. Test Requirements:
   a. Penetration: Per performance requirements.
   b. Bond Strength (Compression Test): Per performance requirements.
6. Evaluation and Acceptance of Tests:
   a. If initial cores pass tests as specified, epoxy resin injection work at area represented by cores will be accepted.
   b. If initial cores fail either by lack of penetration or bond strength, crack or joint repair Work shall not proceed further until areas represented by cores are reinjected or repaired and retested for acceptance.
   c. Obtain verifying core samples, number, and location as selected by Engineer, after rework of areas represented by failed initial cores is complete.
7. Core Hole Repair:
   a. Correct work as result of testing upon notification from Engineer.
   b. Refill initial and verifying core holes with a suitable repair mortar, per Section 03 30 00 Cast In Place Concrete, tamped and rodded in-place to completely fill for full depth of core hole.
   c. Finish surface to blend with adjacent concrete.

END OF SECTION

SECTION 03 64 24
POLYURETHANE INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
   c. D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   d. D3574, Standard Test Method for Flexible Cellular Material Slab, Bonded, and Molded Urethane Foams.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Injection: Method of bonding together; method of addressing or eliminating leakage through cracks or joints by installing polymer under pressure to fill the void in the crack or joint.

C. Joint: A planned and formed discontinuity in the concrete structure at the junction of adjacent and sequential concrete placements, and may contain embedded waterstops.

D. Leak or Leakage: Crack or joint exhibiting moisture, sign of efflorescence, intermittent wet to the touch, or continuous flow of liquid.

E. Narrow Cracks: Width equal to or less than 0.015 inch.

F. Wide Crack: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for polyurethane injection resin.
2. Technical data for metering, mixing, and injection equipment.

3. Submit marked up drawings of proposed polyurethane injection work including locations, depth of penetration, length, materials used, and procedures.
4. Sample bottle.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for polyurethane resin injection.
2. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements. Certified test results for each batch of polyurethane.
3. Statements of Qualification for Polyurethane Resin Injection:
   a. Manufacturer's Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
4. Sample of polyurethane resin mix ratio and injection pressure test records for concrete crack and joint injection work.
5. Installation instructions for repairing core holes with repair mortar.
6. Polyurethane resins injection pressure test records for concrete crack and joint injection work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staff:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of polyurethane injection process for concrete structures.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.
   c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
   a. Licensed or certified by polyurethane resin manufacturer.
   b. Minimum 3 years' experience in successful polyurethane injection for at least 10,000 linear feet of successful crack and joint injection, including 2,000 linear feet of wet crack and joint injection to stop water leakage.

1.05 PERFORMANCE REQUIREMENTS

A. The injected polyurethane resin shall fill the cracks and joints, and in no case shall the depth of penetration of the injection material be less than 90 percent of:

1. The full thickness of the concrete section for cracks.
2. The depth between the waterstop and the face of the structure for joints.

B. In cured state, injected polyurethane resin forms a dense rubber-like closed cell flexible foam compression gasket-type seal material.

C. Notwithstanding the foregoing, injected cracks or joints which exhibit leakage are considered deficient work irrespective of the depth of penetration observed in quality control core drilled samples. Reinject deficient work as required to meet the performance requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Package adhesive material in new sealed containers and label with following information:
   a. Manufacturer’s name.
   b. Product name and lot number.

B. Storage and Protection: Store polyurethane resin material containers in accordance with manufacturer’s printed instructions or in the absence of such information at ambient temperatures below 110 degrees F and above 68 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Master Builders Solutions US, Building Systems, Shakopee, MN; Masterinject 1210 IUG.

B. Sika Corp., Lyndhurst, NJ; SikaFix HH Hydrophilic.

C. Euclid Chemical Co., Cleveland, OH; DURAL Aqua-Fil.

D. Prime Resins, Inc., Conyers, GA; Prime Flex 900 XLV.

2.02 POLYURETHANE RESIN

A. Single-component, water-activated, hydrophilic polyurethane injection resin.

B. Elongation: Minimum 350 percent, in accordance with ASTM D3574 or ASTM D638 test method.

C. Tensile Strength: Minimum 150 psi, in accordance with ASTM D3574 or ASTM D638 test method.

2.03 SURFACE SEAL

A. Provide seal with sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection resin has cured.

2.04 WATER

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

2.05 SAMPLE BOTTLE

A. 5 inches natural wide mouth HDPE bottle or 4 ounces clear PVC cylinder bottle, supplied with caps.

2.06 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of polyurethane resins.

PART 3 EXECUTION

3.01 GENERAL

A. Use of polyurethane injection shall be limited to nonstructural locations such: Cracks and joints that leak.

B. Do not proceed with injection work until action submittals have been reviewed and approved by the Structural Engineer of Record.

C. Perform injection work after performing surface preparation.

D. The width of the cracks shown may vary along the length and through the thickness of the concrete section.

E. Remove all excess unused polyurethane resins materials inside the structure prior to the end of the work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter mixed components, and inject mixture into crack or joint.

B. Pumps:

1. Positive displacement type pump.
2. Equip the polyurethane injection equipment with pail heater(s) suitable for plastic pails capable of maintaining the polyurethane resin and accelerator mixture between 50 degrees F and 160 degrees F.
3. A thermometer with each pump for monitoring the temperature of the polyurethane resin.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed polyurethane resin at pressures in accordance with polyurethane resin manufacturer's printed instructions, and able to maintain such pressure.

D. Proportioning Ratio Tolerance: Maintain polyurethane manufacturer's prescribed mix ratio within a tolerance in accordance with polyurethane resin manufacturer's printed instructions.

E. Pressure gauge capable of sensing pressure behind valve.

3.03 PREPARATION

A. Free cracks and joints from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks and joints in accordance with polyurethane resins manufacturer's printed instructions.

C. Clean surfaces adjacent to cracks and joints from dirt, dust, grease, oil, efflorescence, encrustation, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instructions.

D. Do not use acids and corrosives for cleaning, other than those specified herein, unless neutralized prior to injecting polyurethane resin.

E. During installation and curing of materials, if the ambient temperature is expected to drop below the manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

3.04 APPLICATION

A. Injection Ports:

1. Drill holes shall be installed along cracks and joints designated for injection as required to meet the performance requirements for injection.
2. The requirements for installing drill holes for injection provided below represent acceptable minimum standards of practice.
3. Drill holes for injection at an angle between 45 degrees and 60 degrees from the surface of the concrete and perpendicular to the cracks or joints alignment , to intersect the cracks at the midpoint of the concrete section, and intersect the joints at the midpoint between the waterstop and interior concrete surface.
4. Locate drill holes on alternate sides of the crack or joint where possible, unless orientation of the crack or joint is known or has been verified by nondestructive testing techniques or core drilling.
5. The spacing of drill holes not to exceed the concrete thickness or 12 inches (maximum), except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack or joint and at required angle, such as using a template, during the Work especially at the commencement of drilling holes for.
7. Take measures to prevent damaging the waterstop in joints when drilling holes for injection.
8. Remove dust and debris in drill holes and on interior surface of the structure resulting from drilling operation, by flushing with water prior to installing injection packers or ports.
9. Install injection packers or ports in drill holes in accordance with manufacturer’s printed instructions with zerk coupling, or other one-way ball or check valve, to permit testing for watertightness of cracks and joints.

B. Application of Surface Seal Along Cracks and Joints:

1. Apply surface seal along the length of the cracks and joints designated for injection on the top side and underside of slabs, or both sides of walls, where possible in order to contain, confine, and prevent escape of the injected polyurethane resin, in accordance with manufacturer’s printed instructions.
2. Cure the surface seal in accordance with the material’s manufacturer’s printed instructions.

C. Polyurethane Injection of Cracks B: and Joints:

1. Inject polyurethane resins, mixed with accelerator or in a neat form, into cracks and joints in a sequential manner, and reinjection as required, to meet the performance requirements.

2. Start injection into each crack or joint at lowest elevation entry port for vertical or diagonal cracks and joints and at one end for horizontal cracks and joints in vertical structure. Continue injection at first port until pure uncontaminated resin begins to flow out of next port. Plug first port and start injection at second port until polyurethane resin flows from next port. Inject crack or joint in a sequential manner until the full length of the crack or joint has been injected. At no time inject more than 6 feet length of vertical crack or joint before verifying that the first 12 inches of injected crack or joint is set and cured.
3. Prior to commencing the injection work along a crack or joint in horizontal structure when packers with zerk couplings are used, remove the zerk couplings from the injection packers or ports except for the two packers located where the injection work will commence. Commence injection work in the first two packers. Once clean resin is vented from the third injection packer, cease injection at the first packer, and install the zerk coupling and commence injection at the third packer. Repeat the process for the fourth and subsequent packers until the full length of the crack or joint has been injected.

D. Finishing:

1. Cure polyurethane resins after crack or joints has been completely filled without draining or runback of polyurethane resin material from crack or joints.
2. Remove surface seal and injection packers or ports from along the crack or joints.
3. Finish surface flush and to match surrounding concrete.
4. Indentations or protrusions caused by placement of entry ports drill holes, or damage from removal of surface seal, is not acceptable.
5. Grind off protrusions, and patch indentations and holes from packers and ports with a suitable patch material to the satisfaction of the Engineer.
6. Remove surplus surface seal material on splatters and injection material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect polyurethane component delivery line to pressure check device.
2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.

3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure Test for Each Injection Equipment Unit:
   a. Beginning and end of each injection work day.
   b. When injection work has stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

B. Bottled Samples:

1. During the injection operation, provide at least one sample of the mixed polyurethane injection resins per shift per injection pump in a sample bottle.
2. Half fill each sample bottle, containing a small amount of water (5 percent by volume) with polyurethane injection resin material from the pump discharge hose. Swirl or lightly shake sample to thoroughly mix resin with the water. When foaming rises near the top of the bottle, install the cap to contain the expanding resin material.
3. Label each bottled sample with Contractor's name, date and time sample was taken, and location in structure where sample was taken. Maintain a log of bottle samples.
4. Place filled sample bottle upright in a box or pail and allow sample to cure.
5. After sample cured, cut bottled sample open and visually inspect contents to verify that polyurethane injection resins material has completely reacted and cured.
6. Evaluation and Assessment of Test:
   a. If a bottled sample(s) indicates a problem with the polyurethane injection resins, such as polyurethane resin not cured; take verifying core sample immediately from the cracks or joints, where the material was used.
   b. If the above-referenced bottle sample(s) and core sample(s) indicate a problem with the polyurethane injection resins, have a Technical Representative of the polyurethane injection resins manufacturer come to site to review bottled sample(s) and core drilled sample(s) with Engineer and provide technical advice on corrective measures.
   c. Carry out further investigation work or corrective measures recommended by the Technical Representative of the polyurethane injection resins manufacturer.

END OF SECTION

SECTION 05 05 19
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A143/A143M, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   e. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   f. A380/A380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   g. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
   h. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   i. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   j. A967/A967M, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
   k. E488/E488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
   l. F436/F436M, Standard Specification for Hardened Steel Washers.

m. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Socket Head Cap Screws, and Studs for General Use.
n. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
o. F594, Standard Specification for Stainless Steel Nuts.
p. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

5. International Code Council Evaluation Service (ICC-ES):
   a. Evaluation Reports for Concrete and Masonry Anchors.
   b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
   c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
   d. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   e. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
6. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior below grade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete Anchors:
   a. Manufacturer's product description and installation instructions.
   b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
   c. Adhesive Anchor Installer Certification.
2. Passivation method for stainless steel members.
3. Hot-Dip Galvanizing: Certificate of Compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
Carbon Steel:	
Threaded Rods	F1554, Grade 36
Flat and Beveled Washers (Hardened)	F436/F436M
Nuts*	A194/A194M, Grade 2H
Galvanized Steel:	
All	A153/A153M
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Fastener Schedule at end of this section.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
   b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1 , +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Undercut Anchors:

1. Manufacturers and Products:
   a. USP Structural Connectors, Burnsville, MN; DUC Undercut Anchor (ESR-1970).
   b. Hilti, Inc., Tulsa, OK; HDA Undercut Anchor (ESR-1546).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; TORQ-CUT Self-Undercutting Anchor (ESR-2705).
   d. DeWalt/Powers Fasteners, Brewster, NY; Atomic+ Undercut Anchor (ESR-3067).

D. Self-Tapping Concrete Screw Anchors:

1. Manufacturers and Products:
   a. DeWalt/Powers Fasteners, Brewster, NY; Wedge-Bolt+ (ESR-2526).
   b. DeWalt/Powers Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR-2989).
   c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
   d. Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
   e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713 and IAPMO UES-493).

E. Adhesive Anchors:

1. Threaded Rod:
   a. Diameter as shown on Drawings.
   b. Length as required to provide minimum depth of embedment indicated and thread projection required.
   c. Clean and free of grease, oil, or other deleterious material.
2. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.

3. Packaging and Storage:
   a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
   b. Store adhesive on pallets or shelving in a covered storage area.
   c. Package Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
   d. Dispose of When:
      1) Shelf life has expired.
      2) Stored other than in accordance with manufacturer's instructions.
4. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814).
   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
   c. DeWalt/Powers Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR-3298).

F. Adhesive Threaded Inserts:

1. Type 316 stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-V3 or HIT-HY 200 adhesive.

PART 3 EXECUTION

3.01 CONCRETE ANCHORS

A. Begin installation only after concrete to receive anchors has attained design strength.

B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer's instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated unless otherwise noted on Drawings:

Anchor Type	Minimum Embedment (Bolt Diameters)	Minimum Edge Distance (Bolt Diameters)	Minimum Spacing (Bolt Diameters)
Expansion	9	6	12
Undercut	9	12	16
Adhesive	9	9	13.5

E. Use only drill type and bit type and diameter recommended by anchor manufacturer.

F. Clean hole of debris and dust per manufacturer's requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by Engineer and adhesive manufacturer:
   a. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.
   b. Do not install prior to concrete attaining an age of 21 days.
   c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
   d. Do not disturb anchor during recommended curing time.
   e. Do not exceed maximum torque as specified in manufacturer's instructions.

I. Prestressed Concrete: Do not use drilled-in anchors in prestressed or post-tensioned concrete members without Engineer's prior approval unless specifically shown on Drawings.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

3.03 MANUFACTURER'S SERVICES

A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Engineer of time and place for sessions.

3.04 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
Interior Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
2. All Others		
All service uses and locations	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
   a. Inspection of Hot-Dip Galvanized Steel Products.
   b. Quality Assurance Manual.
3. American Institute of Steel Construction (AISC):
   a. 201, Certification Program for Structural Steel Fabricators.
   b. 206, Certification Program for Structural Steel Erectors—Standard for Structural Steel Erectors.
   c. 303, Code of Standard Practices for Steel Buildings and Bridges.
   d. 325, Steel Construction Manual.
   e. 326, Detailing for Steel Construction.
   f. 360, Specification for Structural Steel Buildings.
   g. 420, Certification Standard for Shop Application of Complex Protective Coating Systems.
4. American Iron and Steel Institute (AISI): Stainless Steel Types.
5. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
6. American National Standards Institute (ANSI).
7. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
8. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
9. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
n. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
o. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
p. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
q. A489, Standard Specification for Carbon Steel Lifting Eyes.
r. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
s. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
u. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
v. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
w. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
x. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
y. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

z. A992/A992M, Standard Specification for Structural Steel Shapes.
aa. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
hh. F436, Standard Specification for Hardened Steel Washers.
ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
kk. F594, Standard Specification for Stainless Steel Nuts.
ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
nn. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

10. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910.23, Ladders.
    b. 29 CFR 1910.28, Duty to Have Fall Protection and Falling Object Protection.
    c. 29 CFR 1910.29, Fall Protection Systems and Falling Object Protection-Criteria and Practices.
    d. 29 CFR 1926.105, Safety Nets.
    e. 29 CFR 1926.502, Fall Protections Systems Criteria and Practices.
11. Specialty Steel Industry of North America (SSINA):
    a. Specifications for Stainless Steel.
    b. Design Guidelines for the Selection and Use of Stainless Steel.
    c. Stainless Steel Fabrication.
    d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Anchor Bolt: Cast-in-place anchor; concrete.

B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

C. Exterior Area: Location not protected from weather by building or other enclosed structure.

D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Metal fabrications, including welding and fastener information.

B. Informational Submittals:

1. Pre-engineered Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.23 requirements, ALI 14.3 requirements and specifications herein.
2. Passivation method for stainless steel members.
3. Provide design calculations for Digester #3 and #4 Stairs and Platforms, signed and sealed by a Professional Engineer registered in the State of Florida. Coordinate with Section 33 16 13.15, Prestressed Concrete Reservoir Tank with Steel Diaphragm.
4. Provide Drawings for Digester #3 and #4 Stairs and Platforms, signed and sealed by a Professional Engineer registered in the State of Florida. Coordinate with Section 33 16 13.15, Prestressed Concrete Reservoir Tank with Steel Diaphragm.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.

B. Package stainless steel items to provide protection from carbon impregnation.

C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

D. Store fabricated items in dry area, not in direct contact with ground.

1.06 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of sidewalk doors found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Steel Pipe	A500, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade C

Item	ASTM Reference
Aluminum:	
Aluminum Plates	B209, Alloy 6061-T6
Aluminum Structural Shapes	ASTM B221/B221M, Alloy 6061-T6
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	F3125, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D

Item	ASTM Reference
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:

1. Headed type, unless otherwise shown on Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE AND MASONRY ANCHORS

A. See Section 05 05 19, Post-Installed Anchors.

2.04 PIPE SLEEVES

A. As specified in Section 40 27 01, Process Piping Specialties.

2.05 EMBEDDED STEEL SUPPORT FRAMES FOR GRATING

A. Same material as grating. Supports embedded in concrete shall have aa integral continuous extruded anchor.

2.06 LADDERS

A. Fabricate ladders with rails, rungs and landings to meet applicable requirements of OSHA, 29 CFR 1910.23, and ALI A14.3.

1. Design ladder for concentrated load of 200 pounds imposed by user concentrated at points that will cause maximum stress in structural member being considered.
2. Include weight of ladder and attached appurtenances together with live load in design of rails and fastenings.
3. Self-closing gates at landings.

B. Aluminum Pre-engineered Pipe Ladder:

1. Rungs:
   a. Aluminum extrusions of Alloy 6063-T6.
   b. Nonslip grip surface, 1-inch wide flat top, and semicircular bottom with mill finish.
2. Side Rails: ASTM B429/B429M, Alloy 6063-T6, 1-1/2 inches, Schedule 40 pipe with anodized finish, AA M32-C22-A41.
3. Ladder Attachments and Fasteners: Stainless steel.
4. Welded, pop riveted, or glued construction is not acceptable.
5. Fabricate to longest length as practical but not to exceed 24 feet.
6. Furnish support attachments to side rails at 6 feet maximum spacing.
7. Manufacturer: Thompson Fabricating Co. Inc., Tarrant, AL.

2.07 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.

3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.
4. Stainless Steel Built-up Shapes: Fabricate built-up shapes in accordance with ASTM A1069/A1069M.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer's instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.

6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use. Cover full bearing surfaces.

H. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

I. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.08 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer’s recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.
5. Do not remove mill markings from concealed surfaces.

6. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
7. Snug-tighten bolts, unless otherwise specified.

B. Steel: Fabrication, erection, connections, bolted and welded construction shall be in accordance with AISC Steel Construction Manual and AWS D1.1.

C. Stainless Steel:

1. Fabrication, erection, connections, bolted and welded construction shall be in accordance with AWS D1.6 and the following SSINA standards:
   a. Specifications for Stainless Steel.
   b. Stainless Steel Fabrication.
   c. Stainless Steel Fasteners.
2. Do not field weld unless approved by Engineer in writing.

D. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and bolted construction shall be in accordance with the AA Aluminum Design Manual.

E. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Locate and hold anchor bolts in place with templates at time concrete is placed.

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer’s written instructions.

B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

C. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.04 PAINTING

A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.

4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control.
2. Manufacturer's Certificate of Compliance per Section 01 61 00, Common Product Requirements, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements and Section 01 88 15, Anchorage and Bracing.

3.06 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	**Product**	**Remarks**
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Stainless steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09 90 00, Painting and Coating

Service Use and Location	Product	Remarks
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
4. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
5. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
6. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 05 52 16
ALUMINUM RAILINGS

PART 1 GENERAL

1.01 REFERENCES

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

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

1.02 DEFINITIONS

A. ICC Evaluation Services Report: ICC report on evaluation of manufactured concrete anchor systems.

B. Railings: This term includes guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

C. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor, platforms, or ramps to prevent miscellaneous items from falling through.

1.03 DESIGN REQUIREMENTS

A. Structural Performance of Railing Systems: Design, test, fabricate, and install railings to withstand the following structural loads without exceeding allowable design working stress or allowable deflection. Apply each load to produce maximum stress and deflection in railing system components.

1. Top Rail: Capable of withstanding the following load cases applied:
   a. Concentrated load of 200 pounds applied at any point and in any direction in accordance with ICC IBC and OSHA.
   b. Uniform load of 50 pounds per linear foot applied in any direction in accordance with ICC IBC.
   c. Concentrated load need not be assumed to act concurrently with uniform loads in accordance with ICC IBC.
2. Intermediate Rail:
   a. Capable of withstanding a horizontally applied normal load of 50 pounds per linear foot applied in any direction.
   b. Horizontal concentrated load need not be assumed to act concurrently with loads on top rails of railings.
3. Toeboard: Capable of withstanding, without failure, a minimum force of 50 pounds applied in any direction at any point along the toeboard.
4. Calculated lateral deflection at top of posts shall not exceed 1 inch.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Project-specific scaled plans and elevations of railings and detail drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
   b. Manufacturer’s literature and catalog data of railing and components.
2. Samples:
   a. Rail sections, 6 inches long showing each type of proposed connection, proposed finish, and workmanship.
   b. Each fitting including castings, toeboard, and rail expansion joints.

B. Informational Submittals:

1. Manufacturer’s assembly and installation instructions.

2. Special Inspection: Manufacturer's instructions for Special Inspection of post-installed anchors.
    a. Design Data: Calculations or test data using specified design performance loads and including the following:
        1) Bending stress in, and deflection of, posts in accordance with ASTM E985 as modified herein.
        2) Design of post base connection.
        3) Documentation that concrete anchors have been designed in accordance with one of the following:
            a) ACI 318, Chapter 17.
            b) ICC Evaluation Services Report for selected anchor.
3. Test Reports: Test data may supplement load calculations providing data covers complete railing system, including anchorage:
    a. Test data for railing and components showing load and deflection as a result of load, in enough detail to prove railing is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 1910, using design loads specified. Include test data for the following:
        1) Railing and post connections.
        2) Railing expansion joint connections.
        3) Railing system gate assembly, including latch, gate stop, and hinges. Both gate latch and stop to support required loads applied independent of each other.
    b. Testing of anchorages shall be in accordance with ASTM E894 and ASTM E935 using applied loads in accordance with ICC IBC.
    c. Deflection Criteria: In accordance with ASTM E985 and design loads specified, except as follows: maximum calculated lateral deflection at top of posts shall not exceed 1 inch.
    d. Aluminum Rail Piping: Test data showing yield strength of pipe as delivered equals or exceeds specified values.
4. Manufacturer's written recommendations describing procedures for maintaining railings including cleaning materials, application methods, and precautions to be taken in use of cleaning materials.
5. Calculations shall be signed and sealed by a qualified professional engineer registered in State of Florida.
6. Shop Drawings shall be signed and sealed by a qualified professional engineer registered in State of Florida.

1.05 QUALITY ASSURANCE

A. Qualifications: Calculations required for design data shall be stamped by an engineer licensed in State of Florida.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package and wrap railings to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to the extent possible until railing is completely installed.

B. Delivery:

1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
2. Deliver toeboards loose for field assembly.
3. Deliver clear anodized railing pipe and posts with protective plastic wrap.

1.07 ENVIRONMENTAL REQUIREMENTS

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

1. Temperature Change Range: 40 degrees F, ambient; 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 ALUMINUM RAILINGS

A. General:

1. Furnish pre-engineered and prefabricated railing systems as shown on Drawings.
2. Railing systems using pop rivets or glued railing construction are not permitted.
3. Sand cast accessories and components are not permitted.
4. Fasteners shall be AISI Type 316 stainless steel, unless otherwise noted.

B. Rails, Posts, and Formed Elbows:

1. Extruded Alloy 6105-T5, 6061-T6, or equivalent.
2. Tensile Strength: 38,000 psi, minimum.
3. Yield Strength: 35,000 psi, minimum.

4. Nominal Wall Thickness: 0.145 inch, minimum.
5. Posts and railings shall be nominal 1-1/2-inch diameter (1.90-inch outside diameter).

C. Accessories:

1. Fittings and Accessories:
   a. Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements.
   b. Gauge metal components are not acceptable for load-resisting components.
   c. Fittings shall match color of pipe in railings.
2. Miscellaneous Extruded Aluminum Parts: Alloys 6063-T6, 6061-T6, or 6105 T5 aluminum, or equivalent, and of adequate strength for all loads.
3. Castings for Railings:
   a. Cast Al-mag with sufficient strength to meet load and test requirements.
   b. Anodizable grade finish with excellent resistance to corrosion when subjected to exposure of sodium chloride solution intermittent spray and immersion.
4. Post Anchorages:
   a. Refer to standard details for types of post anchorages and minimum requirements.
   b. Bolts at anchorages shall be minimum 1/2-inch diameter.
5. Toeboards:
   a. Molded or extruded Alloy 6063-T6 or 6061-T6 aluminum.
   b. Provide slotted holes for expansion and contraction where required.

D. Finishes:

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

2.02 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:

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

B. Bolts and Nuts for Bolting Railing to Metal Beams: ASTM A193/A193M and ASTM A194/A194M, Type 316 stainless steel.

C. Concrete Anchors:

1. Stainless steel, AISI Type 316.
2. Post-installed anchors in accordance with Section 05 05 19, Post-installed Anchors, unless otherwise specified herein.
3. Bolt Diameter: 1/2-inch, minimum.

2.03 FABRICATION

A. Shop Assembly:

1. Post Spacing: Maximum 6-foot horizontal spacing.
2. Railing Posts Bolted to Metal or Concrete:
   a. In lieu of field cutting, provide approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
   b. Field fit-up is required.
3. Free of burrs, nicks, and sharp edges when fabrication is complete.
4. Welding is not permitted.

B. Shop/Factory Finishing:

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

C. Shop Assembly:

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

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

PART 3 EXECUTION

3.01 GENERAL

A. Field fabrication of aluminum railing systems is not permitted.

B. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.

C. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in field and exceeds plus or minus 1/4 inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

D. Modification to supporting structure is not permitted where railing is to be attached.

E. Protection from Entrapped Water:

1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
2. For posts mounted in concrete, bends, and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in plane of rail.

3.02 RAILING INSTALLATION

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

B. Expansion Joints:

1. Maximum intervals of 54 feet on center and at structural joints.
2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
3. Fasten to one side using 3/8-inch diameter set-screw. Place set-screw at bottom of pipe.

C. Posts and Rails:

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

D. Toeboard:

1. Provide at railings, except where 4-inch or higher concrete curbs are installed, at gates, or at stairways unless shown otherwise.

2. Accurately measure in field for correct length; after railing post installation cut and secure to posts.
3. Dimension between bottom of toeboard and walking surface not to exceed 1/4 inch.
4. Install plumb and aligned to within 1/8 inch in 12 feet.
5. Toeboards shall be attached to posts via clamp that complies with design requirements while facilitating expansion and contraction. Do not screw directly to post or its base.

3.03 FIELD FINISHING

A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

3.05 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

C. If stain remains after washing, restore in accordance with railing manufacturer’s recommendations or replace stained railings.

END OF SECTION

SECTION 05 53 00
METAL GRATINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   d. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. National Association of Architectural Metal Manufacturers (NAAMM):
   a. MBG 531, Metal Bar Grating Manual.
   b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
   b. Grating Anchorage: Show details of anchorage to supports to prevent displacement from traffic impact.
   c. Product data for grating, grating clips, anchors, accessories, and other manufactured products specified herein.
   d. Manufacturer’s specifications, including coatings, surface treatment, and finishes.
2. Samples:
   a. Grating: Two samples approximately 12 inches by 12 inches.
   b. Embedded Support Angle: Two 6-inch long samples.
   c. Grating clamps, saddle, and accessories: Two samples of each type to be used on project.
   d. One sample of each item will be retained at site to be used as a basis for acceptance or rejection of grating installed.

B. Informational Submittals:

1. Special handling and storage requirements.
2. Installation instructions.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Insofar as is practical, factory assemble items.

B. Package and clearly tag parts and assemblies that are, due to necessity, shipped unassembled.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Alabama Metal Industries Corporation (AMICO), Birmingham, AL.
2. HARSCO Industrial IKG, Houston, TX.
3. Ohio Gratings, Inc., Canton, OH.

2.02 GRATING MATERIALS

A. Aluminum: Provide alloy and temper as designated below.

1. Bearing Bars and Banding: ASTM B221 alloy 6061-T6 or 6063-T6.
2. Swaged Crossbar Rods: ASTM B221 alloy 6061 or 6063, or ASTM B210 alloy 3003.
3. Finish: Mill.

B. Carbon Steel:

1. Bearing Bars, Banding, and Rectangular Cross Bars: ASTM A1011/A1011M commercial steel Type II for hot rolled carbon steel sheet and strip, or ASTM A36/A36M.
2. Cross Bars made from Wire Rods: Not permitted.
3. Finish: Galvanized after fabrication.

2.03 METAL BAR GRATING

A. General Requirements:

1. Maximum Service Load:
   a. Light Duty (Type A): 100 psf uniformly distributed load.
2. Maximum Deflection: Span/240 or 1/4 inch, whichever is less.

3. Bearing Bar Spacing:
   a. Light Duty: 1-3/16-inch maximum, center-to-center.
4. Cross Bar Spacing: 2 inches maximum, center-to-center. For aluminum I-bar grating with depths greater than 2 inches, provide cross bars at 2 inches maximum, center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 531 or as shown on Drawings.

B. Grating Materials:

1. Aluminum, I-bar grating fabricated by swaging crossbars between extruded I-shaped bearing bars.
2. Galvanized steel, welded, rectangular bar grating fabricated by electro-forging cross bars to bearing bars.

C. Surface: Striated.

D. Stair Treads:

1. Material and Type: Same as grating material and grating type as furnished for connecting walkway or work surface.
2. Nosings: Integral ribbing and serrated edge on one long axis of tread, or nonslip abrasive on each tread along one long edge.
3. Carrier Plate or Angle: Furnish at each end for connection to stair stringers.

2.04 HEAVY-DUTY METAL BAR GRATING (TYPE C)

A. General Requirements:

1. Maximum Service Load: AASHTO H-20.
2. Maximum Deflection: Span/240.
3. Bearing Bar Spacing: 1-7/8-inch maximum center-to-center.
4. Cross Bar Spacing: 4 inches maximum center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 532 or as shown on Drawings.
6. Grating Type: Galvanized steel, heavy-duty, rectangular bar grating fabricated by welding crossbars between rectangular bearing bars.

2.05 ACCESSORIES

A. Grating Clamps:

1. Use at flanged beam and bolted angle frame supports.
2. Removable from above grating walkway surface.

3. Provide hat bracket, recessed bolt, and bottom clamp of same material as grating.
4. Manufacturers and Products:
   a. Direct Metals Company, LLC, Kennesaw, GA; Grating Clamp.
   b. Grating Fasteners, Inc., Harvey, LA; G-Clip.

B. Anchor Stud and Saddle Clip:

1. Use at embedded angle frame supports with stud anchor and nut recessed below top of grating surface.
2. Removable from above grating walkway surface.
3. Provide Type 316 stainless steel welded threaded stud anchor, nut, washer, and saddle clip.
4. Manufacturers and Products:
   a. Welded Stud Anchor:
      1) Nelson Stud Welding, Inc., Elyria, OH.
      2) Stud Welding Associates, Inc. Elyria, OH.
   b. Saddle Clip:
      1) Direct Metals Company, LLC, Kennesaw, GA; Saddle Clip.
      2) Grating Fasteners, Inc., Harvey, LA; Saddle Clip.
      3) Struct-Fast, Inc., Baltimore, MD; Gratefast.

2.06 FABRICATION

A. General:

1. In accordance with NAAMM MBG 531 or NAAMM MBG 532.
2. Do not weld aluminum grating.
3. Conceal fastenings where practical.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Cutouts:
   a. Fabricate in grating sections for penetrations indicated.
   b. Arrange to permit grating removal without disturbing items penetrating grating.
   c. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
6. Do not notch bearing bars at supports to maintain elevation.
7. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
8. Section Length: Sufficient to prevent section from falling through clear opening when oriented in the span direction and one end is touching either the concrete or the vertical leg of grating support.

9. Minimum Bearing: 1 inch for grating depth up to 2-1/4 inches and 2 inches for grating depth greater than 2-1/4 inches.
10. Banding and Toe Plates: Same material as grating and welded to bearing bars in accordance with requirements of NAAMM MBG 531 and NAAMM MBG 532.

B. Metal Bar Grating: A single grating section shall be not less than 1.5 feet or greater than 3 feet in width, or weigh more than 150 pounds.

C. Heavy Duty Metal Bar Grating: Minimum width of grating sections shall be 2 feet regardless of length and weight.

D. Supports:

1. Same material as grating, except that supports which are to be embedded in concrete shall be Type 316 stainless steel, unless part of an extruded aluminum system.
2. Coordinate dimensions and fabrication with grating to be supported.

PART 3 EXECUTION

3.01 PREPARATION

A. Electrolytic Protection:

1. Protect aluminum surfaces in contact with dissimilar metals, or embedded or in contact with masonry, grout, or concrete as specified in Section 09 90 00, Painting and Coating.
2. Allow paint to dry before installation of material.

3.02 INSTALLATION

A. Until grating sections are securely fastened in place, area shall be appropriately barricaded or flagged to alert people working in the area of potential fall hazard.

B. Install manufactured products in accordance with manufacturer's recommendations.

C. Install supports such that grating sections have a solid bearing on both ends, and that grating sections will not rock or wobble under design loads.

D. Install grating supports plumb and level as applicable.

E. Install sections of welded frames with anchors to straight plane without offsets.

F. Field locate and install fasteners to fit grating layout.

G. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

H. Each grating or plank section shall be easily removable and replaceable.

I. Completed installation shall be rigid and neat in appearance.

J. Protect painted and galvanized surfaces during installation.

K. Repair damaged coatings as specified in Section 09 90 00, Painting and Coating.

END OF SECTION

SECTION 06 82 00
GLASS-FIBER-REINFORCED PLASTIC

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus.
   b. D570, Standard Test Method for Water Absorption of Plastics.
   c. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position.
   d. D638, Standard Test Method for Tensile Properties of Plastics.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degrees C and 30 Degrees C.
   g. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   h. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) by Plastics Displacement.
   i. D2344, Standard Test Method for Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short-Beam Method.
   j. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. Occupational Safety and Health Act (OSHA): 29 CFR 19.10, Code of Federal Regulations.
3. Underwriters' Laboratories, Inc. (UL): 94, UL Standard for Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances.
4. Florida Building Code 7th Edition (2020).
5. Design Criteria noted on Structural General Notes Drawings.

1.02 DESIGN REQUIREMENTS

A. This section contains components and connectors that require Contractor design.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Catalog information and catalog cuts showing materials, design tasks, and showing load, span, and deflection; include manufacturer's specifications.
   b. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
   c. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.
   d. Stairs, Platforms, Stringers, Handrails, Ladders, and Support Structures:
      1) Show dimensions, weight, size, and location of connections to adjacent supports and other Work.
      2) Structural calculations for platforms, ladders and cages, handrails, and other fabrications shown.
2. Samples: Each type of grating, handrail, and handrail connection.

B. Informational Submittals:

1. Handling and storage requirements.
2. Manufacturer's installation instructions.
3. Factory test reports for physical properties of product.
   a. Test data for handrails and supports may supplement load calculations providing data covers the complete system, including anchorage.
   b. Test data for all components showing load and deflection due to load, in enough detail to prove handrail is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 19.10, using design loads specified.
4. Manufacturer's Certification of Compliance for specified products.
5. Fabricator's qualification experience.
6. Manufacturer's qualification experience.
7. Independent laboratory test report, dated within 2 years of submittal date, of fire-retardant testing conducted on exact type of grating proposed (not a resin test report).
8. Anchorage and Bracing calculations as specified in Section 01 88 15, Anchorage and Bracing.
9. Design calculations shall be signed and sealed by a qualified Professional Engineer in the State of Florida.
10. Shop Drawings shall be signed and sealed by a qualified Professional Engineer in the State of Florida.

1.04 QUALIFICATIONS

A. Fabricator: Minimum of 5 years' experience.

B. Manufacturer: Minimum of 5 years' experience in manufacturing of products meeting these Specifications.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:

1. Insofar as is practical, factory assemble items provided hereunder.
2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage, and facilitate identification and final assembly in field.

B. Storage and Handling: In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 PRODUCTS

2.01 GENERAL

A. Like Items of Materials: Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

B. Unless otherwise specified, all products shall be manufactured by a pultruded process using vinyl ester resin.

C. Products shall be manufactured with ultra-violet (UV) inhibitor additives.

D. Exterior surfaces shall have a synthetic surface veil covering.

E. Furnish molded products as an option where permitted by Specifications.

F. Fire Retardance:

1. Flame spread shall be less than 25 as measured by ASTM E84.
2. Include combinations of aluminum trihydrate, halogen, and antimony trioxide, where required to meet fire retardance, in the resin system.
3. Meet self-extinguishing requirements of ASTM D635.

G. Color pigment shall be dispersed in resin system.

H. Fabricate FRP products exposed to outdoor conditions with an additional 1-mil thick UV coating to shield product from UV light.

I. All cut ends, holes, and abrasions of FRP shapes shall be sealed with resin to prevent intrusion of moisture.

2.02 GRATING

A. General:

1. 100 psf minimum, unless otherwise shown.
2. Maximum Deflection: 1/4 inch, unless otherwise shown.

B. Pultruded Type:

1. Main bars joined by cross bars secured in holes drilled in main bars.
2. Cross bars with 6-inch maximum spacing shall mechanically lock main bars in position such that they prevent movement.
3. Intersections: Bond using adhesive as corrosive-resistant as pultrusion resin.
4. Main Bar Ends: Minimum bearing support width of 1-1/2 inches.
5. Skid-Resistant Surface: Grit adhesively bonded, manufacturer's standard.
6. Provide extra stiffness around openings.

C. Hold-Down Clamps: Same material as grating or Type 316 stainless steel.

D. Bolts and Connectors:

1. Corrosion-resistant FRP or Type 316 stainless steel.
2. Size and strength to meet UBC requirements.

E. Fabrications:

1. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
2. Section Length: Sufficient to prevent it falling through clear opening when oriented in span direction when one end is touching either concrete or vertical leg of grating support.

F. Manufacturers:

1. Fibergrate Composite Structures, Inc., Addison, TX.
2. IKG/Borden, Clark, NJ.

3. Strongwell Corp., Bristol Division, Bristol, VA or Chatfield Division, Chatfield, MN.
4. International Grating, Inc., Houston, TX.

2.03 STRUCTURAL PLATFORMS

A. Deflection and Safety Factors:

1. Deflection Criteria: Not to exceed L/360.
2. Safety Factors: Minimum ratios of ultimate stress to allowable static service stress:
   a. Flexural Members: 2.5.
   b. Compression Members: 3.0.
   c. Shear: 3.0.
   d. Connections: 4.0.
3. Minimum design safety factors for dynamic or impact loads shall be twice the values for static service loads.

B. Loads:

1. 100 psf uniform live load over platform.
2. Static and dynamic loads for equipment shown.

C. Glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50 percent resin-to-glass ratio.

D. Continuous glass strand rovings shall be used internally for longitudinal strength.

E. Continuous strand glass mats shall be used internally for transverse strength.

F. Material Properties:

Minimum Ultimate Coupon Properties (UN)		
Material Properties	**Test Method**	**Units**
Pultruded Fiberglass Structural Shapes		
Ultimate tensile stress in longitudinal direction, psi (MPa)	ASTM D638	30,000 (207)
Ultimate compressive stress in longitudinal direction, psi (MPa)	ASTM D695	30,000 (207)

Minimum Ultimate Coupon Properties (UN)		
Material Properties	**Test Method**	**Units**
Ultimate flexural stress in longitudinal direction, psi (MPa)	ASTM D790	30,000 (207)
Ultimate short beam shear in longitudinal direction, psi (MPa)	ASTM D2344	4,500 (31)
Ultimate tensile stress in transverse direction, psi (MPa)	ASTM D638	7,000 (48)
Ultimate compressive stress in transverse direction, psi (MPa)	ASTM D695	15,000 (103)
Ultimate flexural stress in transverse direction, psi (MPa)	ASTM D790	10,000 (69)
Density (lb/in.^{3}) (kg/mm^3)	ASTM D792	0.060-0.070 (0.00166-00194)
Water absorption (25-hr immersion)	ASTM D570	0.60 max, % by weight
Barcol hardness	ASTM D2583	45
Coefficient of thermal expansion 10^{-6} in./in./º C	ASTM D696	
Expansion, LW10^{-6} in./in./º F		4.4
Thermal conductivity, Btu-in./ft^2/hr/º F	ASTM C177	
Flame-Retardant Properties		
Flammability test	ASTM D635	Self-extinguishing
Surface burning characteristics	ASTM E84	25 maximum
Flammability class	UL 94	VO
Temperature index	UL 94	130 C

G. Manufacturers and Designers:

1. Strongwell Corp., Bristol, VA.
2. Fibergrate Composite Structures, Inc., Addison, TX.

PART 3 EXECUTION

3.01 GENERAL

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

B. Install plumb or level, rigid and neat, as applicable.

C. Furnish fasteners and anchorages for complete installation.

D. Seal field cut holes, edges, and abrasions with catalyzed resin compatible with original resin.

3.02 GRATING

A. Anchor grating securely to supports to prevent displacement.

B. Install each grating section such that it is easily removable.

C. Clearance (Grating to Vertical Surfaces): 1/4 inch (plus or minus 1/8-inch tolerance).

3.03 STRUCTURAL SHAPES

A. Connect parts with approved connectors meeting manufacturer's design requirements and with corrosion resistance equal to structural shapes.

B. Provide supports and bracings required to comply with applicable codes and design requirements.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C661, Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   b. C834, Standard Specification for Latex Sealants.
   c. C920, Standard Specification for Elastomeric Joint Sealants.
   d. C1193, Standard Guide for Use of Joint Sealants.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Surface preparation instructions. Indicate where each product is proposed to be used.
2. Samples: Material proposed for use showing color selected.

B. Informational Submittals:

1. Installation instructions.
2. Documentation showing applicator qualifications.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
4. Special guarantee.

1.03 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum of 5 years' experience installing sealants in projects of similar scope.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Ambient Temperature: Between 40 degrees F and 80 degrees F (4 degrees C and 27 degrees C) when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

1.05 SPECIAL GUARANTEE

A. Product: Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction or, at the option of the Owner, removal and replacement of Work specified in this section found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

B. Conditions: No adhesive or cohesive failure of sealant.

C. Sealed Joints: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.01 SEALANT MATERIALS

A. Characteristics:

1. Uniform, homogeneous.
2. Free from lumps, skins, and coarse particles when mixed.
3. Nonstaining, nonbleeding.
4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
5. Immersible may be substituted for nonimmersible.

B. Color: Unless specifically noted, match color of the principal wall material adjoining area of application.

C. Type 1—Silicone, Nonsag, Nonimmersible:

1. Silicone base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of withstanding movement up to 50 percent of joint width.
3. Manufacturers and Products:
   a. Dow Corning Corp.; No. 790.
   b. General Electric; Silpruf.
   c. BASF; Sonneborn, Omniseal-50.

D. Type 2—Multipart Polyurethane, Self-leveling, Immersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade P, Class 25.
2. Capable of being continuously immersed in water.

3. Manufacturers and Products:
    a. BASF; Sonneborn, SL-2.
    b. Pecora Corp.; Urexspan NR-200.
    c. Tremco; THC-900/901.
    d. Sika Chemical Corp.; Sikaflex 2c SL.

E. Type 3—Multipart Polyurethane, Nonsag, Immersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
    a. Pecora; DynaTrol II.
    b. Tremco; Dymeric 240.
    c. BASF; Sonneborn NP-2.
    d. Sika Chemical Corp.; Sikaflex 2c NS.

F. Type 4—Multipart Polyurethane, Nonsag, Nonimmersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Manufacturers and Products:
    a. BASF; Sonneborn NP-2.
    b. Pecora Corp.; Dynatrol II.
    c. Tremco; Dymeric 240.
    d. Sika Chemical Corp.; Sikaflex 2c NS.

G. Type 5—One-part Polyurethane, Immersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products for Nonsag:
    a. Sika Chemical Corp.; Sikaflex-1a.
    b. Tremco; Vulkem 116.
4. Manufacturers and Products for Self-leveling:
    a. BASF; MasterSeal, SL-1.
    b. Tremco; Vulkem 45.
    c. Sika Chemical Corp.; Sikaflex 1c SL.

H. Type 6—One-part Polyurethane, Nonimmersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.

2. Manufacturers and Products:
    a. Pecora Corp.; Dynatrol 1 XL.
    b. Tremco; Dymonic.
    c. BASF; Sonneborn, NP-I.

I. Type 7—Multipart Polysulfide, Immersible:

1. Polysulfide base, two-component, chemical curing; ASTM C920, Type M, Grade P or NS, Class 25.
2. Capable of being continuously immersed in water.
3. For use above grade and below grade.
4. Manufacturers and Products:
    a. W. R. Meadows; Deck-O-Seal Gun Grade, two-part.
    b. BASF; Sonolastic, two-part Polysulfde.

J. Type 8—One-part Polysulfide, Nonsag, Nonimmersible:

1. Polysulfide base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 12 1/2.
2. Capable of withstanding movement up to 20 percent of joint width.
3. Manufacturer and Product: W. R. Meadows; Deck-O-Seal, one-part.

K. Type 9—One-part Acrylic Terpolymer, Nonsag, Nonimmersible:

1. Acrylic base, single-component, solvent curing; ASTM C834 nonsag.
2. Capable of withstanding movement up to 7.5 percent of joint width; Shore “A” hardness of 55 maximum.
3. Manufacturer and Product: Tremco; Mono 555.

L. Type 10—Sanitary Sealant:

1. Silicone sealant similar to Type 1, above, formulated to resist mold growth and repeated exposure to high humidity while retaining adhesion, flexibility, and color.
2. Manufacturers and Products:
    a. Dow Corning; 786.
    b. General Electric; Sanitary Sealant SCS1700.

M. Type 11—Fire Penetration Seal:

1. Manufacturers and Products:
    a. 3M Corp.; Fire Barrier Caulk CP25 and Putty 303.
    b. General Electric; Pensil Sealant or Foam.
    c. Unifrax Corporation; Fyre Putty.
    d. Hilti USA; CP 604.

N. Type 12—One-part Polycarbonate, Immersible:

1. Polycarbonate base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturer and Product: Pro-Seal Products, Inc.; Pro-Seal 34.

O. Type 13—Tape Sealant:

1. Compressible polyurethane foam impregnated with polybutylene or polymer-modified asphalt.
2. Color: Black.
3. Size: 3/4-inch wide by length required by expanded thickness recommended by manufacturer for particular application.
4. Manufacturers and Products:
   a. Emseal Joint Systems, Ltd.; AST—High Acrylic.
   b. Dayton Superior; Polytite Standard.
   c. PARR Technologies; PARR Sealant EP-7212-T.

2.02 BACKUP MATERIAL

A. Nongassing, extruded, closed-cell round polyurethane foam or polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.

B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 3/16-inch wide.

C. Manufacturers and Products:

1. BASF; Sonneborn, Sonolastic Closed-cell Backing Rod.
2. Tremco; Closed-cell Backing Rod.
3. Pecora Corporation; Green Rod.

2.03 ANCILLARY MATERIALS

A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Primer: Nonstaining type recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 GENERAL

A. Use of more than one material for the same joint is not allowed unless approved by sealant manufacturer.

B. Install joint sealants in accordance with ASTM C1193.

C. Horizontal and Sloping Joints up to 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.

D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use nonsag (Grade NS) joint sealant.

E. Use joint sealant as required for the applicable application and as follows:

Joint Size	Sealant Type
Less than 1"	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 12
Less than 2"	1, 2, 3, 4, or 7
Over 2"	Follow manufacturer’s recommendation

3.02 PREPARATION

A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.

B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.

1. Mask adjacent surfaces where necessary to maintain neat edge.
2. Starting of work will be construed as acceptance of subsurfaces.
3. Apply primer to dry surfaces as recommended by sealant manufacturer.

C. Verify joint shaping materials and release tapes are compatible with sealant.

D. Examine joint dimensions and size materials to achieve required width/depth ratios.

E. Follow manufacturer’s instructions for mixing multi-component products.

3.03 INSTALLATION

A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.

1. Install backup material as recommended by sealant manufacturer.
2. Where possible, provide full length sections without splices; minimize number of splices.
3. Tape sealant may be used as joint filler if approved by sealant manufacturer.

B. Use bond breaker where recommended by sealant manufacturer.

C. Seal joints around window, door and louver frames, expansion joints, control joints, and elsewhere as indicated.

D. Joint Sealant Materials: Follow manufacturer's recommendation and instructions, filling joint completely from back to top, without voids.

E. Joints: Tool slightly concave after sealant is installed.

1. When tooling white or light color sealant, use a water wet tool.
2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer's instructions.

3.04 PREFORMED SEALS

A. Prepare joint surfaces clean and dry, free from oil, rust, laitance, and other foreign material.

B. Construct joints straight and parallel to each other and at proper width and depth.

C. Apply joint sealant manufacturer's approved primer and adhesive in accordance with manufacturer's instructions.

D. Install seal in accordance with manufacturer's instructions.

3.05 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.

B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.06 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
Expansion/Contraction and Control Joints At:	
Concrete Walls (except water-holding and belowgrade portions of structures)	1, 3, 4, 5, 6, 12
Concrete Floor Slabs (except for water-holding Structures)	2, 5
Concrete Walls and Slabs immersed in water and/or below grade	7
Slabs Subject to Vehicle and Pedestrian Traffic	2, 5
Material Joints At:	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 6, 8, 12
Metal Door, Window, and Louver Frames (Interior)	1, 5, 6, 8, 9
Wall Penetrations (Exterior)	1, 5, 6, 8, 12
Sheet Metal Flashings	5, 13
Sheet Metal Roofing and Siding	5, 13
Other Joints:	
Threshold Sealant Bed	5
Openings Around Pipes, Conduits, and Ducts Through Fire-Rated Construction	11

END OF SECTION

SECTION 08 16 13
FIBERGLASS DOORS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. Steel Door Institute (SDI):
   a. SDI 100/ANSI A250.8, Recommended Specifications, Standard Steel Doors and Frames.
   b. SDI 105, Recommended Erection Instructions for Steel Frames.
3. National Fire Protection Association (NFPA): 80, Standard for Fire Doors and Windows.
4. Underwriters Laboratories Inc. (UL): Building Materials Directory.
5. Warnock Hersey Certification Listings.

1.02 DESIGN REQUIREMENTS

A. Applicable Building Code: Meet the requirements of the Florida Building Code (FBC), Sixth Edition (2017).

B. Structural Performance-Exterior Doors:

1. Provide door, frame and hardware assemblies capable of withstanding developed loads and pressures based on the project defined structural design criteria and the Florida Building Code and ASCE 7-10.
2. Door assemblies shall be designed to safely resist the positive and negative loads as required for the location and type of project designed according to the requirements of the Florida Building Code.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer’s literature, and drawings prepared for this project showing types, sizes, fire ratings, complete details of door and frame construction, including resin used, glass/resin ration, cutouts and anchorage for units.

2. Samples: Two Samples to verify custom color match, if any.

B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Manufacturer's instructions for handling and care of products.
3. Executed guarantee.
4. Certificate of Compliance per Section 01 43 33, Manufacturer's Field Services (or alternately, test results or calculations) that assure items and its anchorages design criteria meets requirements of Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver doors to Job Site after moisture-producing construction operations are complete and building has reached average prevailing relative humidity of locality.
2. Deliver doors and frames in unopened packages, clearly marked with manufacturer's name, brand name, size, thickness, and identifying symbol or mark related to door numbers used in Contract Documents.

B. Storage and Handling:

1. In strict compliance with manufacturer's instructions and recommendations.
2. Minimize onsite storage time.
3. Handle with clean gloves.
4. Do not drag doors across one another or across other surfaces.
5. Store in dry area and protect from damage.

1.05 SPECIAL GUARANTEE

A. As special guarantee, provide manufacturer's extended guarantee or warranty, with Owner named in writing as beneficiary. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this Specification section found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

B. Defects include warp, separation or delamination from core, expansion of core, and failures due to corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chem-Pruf Door Company.

B. Fib-R-Dor, Division of Advance Fiberglass, Inc.

C. Tiger Door, Division of Composite Structures, Inc.

2.02 DOORS

A. Exterior Door and Frame Wind Loads: Design door assembly to withstand developed wind/suction loads using stated structural design criteria with a maximum deflection of 1/120 without damage to door or assembly components.

B. Hardware used within each door and frame assembly must be approved for use as part of the assembly by NOA or other third party testing.

C. General:

1. Flush construction, minimum 1-3/4 inches thick, with no seams, cracks, or joints.
2. Full length integral edge reinforcement.
3. Face shall not deviate more than 1/4 inch from a true plane at any point.
4. Reinforced to receive hardware specified.
5. Doors may be prehung at factory or hung in field.
6. Resins:
   a. Fire retardant formulation plus antimony trioxide to achieve an ASTM E84 flame spread of 25 or less and be self-extinguishing in accordance with ASTM D635.
   b. Contain Ultraviolet light inhibitor additives.
7. Prepare doors and frames for hardware only after receipt of hardware templates.
8. Make cutouts for openings at factory and furnish with FRP frames and stops that prevent moisture from entering or passing through door.

D. Doors:

1. Molded in one continuous piece.
2. Half lite door style.
3. Core of end-grain balsa wood or closed cell, non-absorptive, 2 pounds per square foot density, isocyanurate or urethane rigid foam.
4. Finish: Manufacturer’s standard colors selected by Architect.

E. Hardware: Door manufacturer's standard items.

1. Hinges or pivots.
2. Mortise Lockset, keyed to client standards.
3. Closers.
4. Stops and holders integrated into Closers.
5. Thresholds.
6. Weatherstripping: Head and jambs, and sweep strip at bottom of doors.

F. Glazing: Clear laminated tempered glass.

2.03 FRAMES

A. Manufacturer's standard one-piece-pultruded, three-piece built-up, or one-piece molded FRP with double rabbeted profile, reinforced for specified hardware, assembled with stainless steel fasteners, and furnished with wall anchors for installation after wall opening is complete.

B. Furnished by door manufacturer with finish to match doors and prepared for hardware specified.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify doors and frames comply with approved Shop Drawings and meet indicated requirements for type, size, hardware, location, and swing.

B. Examine openings for conditions that would prevent proper installation.

C. Do not proceed with installation until defects are corrected.

D. Do not install doors in frames that would hinder operation of doors.

3.02 INSTALLATION

A. Install, following manufacturer's written instructions, using only noncorrosive materials and methods.

B. Tolerances:

1. From Door Bottom to Floor Covering: 1/2 inch.
2. From Bottom to Top of Threshold: 1/4 inch.
3. Maximum From Top: 1/8 inch.
4. Bevel Lock and Hinge Edges: 1/8 inch in 2 inches.
5. Clearance of Meeting Stiles of Pairs of Doors: 1/8 inch.

C. Install frames square, plumb, rigid, and in true alignment. Brace securely during construction to retain proper position and clearances. Anchor firmly in place.

D. Do not cut or otherwise alter integrity of door to allow door to fit frame.

E. Frames Set in Concrete or Masonry: Secure each jamb with four stainless steel expansion anchors following manufacturer's instructions.

3.03 ADJUST AND CLEAN

A. Replace or rehang doors that are hinge-bound and do not swing, latch or operate smoothly and freely.

B. Remove and install new prefinished doors in place of those damaged during installation.

C. Refinish, or replace with new, job-finished doors damaged during installation.

D. Modify doors and frames only at manufacturer's factory.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   c. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   d. B221M, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
   e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. Intertek Testing Services (Warnock Hersey Listed) (WH): Certification Listings.
3. National Association of Metal Manufacturers (NAAMM).
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   c. MG 1, Motors and Generators.
5. UL:
   a. Building Materials Directory.
   b. 10B, Standard Safety for Fire Tests of Door Assemblies.
   c. 325, Standard Safety for Door, Drapery, Gate, Louver, and Window Operators and Systems.
6. Florida Building Code, Seventh Edition (2020).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
   a. Anchorage and Bracing calculations as specified on 01 88 15, Anchorage and Bracing.

b. Design calculations shall be signed and sealed by qualified professional engineer registered in the State of Florida.
c. Shop Drawings shall be signed and sealed by qualified professional engineer registered in the State of Florida.

2. Product Data: General construction, component connections and details.
3. Samples: Submit two door slats, 12-inch by 12-inch (300 by 300 mm) in size illustrating shape, color and finish texture.

B. Informational Submittals:

1. Certificate of Compliance per Section 01 43 33, Manufacturer's Field Services (or alternately, test results or calculations) that assure item's and its anchorage's design criteria meets requirements of Section 01 88 15, Anchorage and Bracing for loads provided in Section 01 61 00, Common Product Requirements.
2. Third party testing documentation or manufacturer's literature qualifying door model as meeting required developed wind pressures and impact testing for small or large missile. Miami-Dade Notice of Approval (NOA) documentation is acceptable as third party evidence of certification.
3. Manufacturer's Instructions: Indicate installation sequence and procedures, and adjustment and alignment procedures.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data, include lubrication requirements and frequency, and periodic adjustments required.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 5 years documented experience.
2. Installer: Company specializing in performing work of this section with minimum 5 years documented experience approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products on of the following:

1. Cookson Co.
2. Cornell Iron Works, Inc.
3. Overhead Door Co.; Model 620S (basis of design).

2.02 GENERAL

A. Wind Loads: Design door assembly to withstand wind/suction load of 49.2+ve psf / -53.3-ve psf, with maximum deflection of 1/120, and without damage to door or assembly components.

B. Assembly shall meet small testing as defined by Florida Building Code.

C. Manual Operation: Manual hand chain lift unit with overhead counter balance device, requiring 25 pound (10 kg) nominal force to operate.

D. Surface Burning Characteristics, Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

2.03 COMPONENTS

A. Curtain: Conform to following:

1. Steel Slats:
   a. Interlocking, minimum 22-gauge thick of ASTM A653/A653M steel, minimum galvanized coating designation G60 (Z275) in accordance with ASTM A653/A653M.
   b. Type: Flat slats and slat construction with manufacturer's standard insulated core.
   c. Color: Factory-applied fluoropolymer coating in color as selected by Architect.
2. Nominal Slat Size: 3 inches(75 mm) wide by required length.
3. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
4. Curtain Bottom: Fitted with angles, channels, or tubes to provide reinforcement and positive contact with floor in closed position.

B. Guides:

1. Minimum 3/16-inch (5 mm) thick; galvanized steel conforming to ASTM A653/A653M, minimum galvanized coating designation G60 (Z275) in accordance with ASTM A653/A653M.
2. Furnish continuous angles of profile to retain door in place; mounting brackets of same metal.

C. Guides: Minimum 0.1875-inch (5 mm) thick; rolled steel track continuous, vertical mounted; galvanized steel mounting brackets.

D. Roller Shaft Counterbalance: Springless operation.

E. Hood Enclosure and Fascia Round shape, minimum 24-gauge (0.75 mm) thick galvanized steel internally reinforced to maintain rigidity and shape.

F. Hardware:

1. Locks: Furnish locks to allow doors shutters to be secured.
   a. Electric Doors: Manufacturer's standard cylinder locking system to secure door; interlock with motor to prevent motor from operating when lock is activated.
2. Cylinders: Minimum six-pin cylinders doors keyed alike.
3. Handle: Inside center mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position; interior handle.
4. Weatherstripping (Exterior Assemblies): Moisture and rot proof, resilient type for complete weathertight installation.
   a. Rubber, neoprene, or vinyl water seal at hood to prevent airflow around coil on exterior doors.
   b. Weather seal sealing strip on guide to close space between guide and curtain on exterior doors.

2.04 FINISHES

A. Curtain Slats: Precoated paint finish, manufacturer's standard type; color as selected by Architect.

B. Steel Guides and Hood Enclosure: Primed and painted. Galvanized with A60 zinc coating in accordance with ASTM A653/A653M, prefinished with shop applied fluoropolymer.

2.05 SOURCE QUALITY CONTROL

A. Attach label from agency approved by authority having jurisdiction to identify each fire rated door.

1. Oversize Door Certification: Provide UL Certificate of Inspection or comparable certification acceptable to authorities having jurisdiction, in lieu of label for oversize door assemblies exceeding 120 square feet (11.15 square m) or 24 feet (7.3 m) in any dimension.

B. Apply label from agency approved by authority having jurisdiction to identify each foam plastic insulation board.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

B. Securely and rigidly brace components suspended from structure.

C. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

D. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 92 00, Joint Sealants.

E. Install perimeter trim and closures.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent Work.

B. Maximum Variation from Plumb: 1/16 inch.

C. Maximum Variation from Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 feet (3 mm per 3 m) straight edge.

3.04 ADJUSTING

A. Adjust door, hardware and operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Leave door and components clean.

B. Remove labels and visible markings.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
   b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
7. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
   c. SP 1, Solvent Cleaning.
   d. SP 2, Hand Tool Cleaning.
   e. SP 3, Power Tool Cleaning.
   f. SP 5, White Metal Blast Cleaning.
   g. SP 6, Commercial Blast Cleaning.
   h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
   i. SP 10, Near-White Blast Cleaning.
   j. SP 11, Power Tool Cleaning to Bare Metal.
   k. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   l. SP 13, Surface Preparation of Concrete.
   m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PDS: Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Data Sheets:
      1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
      2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
      3) Technical and performance information that demonstrates compliance with specification.
      4) Furnish copies of paint system submittals to the coating applicator.
      5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
   b. Detailed chemical and gradation analysis for each proposed abrasive material.
2. Samples:
   a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.

b. Reference Panel:
   1) Surface Preparation:
      a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
      b) Provide panel representative of the steel used; prevent deterioration of surface quality.
      c) Panel to be reference source for inspection upon approval by Engineer.
   2) Paint:
      a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
      b) Furnish additional samples as required until colors, finishes, and textures are approved.
      c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
2. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
3. Manufacturer's written verification that submitted material is suitable for the intended use.
4. Coating for Faying Surfaces: Manufacturer's test results that show the proposed coating meets the slip resistance requirements of the AISC Specification for Structural Joints using ASTM A325 or ASTM A490 bolts.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. Manufacturer's written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. SSPC PA 10.
   c. Federal, state, and local agencies having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the products specified herein:

1. Tnemec.
2. Carboline.
3. Sherwin Williams.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single-component, coal-tar pitch based
Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion

Product	Definition
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats

Product	Definition
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Organic Zinc Rich Primer	Epoxy or moisture cured urethane with 85-percent zinc content in the dry film, meeting the requirements of RCSC Specification for Structural Joints using High Strength Bolts, Class A or Class B, as required.
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellant, penetrating stain
Stain, Wood	Satin luster, linseed oil, solid or transparent as required
Varnish	Nonpigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) in gloss, semigloss, or flat finishes, as required
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference paragraph, Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:

1. Ductile Iron Pipe:
   a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
   b. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.
   c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
   d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
   e. For conventional (alkyd) coatings, clean asphalt varnish supplied on pipe and apply one full coat of a tar stop before two full coats of the color coats specified.
2. Steel Pipe:
   a. Surface preparation and application of primer and finish coats shall be performed by pipe manufacturer.
   b. For pipe with epoxy lining, do not place end cap seals until pipe lining material has sufficiently dried.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.
2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Field Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.

B. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 500 square feet by means of a Chlor Test CSN Salts or approved equivalent.
2. Surface with chloride levels exceeding 3 µg/square centimeter for submerged surfaces and 5 µg/square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR*RID (CHLOR*RID International, Chandler, AZ).
3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.

C. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
    a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
    b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
    c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
    d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
    e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations

caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.

g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.

i. SP-16, Brush Blasting of Non-Ferrous Metals: A brush-off blast cleaned non-ferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil).

2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.
4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.

2) No weld spatter on or adjacent to weld or any area to be painted.
3) No sharp peaks or ridges along weld bead.

b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

8. Preblast Cleaning Requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
9. Blast Cleaning Requirements:
   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
   b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
   b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Brush blast in accordance with SSPC SP 16.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

F. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brush-off blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Engineer prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
    a. Synthetic-based wood putty approved by paint manufacturer for paint system.
    b. For natural finishes, color of wood putty shall match color of finished wood.
    c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
    d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
    e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

I. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.

1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

J. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. Application of Cosmetic Coat:
    a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
    b. Check compatibility by application to a small area prior to starting painting.
    c. If lifting or other problems occur, request disposition from Engineer.

8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
   a. Rate: Approximately 2 gallons per 100 square feet.
   b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
   c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
   d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
   e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
   f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a “grit sandpaper” surface profile. If not, repeat treatment.

C. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for existing and new, interior and exterior metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, such as Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with specification.
   c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.

6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 2 Submerged Metal—Domestic Sewage:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Coat Tar Epoxy OR High Build Epoxy	2 coat, 16 MDFT 2 coat, 16 MDFT

1. Use on the following items or areas:
   a. Metal surfaces below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface that are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbes, and structural steel, and the following specific surfaces:
      1) Piping, valves, and equipment within the aerobic digesters.

C. System No. 4 Exposed Metal—Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	High Build Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Exposed ferrous metal surfaces, new and existing located inside or outside of structures and exposed to weather, and the following specific surfaces:
      1) Piping as noted on the Piping Schedule.

2) Above grade or exposed pipe, fittings and related items.
3) Valves and other related accessories associated with piping systems.

b. On ferrous metal surfaces of other equipment items and component assemblies as specified in the Technical Specifications or as identified on the Contract Drawings.

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

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

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as pipe galleries and similar areas, and the following specific surfaces:
      1) Equipment (e.g. pumps, motors, grinders, and related accessories, etc.).

E. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles; and the following specific surfaces:
      1) Wall pipes in the digester slabs and dewatering building slab.

F. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:
   a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

G. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete.

3.08 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 106 Galvanized Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Manufacturer's Recommended Primer	1 coat, as recommended by manufacturer
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Steel guard posts.

3.09 COLORS

A. Provide as designated herein or as selected by Owner.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint equipment and piping one color as selected.
3. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   b. Fire Protection Equipment and Apparatus: OSHA Red.
   c. Radiation Hazards: OSHA Purple.
   d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: As shown in table below.
3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, as approved by Owner.
5. Fiberglass reinforced plastic (FRP) pipe, polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC) pipe located inside of buildings and enclosed structures will not require painting, except as noted or scheduled.

E. Pipe System Color Code:

Pipe System	Color
Drains and Sludge	Light Brown
Decant	Light Brown
Drains	Black

Pipe System	Color
Plant Service Water	Medium Blue
Potable Water	Light Blue
Polymer	Buff
Sludge, Digested	Dark Brown
Sludge, Waste Activated	Dark Brown

3.10 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide calibrated electronic type dry film thickness gauge to test coating thickness specified in mils.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
   b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
   c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
   d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Feather edges and repair in accordance with recommendations of paint manufacturer.
4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.11 MANUFACTURER'S SERVICES

A. In accordance with Section 01 43 33, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:

1. On first day of application of any coating system.
2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
3. As required to resolve field problems attributable to or associated with manufacturer's product.
4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.13 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Paint System Data Sheet (PSDS).
2. Product Data Sheet (PDS).

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

PAINT PRODUCT DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.:_____ max.:_____

Surface Temperature Limitations: min.:_____ max.:_____

Surface Profile Requirements: min.:_____ max.:_____

SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI): A117.1, American Standard for Building and Facilities Providing Accessibility and Usability for Physically Handicapped People.
2. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
3. ASTM International (ASTM):
   a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   b. D709, Standard Specification for Laminated Thermosetting Materials.
4. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
5. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
6. National Fire Protection Association (NFPA):
   a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
   b. HAZ-01, Fire Protection Guide to Hazardous Materials.
7. Occupational Safety and Health Act (OSHA).
8. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices for Streets and Highways.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
   b. Manufacturer’s literature showing letter sizes and styles, sign materials, and standard mounting details.
2. Samples: One full size for each type of nameplate, sign, and label specified.

B. Informational Submittals: Manufacturer’s installation instructions.

PART 2 PRODUCTS

2.01 SIGNS

A. Plastic Signs (Type A):

1. Exterior: Laminated plastic subsurface image type, 3/16-inch thick with high-gloss finish.
2. Interior: Plastic, 1/8-inch thick with nondirectional matte finish and engraved letters.
3. Rounded corners.

B. Metal Signs (Type B):

1. Material: Baked enamel finished 20-gauge (minimum) steel or 18-gauge (minimum) aluminum signs.
2. Manufacturers:
   a. Seton Identification Products.
   b. Nutheme Illustrated Safety Co.

C. Fiberglass Signs (Type C):

1. Material: Three-ply laminated fiberglass, minimum 1/8-inch thick, with contrasting color core message layer between two clear weather-resistant surface layers.
2. Manufacturers:
   a. Best Manufacturing Co.
   b. Brady Signmark.

D. Painted Signs (Type F):

1. Stenciled.
2. Paint System and Surface Preparation: As specified in Section 09 90 00, Painting and Coating, as appropriate for material and sign location.

E. Hazardous Material Signals (Type H):

1. Conform to NFPA 704 and NFPA HAZ-01.
2. Material: Fiberglass 1/8-inch thick.
3. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
4. Manufacturers:
   a. Brady Signmark.
   b. Emed Co., Inc.

2.02 IDENTIFICATION LABELS

A. Pipe Labels:

1. Labels:
   a. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
   b. Provided with ties or straps for pipes of 6 inches and over diameter.
   c. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
2. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: Meet ASME A13.1.
5. Message: Piping system name as indicated on Piping Schedule.
6. Manufacturers and Products:
   a. Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.
   b. Seton Identification Products; Ultra-mark Pipe Markers.

B. Pipe Labels:

1. Labels: Self-adhesive tape, with separate directional flow arrows.
2. Material: Pressure sensitive vinyl.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: ASME A13.1.
5. Message: Piping system name as indicated on Piping Schedule.
6. Manufacturers and Products:
   a. Brady Signmark; B-946 Self-Sticking Vinyl Pipe Markers and Vinyl Arrows.
   b. Seton Identification Products; Opti-Code Markers and Directional Arrows.

C. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: Black bold face, 3/4-inch minimum high.
3. Background: OSHA safety yellow.
4. Materials: Aluminum or stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
5. Furnish 1-inch margin with holes at each end of label, for mounting.

6. Size:
    a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
    b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
    a. Brady Signmark.
    b. Seton Identification Products.

2.03 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Wood Posts: Preservative treated 4 by 4 wood as specified in Section 06 10 00, Rough Carpentry.

C. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53, Type S, Grade B.

D. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.

E. Manufacturer’s standard brackets for wall mounting of two-sided exit signs.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer’s recommendations.

B. Mount securely, plumb, and level.

3.02 SIGNS

A. Fasten to walls or posts or hang as scheduled. Anchor in place for easy removal and reinstallation with ordinary hand tools.

B. Hazardous Material Signals:

1. Install where required by NFPA No. 704 and IFC, Chapter 27.
2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled and on sides of stationary tanks.

3.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
5. Application: To pipe only after painting in vicinity is complete or as approved by Engineer.
6. Installation: In accordance with manufacturer's instructions.

B. Equipment Labels:

1. Locate and install on equipment or concrete equipment base.
2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Sign Schedule: A tabulation of characteristics and mounting information for each sign on the Project. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).

END OF SECTION

SIGN SCHEDULE

Sign									Lettering					
			Size			Mounting								
No.[1]	**Type[2]**	**Format[3]**	**Width**	**Height**	**Color**	**Location**	**Method**	**Height to Top**	**Height**	**Style**	**Color**	**Message**	**Faces**	**Other Requirements**
C-1	C	1014-002	20"	14"	Yellow	Hanging	Chain	5′-6"	1" min.	Helvetica	Black	CAUTION Equipment Starts Automatically	1	Locate at equipment with exposed moving parts or as directed by engineer
C-2	C	1014-002	20"	14"	Yellow	Wall	Bolts	5′-6"	1" min.	Helvetica	Black	CAUTION Ear Protection Required	1	Locate in areas where decibel levels exceeds maximum level per OSHA standard
D-1	C	1014-001	20"	14"	White	Door	Screws or Bolts	5′-6"	1" min.	Helvetica	Black	DANGER High Voltage	1	Locate at Electrical Building doors and generator enclosure
D-6	C	1014-001	20"	14"	White	Wall	Bolts	3′-6"	1" min.	Helvetica	Black	DANGER Nonpotable Water Not for Drinking	1	Provide at interior W2 hose valves

SIGN SCHEDULE

Sign									Lettering					
			Size			Mounting								
No.[1]	Type[2]	Format[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
D-7	B	1014-001	20"	14"	White	Pipe Post	Bolts	3′-6"	1" min.	Helvetica	Black	DANGER Nonpotable Water Not for Drinking	1	Provide at exterior W2 hose valves
D-9	F	N/A	As required		White	Tank Side	Painted	5′-0"	3" min.	Block	Red	*DANGER COMBUSTIBLE LIQUIDS	1	*Put message on one line

[1]Numbers refer to a particular sign type with a particular message.
[2]Letters refer to sign types specified in this section.
[3]Numbers refer to Design Details that show sign layout.
[4]Verify requirements for this sign with Laws and Regulations in state where Project is located.

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

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

1. Factory Mutual (FM).
2. National Fire Protection Association (NFPA): 10, Standard for Portable Fire Extinguishers.
3. National Institute for Occupational Safety and Health (NIOSH).
4. Occupational Safety and Health Administration (OSHA).
5. Underwriters Laboratories Inc. (UL): Fire Protection Equipment Directory.

1.02 PERFORMANCE REQUIREMENTS

A. Conform to Florida Building Code, Seventh Edition 2020.

B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for purpose specified and indicated.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fire Extinguishers: Manufacturer’s product data for each item, including fabrication and assembly details, sizes, ratings, UL listings, or other certifications, accessories, cabinets, wall brackets and mounting information.

B. Informational Submittals:

1. Manufacturer’s Certificate: Certify Products meet or exceed specified requirements.
2. Operation and Maintenance Data: Submit test, refill or recharge schedules and recertification requirements.

C. System Description:

1. Carbon Dioxide: Carbon Dioxide extinguishers can be used on Class B and C fires (flammable liquids and gases, live electrical equipment).

2. Dry Chemical: Dry Chemical extinguishers can be used on Class A, B, and C fires (all the above elements) (not recommended for computers or sensitive electrical equipment - use clean agent or Carbon Dioxide).

1.04 QUALITY ASSURANCE

A. Submit fire extinguishers certifications showing compliance with local codes and regulations.

B. Provide fire extinguishers conforming to NFPA 10. Provide quantity and placement in compliance with the applicable sections of Florida Fire Prevention Code (FFPF), NFPA 101, and NFPA 820.

1. Provide carbon-dioxide type fire extinguishers compliant with UL 154.
2. Provide dry chemical type fire extinguishers compliant with UL 299.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Section 01 61 00, Common Product Requirements: Environmental conditions affecting products onsite.

B. Do not install extinguishers when ambient temperatures are capable of freezing extinguisher ingredients.

PART 2 PRODUCTS

2.01 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers:

1. JL Industries.
2. Larsen’s Manufacturing Co.
3. Nystrom Products Co.
4. Potter Roemer.
5. Approved equal.

B. General:

1. Conform to NFPA 10 for fire extinguishers.
2. Furnish fire extinguishers and cabinets from one manufacturer.
3. UL listed, charged and ready for service.

C. Multipurpose Hand Extinguisher (F. Ext.):

1. Tri-class dry chemical extinguishing agent.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.

4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.
6. Minimum UL Rating: 4A-60B:C, 10-pound capacity.
7. Bracket mounted.

2.02 ACCESSORIES

A. Extinguisher Brackets: For hand extinguishers not located in cabinets, furnish heavy-duty brackets with clip-together strap for wall mounting.

B. Graphic Identification: Provide graphic identification marking for each fire extinguisher type. OSHA approved pictorial markings to indicate the extinguisher uses and nonuses on a single label.

C. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.

1. Interior: Stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify cabinets are correctly sized for fire extinguisher type.

B. Verify rough openings for cabinet are correctly sized and located.

C. Where cabinets are not used, verify location and height of wall brackets.

3.02 INSTALLATION

A. Install where indicated or directed and in accordance with manufacturer's recommendations. Final location and number of extinguishers must meet applicable code.

B. Provide adequate backing for mounting surfaces.

C. Place extinguishers on wall brackets.

D. Position signage as required by authorities having jurisdiction.

3.03 PORTABLE FIRE EXTINGUISHERS AND CABINETS

A. Provide at locations shown or as directed by Engineer.

B. Mount hangers securely in position, following manufacturer's recommendations.

C. Top of Extinguisher: No more than 54 inches above floor.

D. Install wall brackets, maximum 48 inches from finished floor to top of extinguisher handle.

END OF SECTION

SECTION 13 34 19
METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Architectural Manufacturers' Association (AAMA):
   a. 101, Standard Specifications for Windows, Doors, and Unit Skylights.
   b. 605, Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
   c. 606.1, Voluntary Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
2. American Institute of Steel Construction (AISC):
   a. 360, Specification for Structural Steel Buildings.
   b. RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
   c. Design Guide 3: Serviceability Design Considerations for Steel Buildings.
3. American Iron and Steel Institute (AISI): Specification for the Design of Cold-Formed Steel Structural Members.
4. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code - Steel.
5. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   d. A490/A490M, Standard Specification for Structural Bolts, Alloy Steel, Heat-Treated, 150 ksi Minimum Tensile Strength.
   e. A529/A529M, Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
   f. A572/A572M, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   g. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   h. A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

i. A992/A992M, Standard Specification for Steel for Structural Shapes.
j. C991, Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings.
k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
m. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
n. E1514, Standard Specification for Structural Standing Seam Steel Roof Panel Systems.
o. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

6. International Accreditation Service, Inc. (IAS): Quality Certification Program.
7. International Code Council (ICC): International Building Code (IBC).
8. Metal Building Manufacturer's Association (MBMA): Metal Building Systems Manual.
9. Steel Door Institute (SDI): A250.8, Standard Steel Doors and Frames.
10. UL: 580, Tests for Uplift Resistance of Roof Assemblies.

1.02 SYSTEM DESCRIPTION

A. Complete building package using manufacturer's standard components.

B. Primary Framing System:

1. Main Dewatering Building: Clear span, single slope rigid frames designed for support of lean-to truck bay.
2. Truck Bay: Clear span, single slope lean-to frame attached to main building frame to create a double slope structure.

C. Lateral Support System in Longitudinal Direction: Cross bracing, located in center bay as shown on Drawings.

D. Include: Insulation and roof accessories.

1.03 DESIGN REQUIREMENTS

A. Applicable Building Code: Florida Building Code, 7th Edition, (2020).

B. Refer to design criteria on Drawing General Structural Notes.

C. Ground Snow Load (Pg): 0 pounds per square foot.

D. Minimum Roof Live Load: See Drawing General Structural Notes.

E. Building system dead load.

F. Mechanical and Electrical Equipment Loads:

1. Purlins and Secondary Framing: As indicated on Drawings, minimum 15 pounds per square foot collateral load.
2. Primary Frames: As indicated on Drawings, minimum 15 pounds per square foot collateral load.

G. Special Equipment Loads, as shown on Drawings:

1. Conveyors for dewatering equipment.
2. Pipe supports.

H. Wind Load: See Drawing General Structural Notes.

I. Earthquake Load: See Drawing General Structural Notes.

J. Deflection Criteria:

1. In accordance with AISC Design Guide 3 recommendations. Conformance is required to deflection criteria as stated in the Appendix.
2. Applies to primary and secondary framing members, bracing members, roof panels, and wall cladding.

K. Design Standards:

1. AISC 360.
2. AISC RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
3. AISI Specification for the Design of Cold-Formed Steel Structural Members.
4. AWS D1.1/D1.1M.

L. Consider prying action of bolts for bolted moment-resistant connections in primary framing.

M. Design column bases as pinned, unless specifically indicated otherwise.

1.04 CONTRACTOR/METAL BUILDING MANUFACTURER COORDINATION

A. Submit metal building Shop Drawings and obtain approval prior to forming foundation concrete or fabricating foundation reinforcing steel. Confirm size of concrete column pilasters for steel column baseplates and its associated anchor bolt template.

B. Verify interface of building components with foundation and coordinate required foundation revisions with Engineer.

C. Contractor shall verify and coordinate loads and support locations of piping supports and equipment supports that are to be supported by additional roof beam supports to be provided by metal building supplier.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer's literature and technical data.
   b. Anchorage and bracing drawings and/or catalog information, as required by Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements.
2. Samples: Minimum 2-inch by 3-inch metal for components requiring color selection.

B. Informational Submittals:

1. Structural Calculations Stamped by Designer:
   a. Complete analysis and design of structural components and connections in accordance with design requirements indicated.
   b. Summary of building column reactions to foundation level for load cases.
   c. Mark out calculations that do not apply to Project.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements. Submit with Action Submittal for the same item.
3. Manufacturer's written instructions for shipping, handling, storage, protection, and erection or installation of building and components.
4. Manufacturer: IAS Quality Certification: IAS certificate showing name and address of manufacturer, effective date, and category of certification.
5. Erector:
   a. IAS Quality Certification: IAS certificate showing name and address of erector, effective date, and category of certification, or, in lieu of IAS certification, documentation of past 5 years' experience record to include project name, location, date of completion, building manufacturer, and name and phone number of Owner's contact person.
   b. Certification of approval by manufacturer.

6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
7. Drawings Stamped by Designer:
    a. Drawings shall be specifically prepared for this Project.
    b. Mark out details that do not apply to Project.
    c. Show design load criteria, material specifications for framing members and connections, roof framing plan with dimensions and member sizes, baseplate details showing anchor bolt size and bolt layout, elevations of wall framing and bracing, instructions for temporary bracing, framing around roof and wall openings, details for joining and sealing of roof panels and wall cladding, and sections and details for all components and accessories.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Designer: Registered professional engineer valid in same state as Project.
2. Manufacturer: IAS Quality Certification: Metal Building Systems (MB).
3. Erector:
    a. IAS Quality Certification as Certified Steel Erector (CSE), or 5 years of experience in erection of metal building systems in lieu of IAS certification.
    b. Approval by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect building components and accessories from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Deliver to Site with parts individually tagged.

C. Store on wood blocking or pallets, flat and off ground, to keep clean and to prevent damage or permanent distortion. Support bundles so there is no danger of tipping, sliding, rolling, shifting, or material damage. Cover with tarpaulins or other suitable weathertight ventilated covering.

D. Protect finish of metal panels by application of removable plastic film or other suitable material placed between panels. Do not allow panels to come in contact with other material that would result in scratching, denting, staining or other damage to panel finish.

1.08 SPECIAL GUARANTEE

A. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of Work specified in this Specification section found defective during a minimum period of 5 years and as stated below after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

B. Conditions:

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

PART 2 PRODUCTS

2.01 BUILDING SYSTEM MANUFACTURERS

A. Products manufactured or supplied by the following, and meeting these Specifications, may be used on this Project:

1. American Buildings Company, Columbus, GA.
2. Butler Manufacturing Co., Kansas City, MO.
3. Ceco Corp., Columbus, MS.
4. Chief Industries, Inc., Rensselaer, IN.
5. Inland Buildings, Cullman, AL.
6. Kirby Building Systems, Inc., Columbus, GA.
7. NCI Building Systems, Inc., Houston, TX.
8. Nucor Building Systems, Waterloo, IN.
9. Varco-Pruden Buildings, Memphis, TN.

2.02 COMPONENTS

A. Structural Framing and Bracing:

1. Primary Framing: ASTM A36/A36M, ASTM A529/A529M, ASTM A572/A572M, or ASTM A992. Hot-dip galvanized G90 minimum.
2. Secondary Framing: Steel for cold-formed galvanized channel and z-sections shall be ASTM A653/A653M, Structural Steel (SS) Grade 33 or High-Strength Low-Alloy Steel (HSLAS) Grade 50 Type A or B, with G90 galvanized coating.

3. Bracing:
   a. ASTM A36/A36M or ASTM F1554, Grade 36, for threaded rod, or ASTM A36/A36M for rolled shapes.
   b. Do not use wire rope or cable for permanent bracing.
   c. G90 galvanized coating.
4. Bolted Connections:
   a. Primary Framing: ASTM A325 or ASTM A490/A490M high-strength bolted connections.
   b. Secondary Framing: ASTM A307 or ASTM A325.
   c. G90 galvanized coating.
5. Screwed Fasteners: Stainless steel fasteners for all secondary and panel fasteners, grade Type 316 stainless steel.

B. Roof and Wall Panels:

1. Material:
   a. ASTM A653/A653M or ASTM A792/A792M preformed ribbed steel panels, Grade 50, minimum.
   b. Minimum 24-gauge (roof) and 26-gauge (wall) galvanized steel with roll-formed corrugations for structural stiffness and appearance.
   c. Finish: Factory-applied baked enamel, in color selected by Owner.
2. Roof Panel System:
   a. ASTM E1514 structural standing seam steel roof panel system.
   b. Panels: One piece from eave to ridge, with concealed clips and fasteners to purlins to allow for thermal movement over 120-degree ambient temperature range.
   c. Sidelap Joints: Fabricate with a factory caulked, mechanically seamed cleat.
   d. Tested and certified to meet UL 580, Class 90 wind uplift rating.
3. Wall Panel System:
   a. One piece from eave to sill, with base trim at sill.
   b. Sidelaps: Interlocking ribs with concealed fasteners.
4. Liner Panels:
   a. Ceiling: One piece from eave to ridge.
   b. Walls: One piece from eave to sill, with base trim at sill.
   c. Sidelaps: Overlapping major ribs with exposed color-matched fasteners.

2.03 ACCESSORIES

A. Overhead Doors: As specified in Section 08 33 23, Overhead Coiling Doors.

B. Roof Accessories:

1. Continuous Ridge Ventilator: Building manufacturer's standard.

C. Metal Building Blanket Insulation:

1. ASTM E2178.
2. Provide at roof: R-19 batts plus R-11 Linear System with continuous vapor barrier.
3. Provide at walls: R-6.5 continuous rigid insulation plus R-13 batt insulation with continuous vapor barrier.
4. Vapor barrier; 2-mil thick white vinyl vapor barrier backing with Water Vapor Permeance Rating of 0.1 maximum, ASTM E96/E96M, Procedure A.
5. Flame Spread: ASTM E84, less than 25.

D. Thermal Blocks: High-density, 3/4-inch thick extruded polystyrene, for installation over structural framing members. Minimum R-3.

E. Trim: Factory-formed and factory-painted ridge cap, rake trim, simple eave trim, panel side trim, corner trim, door trim, and other trim as necessary.

F. Gutter Fascia and Downspouts:

1. Material: ASTM A653/A653M, 26-gauge galvanized steel.
2. Gutter Fascia:
   a. Prefinish.
   b. Furnish hangers with factory-applied paint.
3. Preformed Corner Closures: Furnish to match configuration of gable fascia.
4. Downspouts:
   a. Configuration: Nominal 4-inch corrugated rectangular box with minimum 11 square inches of cross section area.
   b. Factory finish to match wall panels.

G. Miscellaneous: Furnish fasteners, metal-backed neoprene washers, weatherstripping, sealants, roof jacks, roof curbs, gaskets, and other items as required for a complete installation.

2.04 FABRICATION

A. Factory Fabricate: To manufacturer's written standards, MBMA Metal Building Systems Manual, and AISC Specification for Structural Steel Buildings.

B. Building Parts: Accurate and true to dimension to facilitate building erection without cutting, fitting, or other alterations.

C. Welded Connections: In accordance with AWS D1.1/D1.1M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting concrete foundation and anchor bolt placement for compliance with requirements for installation tolerances and other conditions affecting performance of metal building.

3.02 BUILDING ERECTION

A. Erect building system in accordance with manufacturer's standards and instructions.

B. Provide temporary bracing in accordance with MBMA standards and as required for safe installation.

C. Structural Framing:

1. Do not field cut or alter primary or secondary framing members.
2. Installation and Tolerances: In accordance with MBMA Metal Building Systems Manual.

D. Roof and Wall Panels:

1. Field cutting of panels by torch is not permitted.
2. Attach panels to structural supports to maintain a weathertight seal while allowing for thermal and structural movement.
   a. Install exposed fasteners in true vertical and horizontal alignment.
   b. Field seam side laps of standing seam roof panels using electrically operated seaming machine.
   c. Use proper tools to install screw fasteners to compress neoprene washer without damaging washer or stripping metal.
3. Install manufacturer's standard joint sealants, gaskets, and closure strips as required for weathertight installation.
4. Install roof curbs for roof top equipment.
5. Field Cutting and Patching: Perform in manner not to impair appearance, weathertightness, or structural capacity of panel system.

3.03 REPAIR, CLEANING, AND PAINTING

A. Immediately following erection, remove unused material, screws, fasteners, and other debris from completed installation. Use caution in removing metal cuttings from surface of prefinished metal panels.

B. Replace damaged, dented, buckled, or discolored metal panels.

C. Repair damaged painted and galvanized surfaces as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY CONTROL

A. Special inspection will be provided by Owner where indicated on Drawings.

3.05 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation.

END OF SECTION

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS

Prepared for the
City of Crestview
Crestview, Florida

Volume 2 of 3
Specifications

For information regarding
this project, contact:
SCOTT JERNIGAN
25 WEST CEDAR STREET,
SUITE 350
PENSACOLA, FL 32502
PHONE: 850-941-7282

Jacobs

Project No. D3403200

APRIL 2021

BID DOCUMENTS

CITY OF CRESTVIEW

DEPARTMENT OF PUBLIC SERVICES

CRESTVIEW WWTP SOLIDS HANDLING IMPROVEMENTS PROJECT

FY-2021

Bid No. 21-05-11

Brona D. Steele
Director of
Public Services

Marc D. Bonifay, P.E.
City Engineer

Prepared by:
Jacobs Engineering Group
25 West Cedar Street, Suite 350
Pensacola, FL 32502

CITY OF CRESTVIEW

CRESTVIEW, FLORIDA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

CRESTVIEW WWTP SOLIDS HANDLING IMPROVEMENTS PROJECT

Jacobs Contract No. D3403200

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JACOBS

Pensacola, Florida

April 2021

Project No. D3403200 Copy No.____

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END OF SECTION

SECTION 23 05 48
VIBRATION ISOLATION FOR HVAC

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. American Society of Testing and Materials (ASTM).
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code—Steel.
4. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. EPDM: Ethylene-Propylene-Diene Monomer.

C. Withstand: Unit will remain in place without separation of any parts from the device.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings, Vibration Isolators:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Product Data:
      1) Manufacturer’s product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of vibration isolator type with location and static and dynamic load on each.
      3) Vibration Isolation Base Details:
         a) Detail fabrication, including anchorages and attachments to structure and to supported equipment.

b) Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

B. Informational Submittals:

1. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
2. Certifications:
   a. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
   b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
   c. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.04 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Isolation materials and flexible connectors shall be same manufacturer, Select and certify using published or factory certified data.

C. Vibration isolation manufacturer shall be a member of the Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION

A. General:

1. Provide for mechanical piping, ductwork, and equipment as identified by this Specification.
2. Select in accordance with equipment, pipe, or duct weight distribution to produce reasonably uniform deflections.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 30 percent and 60 percent of maximum deflection.

B. Elastomeric Pad:

1. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.
2. Waffle pads bonded each side of galvanized steel separator plate.
3. Height of waffle ribs shall not exceed 0.7 times width.

4. Maximum Loading: 413 kPa.
5. Separator plate of sufficient stiffness for uniform loading over pad area.
6. Factory cut to size that matches requirements of supported equipment.
7. Waffle Pad Material: Standard neoprene.
8. Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.

C. Elastomeric Mount:

1. Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements.
2. Factory-drilled, encapsulated top plate for bolting to equipment.
3. Baseplate for bolting to structure.

D. Open Spring Isolator:

1. Freestanding, laterally stable, open-spring isolators.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Elastomeric Hanger:

1. Double-deflection type.
2. Molded, oil-resistant rubber or neoprene isolator elements bonded to steel housing.
3. Threaded connections for hanger rods.

F. Spring Hanger:

1. Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element:
   a. Molded, oil-resistant rubber or neoprene.
   b. Steel washer-reinforced cup to support spring and bushing projecting through bottom of frame.

G. Thrust Limit:

1. Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop.
2. Rod and angle-iron brackets for attaching to equipment.
3. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
4. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
5. Minimum Additional Travel: 50 percent of required deflection at rated load.
6. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

H. Manufacturers:

1. Mason Industries, Inc.
2. Peabody Noise Control, Inc.
3. Kinetics Noise Control, Inc.
4. California Dynamics Corp.
5. M.W. Sausse & Co., Inc. (VIBREX).
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation Co., Inc.
8. The VMC Group.

2.02 EQUIPMENT BASES

A. Rooftop Isolation Rails:

1. Factory-assembled, fully enclosed, insulated, airtight, and watertight curb rail designed to resiliently support equipment.
2. Lower Support Assembly:
   a. Sheet metal “Z” section containing adjustable and removable steel springs that support upper floating frame.
   b. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces.

c. Provide means for attaching to building structure and a wood nailer for attaching roof materials.

3. Isolators:
   a. Adjustable, restrained spring type, mounted on elastomeric vibration isolation pads.
   b. Provide access ports, for level adjustment, with removable waterproof covers at isolator locations.
   c. Locate so they are accessible for adjustment during the life of the installation without interfering with the integrity of the roof.
   d. Restrained Spring Isolators:
      1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
      2) Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
      3) Minimum Additional Travel: 50 percent of required deflection at rated load.
      4) Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
      5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   e. Elastomeric Isolator Pads:
      1) Oil-resistant and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern.
      2) Galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to size that match requirements of supported equipment.
      3) Material: Standard neoprene.
      4) Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.
4. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter-flashed over roof materials.

B. Manufacturers:

1. Mason Industries, Inc.
2. Peabody Noise Control, Inc.
3. BDR Noise and Vibration Control, Inc.
4. Kinetics Noise Control, Inc.
5. Amber/Booth Company, Inc.
6. California Dynamics Corp.
7. Isolation Technology, Inc.
8. M.W. Sausse & Co., Inc. (VIBREX).
9. Thybar Inc.

10. Vibration Eliminator Co., Inc.
11. Vibration Isolation Co., Inc.
12. The VMC Group.

2.03 FLEXIBLE CONNECTORS

A. Flexible Duct Connectors: Refer to Section 23 31 13, Metal Ducts and Accessories.

2.04 SHOP/FACTORY FINISHING

A. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment, before shipping.

1. Powder coating on springs and housings.
2. Electro-galvanize hardware.
3. Hot-dip galvanize metal components for exterior use.
4. Baked enamel coat metal components for interior use.

B. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Install products in accordance with manufacturers' written instructions.
2. Connect wiring to isolated equipment with flexible hanging loop.
3. Install roof curbs, equipment supports, and roof penetrations as specified.
4. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.
5. Locate isolation hangers as near overhead support structure as possible.

B. Vibration Isolators:

1. Install spring hangers without binding.
2. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

3.03 FIELD QUALITY CONTROL

A. Testing: Conduct the following field quality-control testing:

1. Isolator deflection.
2. Snubber minimum clearances.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative present at site or classroom designate by The City, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for facility startup.

3.05 ADJUSTING

A. Vibration Isolation Devices:

1. Adjust isolators after piping systems have been filled and equipment is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height.
3. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
4. Adjust isolators to ensure units do not exceed rated operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points.
5. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

3.06 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
3. Canadian Associated Air Balance Council (CAABC): National Standards for Field Management and Instrumentation Total System Balance.
4. National Environmental Balancing Bureau of Canada (NEBBC):
   a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
   b. Procedural Standards for Measuring Sound and Vibration.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.02 SUBMITTALS

A. Informational Submittals:

1. Documentation of experience record of testing authority.
2. Documentation of current CAABC or NEBBC certifications for those technicians in responsible charge of the work under this Contract.
3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
4. Written verification of calibration of testing and balancing equipment.
5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.03 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Certification by CAABC of NEBBC for testing, adjusting and balancing of HVAC systems.
2. Corporately and financially independent organization functioning as an unbiased testing authority.

3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.
4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

C. Drives for Belt-Driven Fans:

1. Furnish cast iron or flanged steel sheaves.
2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the CAABC, NEBBC or SMACNA.

B. Adjust and balance the following systems:

1. Supply, and exhaust air systems.
2. Electric heating system.

3.02 ADJUSTING AND BALANCING AIR SIDE

A. Preparation:

1. Prior to beginning the Work, perform the following activities:
   a. Review Shop Drawings and installed system for adequate and accessible balancing devices and test points.
   b. Verify proper startup procedures have been completed on the system
   c. Verify controls installation is complete and system is in stable operation under automatic control.

d. Verify test instruments have been calibrated to a recognized standard and are within manufacturer's recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Read just as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.
3. Correct fan and airflow measurements for Site elevation.
4. For rooms, the allowable variations are plus 5 percent/minus 5 percent for supply and plus 5 percent/minus 5 percent for exhaust.

C. Equipment Data:

1. Collect the following data and included in final report:
   a. Type of unit.
   b. Equipment identification number.
   c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
   d. Motor data (frame, kW, volts, FLA rpm, and service factor).
   e. Sheave manufacturer, size, and bore.
   f. Belt size and number.
   g. Sheave centerline distance and adjustment limits.
   h. Starter and motor overload protection data.
   i. Include changes made during the course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
   a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation aforementioned.
   b. After final adjustments, do not operate motor above nameplate amperage on any phase.
   c. After final adjustments, do not operate fan above maximum rated speed.
   d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.

e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit manufacturer and Engineer if drive or belt changes were made.

4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

E. Air Terminal Devices:

1. Terminal Airflow Calibration: Calibrate and set the flow coefficients in terminal controller units to ensure controller readings are identical to measured values. This shall be a one-point calibration at maximum flow conditions. Record coefficient values.
2. Test each terminal flow device at minimum and maximum flow conditions. Ensure terminal controller is under control at time of each test.
3. If airflow of terminal device is derived from two or more flow streams, the individual air streams shall be measured and recorded independently for each test.
4. In each terminal system at least one airpath from terminal to final duct termination shall have dampers fully open.
5. Adjust air volumes on each terminal to quantity shown, with allowable variation aforementioned.

F. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation aforementioned.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

G. Building Static Pressure:

1. Measure building static pressure relative to outside in perimeter entrances during normal system conditions that would yield widest range in internal building pressure.
2. Adjust building static pressure control parameters to ensure perimeter entrances are positive to outdoors by 0.05-inch WC with entrance doors closed.

3.03 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by Section 01 91 14, Equipment Testing and Facility Startup.

B. Performance Testing:

1. Electric Heating Coil Testing:
   a. Adjust system as required to achieve full output from coil.
   b. Read and record amperages and voltages for all phases.
2. Vibration Testing:
   a. Upon completion of air system balance, perform vibration testing as specified below for the following rotating or reciprocating equipment:
      1) Wall fans.
      2) Electric heater.
   b. Vibration Test Procedures:
      1) Take measurements at each bearing housing, using a calibrated electronic analyzer.
      2) Record log shall include equipment symbol, location, identification, and peak-to-peak displacement in a direction parallel to shaft in a horizontal plane, and in a direction perpendicular to shaft in both horizontal and vertical planes.
      3) Notify Engineer if amplitude exceeds upper limit specified.
      4) After readjustment for vibration, measure and record only the readjusted equipment to determine its conformance with design.

C. Balancing Log Report Requirements:

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.
2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.

4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air or water systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

D. Quality Control Verification:

1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:
   a. Air and water balancing procedures, vibration tests, and verification of test results.
   b. Perform spot tests on a maximum of 20 percent of total diffusers and grilles, on two fan devices per building, , with measuring equipment used in original tests, at random points selected by Engineer.
   c. Results of these spot tests shall agree with balance logs within percentage tolerances specified. Where this accuracy cannot be verified, rebalance portions of system as requested by Engineer.
   d. At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION

SECTION 23 09 13
HVAC CONTROLS, FIELD COMPONENTS, AND INSTRUMENTS

PART 1 GENERAL

1.01 GENERAL

A. Section includes the design, manufacture, testing, calibration, and delivery, and installation of the laboratory airflow control system, complete with accessories.

1.02 EXTRA MATERIALS

A. HVAC Control Panel (HCP) Spare Lamps: Furnish spare lamps for each type and color of pilot light used, a minimum of one per HCP, stored inside HCP in dummy light sockets secured to back panel surface.

PART 2 PRODUCTS

2.01 HVAC CONTROL PANELS (20-HCP-01)

A. Provide at locations shown on Drawings for convenient operator interface with control system.

B. A single 120-volt, 20-amp feeder shall serve each HCP, unless otherwise indicated.

C. HCP Contents: Electronic indication relays, control switches, transformers, pilot lights, alarm lights, and other devices necessary for particular system.

D. HCP Construction:

1. Construct each HCP to NEMA 250 rating as indicated in Schedule below**,** except where indicated otherwise:

HVAC Control Panel (HCP) NEMA 250 Construction Schedule

Location	NEMA 250 Type
Dewatering building (20-HCP-01)	1X

2. Metal enclosure to accommodate secure conduit fittings and protect against electrical transients.
3. Hinged front door with locking handle.
4. Flush-mount manual switches, pilot lights, etc on front panel face.

E. Panel Listing: Panels shall bear UL or ETL listing mark stating “LISTED ENCLOSED INDUSTRIAL CONTROL PANEL.”

F. Control Devices:

1. Mount inside HCP.
2. Prewired internally.
3. Terminate wires leaving HCP at separately numbered terminal strips (one terminal pair per circuit).
4. Furnish individual connectors for every item of mechanical equipment, integral and remote pilot lights, and other devices described for each panel.
5. Refer to Drawings for power and control circuit requirements.
6. Identify wires by color coding or numerical tags at both ends.
7. Wire control devices without splices to the terminal strip.
8. Furnish integral circuit protection for panel mounted control devices.
9. Acknowledge and Reset buttons for the associated ventilation monitoring system. See panel face design in drawings. The buttons shall be a momentary pushbutton switch, is corrosion resistant, suitable for wall mounting and is rated at 120V ac, 60 Hz, three amperes. The test button shall be an Allen-Bradley Company Bulletin 800H, heavy duty pushbuttons factory assembled station or equal.

G. Terminal Blocks:

1. One-piece molded plastic blocks with screw type terminals and barriers rated for 600 volts.
2. Double sided and supplied with removable covers to prevent accidental contact with live circuits.
3. Furnish permanent, legible identification, clearly visible with protective cover removed.
4. Terminate wires at terminal blocks with crimp type, preinsulated, ring-tongue lugs.
5. Size lugs for terminal block screws and for the number and size of wires terminated.
6. Provide screwdriver access for blade width of a minimum of 3/16 inch or Klein 601 Series screwdrivers. Terminals requiring use of special screwdrivers are not acceptable.

H. Miscellaneous Accessories:

1. Furnish panel as-built electrical wiring schematics, secured to inside of panel door, or enclosed in plastic jackets placed inside each panel.
2. Install plastic or stick-on labels on interior control devices to identify them in conjunction with control schematics.

2.02 VENTILATION MONITORING STATION (20-VMS-01)

A. Signaling notification alarm panels shall be installed where shown on the Drawings and interlocked with the HVAC control panel 20-HCP-01 as shown to provide ventilation system status and alarm.

B. Each Panel shall include the following.

1. Green indicating status light with “VENTILATION SYSTEM ACTIVE” sign.
2. Red indicating status light with “WARNING – VENTILATION SYSTEM FAIL” sign.
3. Horn with test push button.

C. Stations shall be wall mounted with Type 316 stainless steel hardware. Mounting fittings shall be provided by the manufacturer.

D. VMS Indicating lights:

1. General: Green and Red indicating lights shall provide a visual indication of the ventilation system status.
2. Required Features:
   a. LED Light: Steady-burn; 60,000 hours.
   b. Lens Color: Red and Green as indicated.
   c. Enclosure: NEMA 4X.
   d. Power: Loop-Feed from 20-HCP-01.
   e. Approvals: UL Listed for Class 1, Div 1, Groups C & D.
   f. Dimensions: 15.63-inch high and 8.82-inch diameter.
   g. Dome guard.
   h. 90 degrees wall mounted bracket.
3. Manufacturer: Provide one of the following:
   a. Federal Signal Corporation.
   b. Larson Electronics, LLC.
   c. Or “Equal”.

E. VMS Horn:

1. General:
   a. Function: Audible alarm suitable for use in a hazardous location and also indoor/outdoor use.
2. Performance:
   a. Temperature, Operating: Minus 54 degrees C to 66 degrees C.
3. Features and ratings:
   a. Hazardous Location: Class I, Div 2, Groups A, B, C, D.
   b. Dimensions: 4.4 inches in height and width, and 4.0 inches in depth, nominal.

c. Speaker Cone: Polymeric.
d. Listings: UL, cUL listed, FM, CSA approved.

4. Enclosure:
   a. Type: Non-metallic polycarbonate light gray.
   b. Rating: NEMA 4X.
   c. Mounting: Surface mount.
5. Power: Loop-feed from 20-HCP-01.
6. Manufacturer:
   a. Federal Signal Corporation.
   b. Or “Equal”.

F. VMS Test button: A test button shall be conveniently located in each VMS for the purpose of activating the audible and visual signals in order to validate their operation. The test button shall be a momentary pushbutton switch, is corrosion resistant, suitable for wall mounting and is rated at 120V ac, 60 Hz, three amperes. The test button shall be an Allen-Bradley Company Bulletin 800H, heavy duty pushbuttons factory assembled station or equal.

2.03 STROBE WARNING LIGHTS/AUDIBLE

A. Strobe warning lights shall be installed where shown on Drawings to provide ventilation system status and alarm. General:

1. Function: Warning light and audible alarm suitable for use in a hazardous location and also indoor/outdoor use.
2. Type:
   a. Flashing LED.
   b. Suitable for hazardous locations.
   c. Audible/visible base housing with visual alarm and front mounted.
3. Operating Temperature: minus 58 to 150 degrees F.
4. Performance:
   a. Flash Rate: 60 per minute.
5. Features:
   a. Flashing, super bright LED array.
   b. Lamp Life: 60,000 hours.
   c. Construction:
      1) Aluminum Powder-coated base.
      2) Glass dome with Gasket.
   d. Dome guard.
   e. Dome Color: Red, unless otherwise noted.
   f. Mounting: Pipe, unless otherwise noted.
   g. Enclosure Rating: NEMA 4X.
   h. Light Diameter: 6 inches nominal.

6. Power: Loop-feed from 20-HCP-01.
7. Hazardous Approvals: Class I, Division 2, Groups A, B, C and D.
8. Manufacturer:
    a. Federal Signal Corporation.
    b. Or “Equal”.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 23 31 13
METAL DUCTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
3. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure Test).
4. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
   c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
   e. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
   h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment.
   j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.
   k. A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   l. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

5. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
6. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   b. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
   c. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   d. 259, Standard Test Method for Potential Heat of Building Materials.
   e. 701, Standard Method of Fire Test for Flame Propagation of Textiles and Films.
7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Construction Standards.
   b. Fibrous Glass Duct Construction Standards.
   c. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
   d. HVAC Air Duct Leakage Test Manual.
8. Underwriters Laboratories Inc. (UL):
   a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
   b. 214, Tests for Flame-Propagation of Fabrics and Films.
   c. 555, Standard for Safety Fire Dampers.
   d. 555S, Standard for Safety Smoke Dampers.
   e. Underwriters Laboratories of Canada (ULC).
   f. National Fire Code of Canada.
   g. National Building Code of Canada.

1.02 DEFINITIONS

A. Sealing Requirements: For the purpose of duct systems sealing requirements specified in this section, the following definitions apply:

1. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
2. Joints, duct surface connections including:
   a. Girth joints.
   b. Branch and subbranch intersections.
   c. Duct collar tap-ins.
   d. Fitting subsections.
   e. Louver and air terminal connections to ducts.
   f. Access door, and access panel frames and jambs.
   g. Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Rectangular and Rigid Round Ductwork:
      1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      2) SMACNA Figure Numbers for each shop fabricated item.
      3) Reinforcing details and spacing.
      4) Seam and joint construction details.
      5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
   b. Ductwork Accessories:
      1) Manufacturer’s product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
         a) Fittings and volume control damper installation (both manual and automatic) details.
         b) Duct liner.
         c) Sealing materials.
         d) Dampers; include leakage, pressure drop, and maximum back pressure data.
         e) Duct-mounted access panels and doors.
         f) Flexible ducts.
         g) Sheet metal fasteners.

2. Duct Fabrication Drawings:
    a. Drawn after actual job measurements are obtained.
    b. Drawn to a scale not smaller than 6 mm equals 300 mm, on drawing sheets same size as Contract Drawings.
    c. Include the following features:
        1) Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other work.
        2) Duct layout, indicating pressure classifications, and sizes in plan view.
        3) For materials handling exhaust duct systems, indicate classification of materials handled.
        4) Duct material and thickness.
        5) Fittings and volume control damper installation (both manual and automatic) details.
        6) Reinforcing details and spacing.
        7) Seam and joint construction details.
        8) Penetrations through fire-rated and other partitions.
        9) Duct accessories and control devices such as automatic dampers, airflow monitors, terminal units, smoke detectors, regulators, air distribution devices, etc.
        10) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
        11) Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installation.
        12) Coordination with ceiling suspension members.
        13) Spatial coordination with other systems installed in same space with duct systems.
        14) Coordination of ceiling- and wall-mounted access doors and panels required for access to dampers and other operating devices.
        15) Coordination with ceiling-mounted lighting fixtures, air outlets, and inlets.
        16) Coordination of ductwork with sprinkler piping and other mechanical and electrical services, and equipment installed under Division 23, Heating, Ventilating, and Air-Conditioning (HVAC), Division 40, Process Integration, and Division 26, Electrical.

B. Informational Submittals:

1. Sound Attenuators Certified Test Data:
    a. Dynamic insertion loss.
    b. Self-noise power levels.
    c. Static pressure loss.

d. Dimensions and weights.

2. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

1.04 QUALITY ASSURANCE

A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA duct construction standard relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.
2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

C. Suppliers of duct and fitting components shall provide on request the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
2. Laboratory performance data for fittings, including zero-length dynamic losses.

D. Installer shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Project.

E. Changes or alterations to layout or configuration of duct system shall be:

1. Specifically approved in writing by Contract Administrator.
2. Proposed layout shall provide original design results, without increasing system total pressure.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on jobsite, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. Deliver sealant materials to site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

C. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

D. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.01 SCHEDULES

A. Ductwork Schedule: Refer to Drawings.

2.02 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork thinner than 26 gauge will not be allowed.

D. Ductwork Interior Surfaces:

1. Smooth.
2. No sheet metal parts, tabs, angles, screws, or other items may project into air ducts, unless otherwise specified.
3. Seams and joints shall be external.
4. For ductwork that is required to be reinforced. Contractor may use either external or internal reinforcing.

2.03 SHEET METAL MATERIALS

A. Construct metal duct systems from materials as indicated in Article, Ductwork Schedule.

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

C. Aluminum Ductwork (AL 61):

1. Comply with ASTM B209.
2. Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.
3. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or equivalent.

D. Stainless Steel Ductwork (SS 64):

1. Comply with ASTM A167, A176, A240/A240M, and ASTM A480.
2. Stainless Steel Sheet: Type 304, unless indicated otherwise.
3. Gauge shall comply with SMACNA manual, unless specified otherwise.
4. Finish: No. 2 B (cold-rolled, bright) finish, except as otherwise noted.
5. With No.4 finish on exposed surface for ducts exposed to view.

E. Stainless Steel Ductwork (Odorous Air) (SS 66):

1. Comply with ASTM A167, ASTM A176, ASTM A240/A240M, and ASTM A480/A480M.
2. Stainless Steel Sheet: Type 316/316L, unless indicated otherwise.
3. Duct construction, including sheet metal gauge and reinforcements, shall comply with SMACNA Round Industrial Duct Construction Standards and SMACNA Rectangular Industrial Duct Construction Standards as applicable, unless specified otherwise.
4. Finish: No. 2 B (cold-rolled, bright) finish. Welds shall be grinded smooth and passivated.
5. Longitudinal fusion welded butt seam, flanged fittings, and joints with all seams welded.
6. Elbows: Provide centerline equal to radius 1.5 times elbow diameter.
7. Fittings: Continuously welded along seams.
8. Duct Classification: Class 5 (Corrosive Fumes).
9. Maintenance load provision: 250 pound.

F. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

G. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.04 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
   a. Foster; Series 32.
   b. Childers; CP-145A, 146.
   c. Rectorseal; Airlok 181.

2.05 DUCTWORK FASTENERS

A. General:

1. Rivets, bolts, or sheet metal screws.
2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:

1. Aluminum Ductwork System:
   a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Type 410 stainless steel, complete with bonded metal and fiber washer for dielectric separation.
   b. Manufacturers:
      1) DB Building Fasteners Inc., Santa Fe Springs, CA.
      2) Clark Craft Fasteners, Tonawanda, NY.

2. Stainless Steel Ductwork System:
   a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Type 410 stainless steel.
   b. Manufacturers:
      1) DB Building Fasteners Inc., Santa Fe Springs, CA.
      2) Clark Craft Fasteners, Tonawanda, NY.
      3) UCAN Fastening Products.

2.06 DUCTWORK PRESSURE CLASS

A. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 2-inch WC pressure class shall be basis of Contract.

2.07 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

2.08 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:

1. Fit square-turn elbows with vane side rails.
2. Shop fabricate double-blade turning vanes of same material as ductwork.
3. Fabricate with equal inlet and outlet.
4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
5. Manufacturers and Products:
   a. Elgen; All-Tight.
   b. Duro-Dyne; Type TR.

2.09 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using factory fabricated fittings with spot welded tap to main duct connections. Field installed taps are not acceptable.

2.10 ROUND DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections (taps) to round duct mains shall be made using factory fabricated fittings.

2.11 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
3. Wire hangers are not acceptable.
4. Hanger Spacing:
   a. Ducts Up to 60 inches in Largest Dimension: 9 feet, maximum.
   b. Ducts Over 60 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

1. Galvanized Steel Ductwork:
   a. Indoors: Carbon steel, zinc electroplated.
   b. Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
2. Aluminum Ductwork Indoors and Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
3. Stainless Steel Ductwork Indoor and Outdoors: Stainless steel, same ASTM Grade as ductwork.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
3. Upper Attachment (Concrete):
   a. Drive pin fastener and expansion nail anchor may be used for ducts up to 17 inches maximum dimension.
   b. Threaded stud fastener may be used for ducts up to 35 inches maximum dimension.
   c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fastener.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.12 DUCT INSPECTION DOORS

A. General:

1. Insulated, gasketed, and at least 15-inch by 15-inch mm when duct dimensions are large enough.
2. On ductwork where largest side dimension is less then 15 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware.
4. Fabricated of same material as ductwork.

B. Round Spin-in Type Access Doors:

1. Size: 17-inch and 23-inch diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.
2. Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.
3. Manufacturers: Flexmaster, Inspector Series.

C. Manufacturers:

1. Ventlock.
2. Flexmaster.
3. Duro-Dyne.

2.13 MANUAL DAMPERS

A. Butterfly Manual Dampers:

1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
2. Align operating handle with damper blade.
3. Damper Manufacturers:
   a. Ruskin.
   b. American Warming and Ventilating.
4. Operator Manufacturers:
   a. Accessible Ductwork: Ventlok; Type 620 or 635.
   b. Accessible Insulated Ductwork: Ventlok; Type 639.
   c. Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

2.14 BACK DRAFT DAMPERS

A. General:

1. Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.
2. Roofs fans provided with back draft dampers.

2.15 MISCELLANEOUS ACCESSORIES

A. Sheet Metal Plenums:

1. Fabricate from minimum 18-gauge metal of same material as ductwork.
2. Brace with frame of same material for rigidity.
3. Line with sound attenuation material where indicated.

B. Louver and Grille Blank-Off Sections:

1. Fabricate from 20-gauge sheets of same material as louver/grille.
2. Line with sound attenuation/insulating material.
3. Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

C. Prefabricated Roof Curb:

1. Lower section of roof curb that will be integrated with roofing system shall be constructed to accommodate roofing system provided.
2. Top surface of curb shall have rubber weather-seal pad. Provide wooden nailer sections as required for installation.
3. Sheet metal counterflashing shall be provided to accommodate rectangular or round ductwork.
4. Sheet metal screws and rivets shall be stainless steel or coated with corrosion-resistant material.
5. Length and width of roof curb shall be sized by Contractor for particular application.
6. Manufacturer: Factory fabricated by equipment manufacturer.

D. Accessories Hardware:

1. Instrument Test Holes:
   a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
   b. Size to allow insertion of pitot tube and other testing instruments.
   c. Provide in length to suit duct insulation thickness.
2. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

2.16 DUCTWORK IDENTIFICATION

A. Painted Identification Materials:

1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of ASME A13.1 for piping and similar applications, but not less than 32 mm high letters for ductwork and not less than 20 mm high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.

B. Plastic Duct Markers:

1. General: Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color code:
   a. Black text on yellow background: Odorous Air.
   b. White text on blue background: Services other than hazardous exhaust and odorous air.
   c. For other hazardous exhausts, use colors and designs recommended by ASME A13.1.

C. Nomenclature: Include the following:

1. Direction of air flow.
2. Duct service (supply, return, exhaust).
3. Duct origin (from).
4. Duct destination (to).

D. Manufacturers:

1. W.H. Brady, Co.
2. Seton Identification Products.
3. Craftmark.
4. Brimar Industries, Inc.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Miscellaneous:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.
3. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
2. Avoid diagonal runs wherever possible.

3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
4. In general, install as close to bottom of structure as possible.
5. For ductwork run above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.
6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
2. Clearances:
   a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
   b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.
3. Closure Collars:
   a. Minimum 4-inch mm wide on each side of walls or floors where sleeves or prepared openings are installed.
   b. Fit collars snugly around ducts and insulation.
   c. Same gauge and material as duct.
   d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
   e. Use fasteners with maximum 6-inch centers on collars.
4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Coordination with Other Trades:

1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

E. Shower Room and Toilet Room Exhaust Ductwork:

1. Joints and Seams: Seal watertight.
2. Slope branch ducts downward to grille.

F. Fume Hood, Laboratory, and Chlorine Room Exhaust Ductwork:

1. Seal joints and seams with chemical-resistant mastic.
2. Rivet butt joints with minimum of eight pop rivets.

3.02 RECTANGULAR DUCTWORK

A. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.

B. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

3.03 RECTANGULAR DUCTWORK FITTINGS

A. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.

B. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.

C. Make offsets with maximum angle of 45 degrees.

D. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

3.04 RECTANGULAR DUCTWORK TRANSVERSE JOINTS

A. Install each run with a minimum of joints.

B. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

C. Mechanical Joint Option:

1. Construct transverse joints with Ductmate 25/35 duct connector systems, W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system.
2. When using W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.

3. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
4. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
5. Conform to SMACNA Class A sealing requirements.

3.05 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 23 inches of each elbow and within 48 inches of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

3.06 DAMPERS

A. General:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Contract Administrator of conditions that would adversely affect installation or subsequent utilization of dampers.
   c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on Drawings and in accordance with manufacturer's installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.

6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

B. Manual Dampers:

1. Provide balancing dampers for grilles and diffusers in branch duct as near main as possible.
2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

C. Back Draft Dampers:

1. Install dampers square and free from racking with blades running horizontally.
2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

D. Control Dampers:

1. Install at locations indicated on Drawings and in accordance with manufacturer's instructions.
2. Install square and free from racking with blades running horizontally.
3. Operate opposed blade dampers from a power blade or drive axile.
4. Bracing:
   a. Install for multiple section assemblies to support assembly weight and to hold against system pressure.
   b. Install at every horizontal and vertical mullion.

3.07 MISCELLANEOUS ACCESSORIES

A. Auxiliary Drain Pans:

1. Under equipment for which pan is shown on Drawings and under all horizontal air handling units located above ceilings and piping located in ceiling space directly above computer facility areas; furnish and install auxiliary drain pans.
2. Route drain lines to nearest floor or hub drain independent of any other drain.
3. Slope drain pans toward drain connection to promote drainage.
4. Louver and Grille Blank-off Sections: Attach airtight to louver or grille and install to allow for easy removal.

B. Inspection Plates and Test Holes:

1. Where required in ductwork for balance measurements.
2. Test holes shall be, airtight and noncorrosive with screw cap and gasket.
3. Extend cap through insulation.

3.08 DUCT SEALING

A. Seal duct seams and joints as follows:

1. In accordance with SMACNA requirements.
2. In accordance with the following:
   a. Pressure Classifications Greater than 3-inch W.G.: Transverse joints, longitudinal seams, and duct penetrations.
   b. Pressure Classification Between 2-inch W.G. and 3-inch W.G.: Transverse joints and longitudinal seams.
   c. Pressure Classification Less than 2-inch W.G.: Transverse joints only.

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Seal externally insulated ducts prior to insulation installation.

D. Provide additional duct sealing as required to comply with paragraph Ductwork Leakage Testing.

E. Seal all audible leak.

3.09 BALANCING AND TESTING OF AIR SYSTEMS

A. Perform testing in accordance with the requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.10 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.11 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

END OF SECTION

SECTION 23 34 00
HVAC FANS

PART 1 GENERAL

1.01 REFERENCES

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

1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration – Balance Quality Requirement of Rigid Rotors – Part 1, Determination of Permissible Residual Unbalance.
2. Air Movement and Control Association International (AMCA):
   a. 99, Standards Handbook.
   b. 201, Fans and Systems.
   c. 203, Field Performance Measurement of Fan Systems.
   d. 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
   e. 300, Reverberant Room Method for Sound Testing of Fans.
   f. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): HVAC Applications Manual.
   a. 52.2 Method of Testing General Ventilation Air – Cleaning Devices for Removal Efficiency by Particle Size.
   b. HVAC Applications Manual.
5. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   d. D3363, Standard Test Method for Film Hardness by Pencil Test.
   e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
7. National Fire Protection Association (NFPA): 45, Fire Protection for Laboratories Using Chemicals.

8. Occupational Safety and Health Act (OSHA).
9. Society for Protective Coatings (SSPC):
    a. SP 3, Power Tool Cleaning.
    b. SP 5, Joint Surface Preparation Standard White Metal Blast Cleaning.
    c. SP 6, Joint Surface Preparation Standard Commercial Blast Cleaning.
    d. SP 10, Joint Surface Preparation Standard Near-White Blast Cleaning.
10. Underwriters Laboratories Inc. (UL/ULC): 507, Electric Fans.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:

1.	AC:	Alternating Current.
2.	CISD:	Chemical Industry, Severe-Duty.
3.	dB:	Decibel.
4.	DWDI:	Double Width, Double Inlet.
5.	FRP:	Fiberglass Reinforced Plastic.
6.	kW:	Kilowatt.
7.	ODP:	Open Drip Proof.
8.	SWSI:	Single Width, Single Inlet.
9.	TEFC:	Totally Enclosed, Fan Cooled.
10.	UV:	Ultra Violet.
11.	XP:	Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide for all products specified, as follows:
    a. Identification as referenced in Contract Documents.
    b. Manufacturer’s name and model number.
    c. Descriptive specifications, literature and drawings.
    d. Dimensions and weights.
    e. Fan sound power level data (reference 10 to power minus 12 Watts) at design operating point.
    f. Fan Curves:
        1) Performance Curves Indicating:
            a) Relationship of flow rate to static pressure for various fan speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range (surge curves, maximum revolutions per minute, etc.).

d) Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.

2) For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.

g. Capacities and ratings.
h. Construction materials.
i. Fan type, size, class, drive arrangement, discharge, rotation and bearings.
j. Wheel type, diameter, revolutions per minute, and tip speed.
k. Motor data.
l. Power and control wiring diagrams, including terminals and numbers.
m. Vibration isolation.
n. Factory finish system.
o. Color selection charts where applicable.
p. Corrosion protection coating product data.
q. Fiberglass Material: Statement of resins and reinforcing proposed for use.

B. Informational Submittals:

1. Recommended procedures for protection and handling of products prior to installation.
2. Manufacturer’s installation instructions.
3. Manufacturer’s Certificate of Compliance in accordance with Section 01 43 33, Manufacturers’ Field Services, for the following:
   a. Motors specified to be premium efficient type.
   b. Fans.
4. Test reports.
5. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Performance Ratings: Tested in accordance with AMCA 210.

B. Sound Ratings: Tested in accordance with AMCA 300.

C. Fabrication: In accordance with AMCA 99.

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Some specific equipment requirements are listed in Equipment Schedules. Refer to paragraph, Supplements.

2.02 SPARK RESISTANT CONSTRUCTION

A. Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

B. Alternative fans can also be FRP with graphite liner and grounding.

2.03 NAMEPLATES

A. All units shall include factory installed permanently attached nameplate displaying unit model and serial number.

2.04 OPERATING LIMITS

A. Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408-69.

2.05 ACOUSTICAL LEVELS

A. Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.

2.06 FAN DRIVES

A. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.

B. Sheaves shall be capable of providing 150 percent of motor horsepower.

C. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.

D. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.

E. All motors driven by VFDs to have a shaft grounding ring installed:

1. Current rating: 10 amps high frequency current up to 100 Mhz.
2. Continuous fiber ring with frequency current up to 100 Mhz.

3. Fiber wear: Less than 0.03 mm per 10,000 hours, designed for 200,000 plus hours of operation.
4. Maintenance Requirements: None.
5. Shaft grounding ring may be installed by the motor manufacturer or the fan manufacturer.
6. Shaft grounding ring to be installed in accordance with manufacturer's recommendations.
7. Acceptable Products:
   a. AEGIS® Shaft Grounding Ring kit.
   b. Or integral to motor assembly.

F. Drive Adjustment:

1. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
2. Provide trial and final sheaves, as well as drive belts, as required.

G. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.

H. Belt and Shaft Guards:

1. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and Province of Manitoba requirements.
2. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
3. Bright yellow finish.

I. Provide speed test openings at shaft locations.

2.07 FINISHES

A. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.

1. Parts cleaned and chemically pretreated with a phosphatizing process.
2. Alkyd enamel primer.
3. Air-dry enamel topcoat.

B. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

C. Stainless Steel Parts: Finished smooth and left unpainted.

D. Fiberglass Parts: Finished in accordance with paragraph, Fiberglass Material.

2.08 DIRECT DRIVE PANEL FANS

A. General:

1. Factory-assembled centrifugal wall fan; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:

1. Construction: galvanized steel.
2. Windband: Finish with rolled bead.
3. Top Cap: Motor access via quick release latches.
4. Motor cooling via exhaust air stream.
5. Integral conduit chase for wiring.
6. Drain trough at lowest point of housing.
7. Fan Inlet:
   a. Full inlet cone of steel construction.
   b. Match inlet shroud.

C. Wheel:

1. Steel construction, backward inclined centrifugal.
2. Machined, cast steel hub.
3. Matched to deep spun inlet venturi.

D. Shaft, Bearings, Drive:

1. Shaft:
   a. Turned, ground and polished carbon steel.
   b. Keyed for sheave installation.
   c. Zinc-phosphate coated and oil emulsion-dipped.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
   b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
   c. Terminate with zerk fittings.
3. Drives:
   a. In accordance with Article, Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: As scheduled in Equipment Schedule.

E. Manufacturers and Products: Aerovent.

2.09 CORROSION PROTECTION COATING

A. General:

1. Factory-applied corrosion protection coating for application to fan components and accessories, where required by this section.
2. Quality Control:
   a. Verify dry film thickness before final baking.
   b. Finished coating system shall be free from voids, checks, cracks and blisters.
3. Surface Cleaning: Clean parts to be coated as follows:
   a. Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
   b. Follow with immersion in potable water bath to neutralize and remove cleaning solution.
   c. Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.

2.10 MOTORS

A. General:

1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction.
2. Provide integral self-resetting overload protection on single-phase motors.
3. Motors for fans operate at constant speed
4. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Premium efficient.
7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.
9. Service Factor: 1.15.

2.11 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pound.

C. Weatherhood to protects the fan, shutter and inside the building against rain and snow.

2.12 SOURCE QUALITY CONTROL

A. General:

1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:

1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
2. Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

D. Balancing:

1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

E. Vibration Test:

1. Each fan furnished with a 3.7 kW or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
2. Written records of run test and vibration test shall be made available upon request.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install fans level.

B. Wall Units: Suspend units from structure; use steel wire or metal straps.

C. Labeling:

1. Label fans in accordance with paragraph, Accessories.
2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

D. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

E. Equipment Support and Restraints:

1. Refer to Section 23 05 48, Vibration Isolation for HVAC.
2. Install floor-mounted units on concrete bases designed to withstand, without damage to equipment.
3. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.

F. Connections

1. Refer to Section 23 31 13, Metal Ductwork and Accessories and Section 23 31 16.16, Thermoset Fiberglass-Reinforced Plastic Ducts and Accessories.
2. Isolate duct connections to fans.
3. Install ductwork adjacent to fans to allow proper service and maintenance.

3.02 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.

2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
   a. Energize motor and adjust fan to indicated revolutions per minute.
   b. Measure and record motor voltage and amperage.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
   c. Test and adjust control safeties.
   d. Replace damaged and malfunctioning controls and equipment.

3.03 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of personnel for specified component, subsystem, equipment, or system.

B. Manufacturer's Representative: Present at site, for minimum person-days listed below, travel time excluded:

1. One person-day for installation assistance and inspection.
2. One person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. One person-day for prestartup classroom or site training.
4. One person-day for facility startup.
5. One person-day for post-startup training of buildings personnel.
6. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Contract Administrator.

C. Refer Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Balancing:

1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Replace fan and motor sheaves as required to achieve design airflow.

E. Vibration Testing:

1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.

3.05 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.06 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.

1. Supplement 1, 23 34 00.01, Fans.

END OF SECTION

FANS					**23 34 00.01**
SYMBOL				EF-1	EF-2
LOCATION				DEWATERING BUILDING	DEWATERING BUILDING
TYPE				WALL DIRECT DRIVE PANEL FAN - EXHAUST	WALL DIRECT DRIVE PANEL FAN - SUPPLY
FAN DATA	AIRFLOW	MAX	CFM	5500	6000
		@ SP	in W.G.	1	1
		MIN	CFM	2750	3000
	SPEED	RPM		1750	1750
	DRIVE TYPE			DIRECT	DIRECT
	WHEEL	TYPE		AF	AF
		MIN. DIA.	in	24	24
	MAXIMUM	kW		2.9	2.9
SOUND DATA	SOUND POWER LEVEL		63	3.2	3.2
	dB (RE 10^{-12} W)		125	4.7	4.7
	@ MID OCTAVE BAND		250	7.7	7.7
	FREQUENCY (Hz)		500	22.9	22.9
			1K	26.4	26.4
			2K	31.2	31.2
			4K	36.3	36.3
			8K	41.5	41.5
ELECTRICAL DATA	MOTOR		kW	0.6	0.4
			RPM	620	650
			ENCL.	EXP	EXP
	VOLT			460	460
	PH			3	3
MAXIMUM DIMENSIONS	LENGTH		in	21	21
	WIDTH		in	21	21
	HEIGHT		in	21	21
	WEIGHT		l.b.s.	150	150
MANUFACTURER				AEROVENT	AEROVENT
MODEL NO.				DDP 21L430	DDP 21L430
APPLICABLE REMARKS:				A/C/E/F/G/H	A/C/E/F/G/H

ABBREVIATIONS: FC: FORWARD CURVED BI: BACKWARD INCLINED AF: AIR FOIL

REMARKS:

A: AMCA TYPE B SPARK RESISTANT
B: INVERTER DUTY-RATED MOTOR
C: DISCONNECT SWITCH
D: 300 mm HEIGHT ROOF CURB WITH EXTENDED CURB & DAMPER TRAY
E: BAKED EPOXY PHENOLIC COATING
F: INSULATED FAN HOUSING
G: DRAIN WITH PLUG
H: SUITABLE FOR CLASS I, ZONE 2
I:
J:

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning and Refrigeration Institute (ARI): 880, Air Terminals.
2. ASTM International (ASTM): C636, Standard Practice for Installation of Metal Ceiling Suspension System for Acoustical Tile and Lay-in Panels.
3. Underwriters' Laboratories of Canada. (ULC): Product Directories.

1.02 DEFINITIONS

A. NC: Noise Criteria; background sound rating method for indoor sound.

B. VAV: Variable air volume.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer's data and descriptive literature for products specified.
   b. Furnish the following information for each type of diffuser, register, and grille furnished.
      1) NC sound data.
      2) Static pressure loss data.
      3) Throw data.

B. Informational Submittals: List of recommended spare parts for products specified.

PART 1 PRODUCTS

2.01 SUPPLY GRILLES AND REGISTERS

A. Supply Grilles and Registers (SG1, SR1):

1. Construction: As follows:
   a. Material: Aluminum.
   b. Finish: Aluminum face finish.

c. SR Register Accessories:
1) Gang-operated opposed-blade volume control damper.
2) Material to match grille.

2. Adjustable front horizontal and rear vertical vanes on 1 inch centers.
3. Continuous sponge rubber gasket at face flange.
4. 25 mm minimum flat rectangular frame.
5. Performance: As follows:
a. Maximum Pressure Drop: 0.1-inch WC.
b. Sound: Maximum NC 30.
6. Manufacturers and Products:
a. Krueger; 880/5880 Series.
b. Titus; 300 Series.

B. High Capacity Supply Grilles and Registers (SG2, SR2):

1. Construction: As follows:
a. Material: Aluminum.
b. Finish: Aluminum face finish.
c. SR Register Accessories:
1) Gang-operated opposed-blade volume control damper.
2) Material to match grille.
2. Industrial type, rectangular shaped.
3. 1.2-inch minimum flat rectangular frame.
4. Individually adjustable front horizontal and rear vertical airfoil shaped extruded aluminum blades on 1.2-inch centers.
5. Continuous sponge rubber gasket at face flange.
6. Manufacturer and Product: Titus; AeroBlade Series.

2.02 RETURN, EXHAUST AND TRANSFER GRILLES AND REGISTERS

A. Louvered Return, Exhaust and Transfer Grilles and Registers (RG1, RR1, EG1, ER1, TG1):

1. Construction: As follows:
a. Material: Aluminum.
b. Finish: Aluminum face finish.
c. RR and ER Register Accessories:
1) Gang-operated opposed-blade volume control damper.
2) Material to match grille.
2. Fixed horizontal louvers set at 35 degrees to 45 degrees.
3. 25 mm minimum flat, rectangular frame.
4. Manufacturers and Products:
a. Krueger; S80/S580H Series.
b. Carnes; Type RAAAH.
c. Titus; 350 Series.

B. Perforated Ceiling Return, Exhaust and Transfer Grilles and Registers (RG2, RR2, EG2, ER2, TG2):

1. Construction: As follows:
   a. Material: Aluminum.
   b. Finish: Aluminum face finish. Flat black interior.
   c. RR and ER Register Accessories:
      1) Gang-operated opposed-blade volume control damper.
      2) Material to match grille.
2. Removable perforated faceplate.
3. Frame as required for mounting surface. Size to fit into standard lay-in tee-bar ceiling.
4. Round neck.
5. Manufacturers and Products:
   a. Krueger; Model 6500 Series.
   b. Carnes; Type SLRB (aluminum).

C. High Capacity Return, Exhaust and Transfer Grilles and Registers (RG3, RR3, EG3, ER3, TG3):

1. Construction: As follows:
   a. Square aluminum eggcrate construction.
   b. Baked white enamel finished frame.
   c. RR and ER Register Accessories: Aluminum gang-operated opposed-blade volume control damper.
2. Extruded 1-inch flat frame with concealed fasteners.
3. Fixed louver grid with 0.5-inch by 0.5-inch by 0.5-inch louver spacing.
4. Manufacturers and Products:
   a. Krueger; Model EGC5.
   b. Carnes; Type RAPAF.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to architectural reflected ceiling plans for coordination of locations of ceiling-mounted air outlets and inlets with ceiling grids and lighting. Where locations of devices shown on Mechanical Drawings do not agree with locations that are shown on architectural reflected ceiling plans, reflected ceiling plans shall take precedence. If air outlets or inlets are shown on Mechanical Drawings, but are not shown on architectural reflected ceiling plans, devices shall be located as near as possible to locations shown on Mechanical Drawings when coordinating with ceiling.

B. Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

C. Support air inlets and outlets where installed in metal suspension systems for acoustical tile and lay-in panel ceilings as specified in ASTM C636 and applicable building code.

END OF SECTION

SECTION 23 82 00
ELECTRIC HEATERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes the requirements necessary to furnish and install electric heaters intended for HVAC service.

B. Related Sections:

1. Use this section in conjunction with the following Documents to establish the requirements for the referenced electric duct heaters:
   a. Data sheets included at the end of this section.

1.02 REFERENCES

A. Approvals: Confirm assemblies meet the requirements of the National Electric Code and are listed by Underwriters Laboratories for their applicable use.

1.03 SUBMITTALS

A. Refer to Submittal Schedule at the end of Part 3 for a list of the submittal requirements for this section.

PART 2 PRODUCTS

2.01 ELECTRIC HEATERS

A. Acceptable Manufacturers:

1. Brasch Manufacturing Co.
2. Indeeco.
3. Chromalox.
4. Markel Products Co.
5. Modine.

B. Frame: Aluminized steel, spot welded; flanged or slip-in style as scheduled.

C. Heating Elements:

1. Open Coil Type:
   a. Resistance Wire: 80 percent nickel, 20 percent chromium.
   b. Insulators: Floating ceramic bushings.
   c. Supports: Aluminized steel brackets.

d. Terminals: Mechanically crimp coils in stainless steel terminals which are insulated from the frame with high-temperature molded phenolic bushings.

2. Finned Tubular Type:
   a. Element: 80 percent nickel, 20 percent chromium resistance wire embedded in a refractory material, centered in a steel tube.
   b. Fins: Corrugated, copper-plated steel brazed to the tube to increase heat exchange surface.
   c. Corrosion Protection: Aluminum paint.

D. Electrical:

1. General: Completely factory wire units with terminal blocks for connection of field wiring.
2. Stages: Manufacture three-phase heaters with equal, balanced three-phase stages.
3. Internal Wiring: Stranded copper with 105 degree C insulation, terminated in crimped connectors or box lugs.

E. Controls:

1. Overtemperature Protection:
   a. Primary Protection: Disc type, automatic reset thermal cutout.
   b. Secondary Protection: Load-carrying manual reset thermal cutout, factory wired in series with heater stages.
2. Overcurrent Protection: Built-in and prewired fuses as required by UL and NEMA, with one overcurrent device for each 48-ampere circuit, except that only one overcurrent device is required for the entire heater for heaters rated 48 amperes or less.
3. Thermostats:
   a. Room, Single Stage, Pilot Duty:
      1) Features: Wall mounted thermometer.
      2) Range: 40 to 90 degrees F.
      3) Differential: 1 degree F.
      4) Inductive Rating: 1 amp at 30 volts maximum.
4. Control Transformer: Provide with primary fuse protection for the control voltage scheduled.

PART 3 EXECUTION

3.01 INSTALLATION, ELECTRIC HEATERS

A. General: Install heaters in accordance with their UL listings and the manufacturer’s installation instructions.

B. Support: Support heaters from the structure.

C. Clearance: Maintain NEC-required clearances.

D. Damage: Protect fins and flanges from damage.

3.02 SUPPLEMENTS

A. The supplement listed below, following “End of Section”, is part of this specification.

1. Electric Heater Data Sheet.

END OF SECTION

ELECTRIC HEATERS			**23 82 00.01**	
SYMBOL			HTR-1	HTR-1
LOCATION			DEWATERING	DEWATERING
TYPE			ELECTRIC HEATER CEILING MOUNTED	ELECTRIC HEATER CEILING MOUNTED
UNIT ELECTRICAL DATA	CAPACITY	kW	25.0	25.0
	VOLTAGE	V	480	480
	PHASE	-	3	3
MAXIMUM DIMENSIONS	LENGTH	in	25	600
	WIDTH	in	25	600
	HEIGHT	in	15	400
	WEIGHT	l.b.s.	73	73
MANUFACTURER			MODINE	MODINE
MODEL NO.			VE 250	VE 100
APPLICABLE REMARKS:			C	C

REMARKS:

A: THERMOSTATIC CONTROL VALVE
B: BUILT-IN THERMOSTAT WITH CONTROL KNOB
C: WALL MOUNTED THERMOSTAT WITH CONTROL KNOB
D:
E:
F:
G:
H:
I:
J:

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

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

1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. Z535.4, Product Safety Signs and Labels.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.03 SUMMARY OF WORK

A. Major electrical elements of the project are summarized below:

1. Provide, install, and test new circuit breaker in existing main low voltage switchgear. Existing Switchgear is part of the standby power generator system. Modifications to the existing switchgear, and controls in ISO gear will be required. Contractor to have Cat Switchgear preform any modifications to the existing switchgear including any software modifications to existing required.
2. Provide install, and test low voltage motor control center.
3. Provide, install and test low voltage distribution and lighting panel boards and low voltage dry type transformers.
4. Provide and install new concrete encased duct bank system.

1.04 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following: Nameplates, signs, and labels.

1.05 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.

C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

1.06 ENVIRONMENTAL CONDITIONS

A. The following areas are classified hazardous, Class I, Division 2, Group D, because of the potential for accumulation of hazardous concentrations of combustible gases, and for exposure to corrosive environment. Use materials and methods required for such areas.

1. Aerobic digester: Area within 18 inches above tank wall and 10 feet horizontally form wetted wall.

B. The following areas are classified nonhazardous, wet, and corrosive. Use materials and methods required for such areas.

1. Inside of dewatering Building.
2. Outdoor abovegrade areas not covered above.

C. The following areas are classified as indoor and dry:

1. Operations Building.
2. Main Electrical Building.

PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range stated in Section 01 61 00, Common Product Requirements.

D. Equip panels installed outdoors in direct sun with sun shields.

2.02 EQUIPMENT FINISH

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

2.03 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws:

1. Stainless steel.
2. Adhesive: Single-part, room temperature vulcanizing adhesive suitable for the environment and materials installed. Use adhesive on NEMA 4 or NEMA 4X enclosures only.

C. Color: White, engraved to a black core.

D. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.
2. Other Electrical Equipment: 1/4 inch.

2.04 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.

C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.02 ANCHORING, BRACING, AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for Project design criteria provided in Section 01 61 00, Common Product Requirements.

3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Drawings show each homerun circuit to be provided. Do not combine power or control circuits into common raceways without authorization of Engineer.

3.04 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:

1. Field mark switchboards, motor control centers, panelboards, and adjustable frequency drives to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
2. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis as basis for warning signs.

B. Available Fault Current Signs:

1. Install label on service equipment to indicate the maximum available fault current at the equipment. Labels shall be of sufficient durability for the environment in which the equipment is installed. Labels shall include the following information:
   a. Equipment name or identification.
   b. Available fault current at the equipment.
   c. Date the fault current calculations were performed.
2. Use bolted fault current and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for the label.
3. Where existing electrical systems are modified, completely remove existing fault current labels if present, and install new labels in accordance with the above requirements.

C. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including switchgear, switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
2. Switchgear, motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

3.05 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.07 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

END OF SECTION

SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   b. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C12.1, Code for Electricity Metering.
   c. C12.6, Phase-Shifting Devices Used in Metering, Marking and Arrangement of Terminals.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories, Inc. (UL):
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.

f. 810, Standard for Capacitors.
g. 943, Standard for Ground-Fault Circuit-Interrupters.
h. 1059, Standard for Terminal Blocks.
i. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
a. Control devices.
b. Control relays.
c. Circuit breakers.
d. Fused switches.
e. Nonfused switches.
f. Timers.
g. Fuses.
h. Magnetic contactors.
i. Intrinsic safety barriers.
j. Firestopping.
k. Enclosures: Include enclosure data for products having enclosures.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0 Volt to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Type: Molded case.
2. Trip Ratings: 15 amps to 800 amps.
3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
4. Suitable for mounting and operating in any position.
5. UL 489.

B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in OPEN position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a CENTER position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or interrupting rating shown.
2. Equal to rating of existing equipment.
3. Series Connected Ratings: Do not apply series connected short circuit ratings.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.
2. Push-to-test button.

F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL-listed for equipment ground fault protection).

G. Connections:

1. Supply (line side) at either end.
2. Mechanical wire lugs, except crimp compression lugs where shown.
3. Lugs removable/replaceable for breaker frames greater than 100 amperes.

4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.

H. Enclosures for Independent Mounting:

1. See Article Enclosures.
2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. UL 98 listed for use and location of installation.

B. NEMA KS 1.

C. Short Circuit Rating: 200,000 amps rms symmetrical with Class R, Class J, or Class L fuses installed.

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

E. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.
2. Lugs removable/replaceable.
3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions:

1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

G. Enclosures: See Article Enclosures.

H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. NEMA KS 1.

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

C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Auxiliary Contact:

1. Operation: Make before power contacts make and break before power contacts break.
2. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

E. Enclosures: See Article Enclosures.

F. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.
2. Provide to fit mountings specified with switches.
3. UL 248.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Class: RK-1.
2. Type: Dual element, with time delay.
3. Manufacturers and Products:
   a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
   b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).

C. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10 amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.
4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
   a. Bussmann.
   b. Littlefuse, Inc.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Light: LED, full voltage.

D. Pushbutton Color:

1. ON or START: Red.
2. OFF or STOP: Black.

E. Pushbutton and selector switch lockable in OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: Enamel filled in high contrasting color.
3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
4. Letter Height: 7/64 inch.

G. Manufacturers and Products:

1. Heavy-Duty, Oil-Tight Type:
   a. General Electric Co.; Type CR 104P.
   b. Square D Co.; Type T.
   c. Eaton/Cutler-Hammer; Type 10250T.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D Co.; Type SK.
   b. General Electric Co.; Type CR 104P.
   c. Eaton/Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.

2.06 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.
3. Electrovert USA Corp.

2.07 MAGNETIC CONTROL RELAY

A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

B. NEMA ICS 2, Designation: A600 (600 volts).

C. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2 second to 60 seconds (minimum) from 5 seconds to 200 seconds minimum.
2. Field convertible from ON delay to OFF delay and vice versa.

D. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

E. Manufacturers and Products:

1. Eaton/Cutler-Hammer; D26 Type M.
2. General Electric Co.; Type CR120B.
3. Square D; Type X.

2.08 TIME DELAY RELAY

A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.

B. NEMA ICS 2 Designation: B150 (150 volts).

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

D. One normally open and one normally closed contact (minimum).

E. Repeat accuracy plus or minus 2 percent.

F. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on Drawings.

G. Manufacturers and Products:

1. Square D Co.; Type XO.
2. Eaton/Cutler-Hammer; Type D26MR.
3. General Electric Co.; Type CR120.

2.09 RESET TIMER

A. Drive: Synchronous motor, solenoid-operated clutch.

B. Mounting: Semiflush panel.

C. Contacts: 10 amps, 120 volts.

D. Manufacturers and Products:

1. Eagle Signal Controls; Bulletin 125.
2. Automatic Timing and Controls; Bulletin 305.

2.10 PHASE MONITOR RELAY

A. Features:

1. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.
2. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.
3. Adjustable trip and time delay settings.
4. Transient Protection: 1,000V ac.
5. Mounting: Multipin plug-in socket base.

B. Manufacturer and Product: Automatic Timing and Controls; SLD Series.

2.11 MAGNETIC LIGHTING CONTACTOR

A. Comply with NEMA ICS 2; provide UL 508 listing.

B. Electrically operated by dual-acting, single coil mechanism.

C. Inherently interlocked and electrically held in CLOSED position.

D. Main Contacts:

1. Double-break, continuous-duty, rated 30 amperes, 600 volts, withstand rating of 22,000 amps rms symmetrical at 250 volts.
2. Marked for electric discharge lamps, tungsten, and general purpose loads.
3. Position not dependent on gravity, hooks, latches, or semipermanent magnets.
4. Capable of operating in any position.
5. Visual indication for each contact.

E. Auxiliary contact relay for three-wire Form 3 control.

F. One normally open and one normally closed auxiliary contact rated 10 amperes continuous, 7,200VA make, 720VA break with NEMA designation of A600 (600 volts).

G. Fully rated neutral terminal.

H. Provision for remote pilot lamp with use of auxiliary contacts.

I. Clamp type, self-rising terminal plates for solderless connections.

J. Enclosures: See Article Enclosures.

K. Manufacturers and Products:

1. ASCO.
2. Eaton/Cutler-Hammer; Class A202.
3. General Electric Co.; Class 360 electrically held.
4. Square D; Class 8903, Type L electrically held.

2.12 SUPPORT AND FRAMING CHANNELS

A. PVC-Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

B. Stainless Steel Framing Channel: Rolled, Type 316 stainless steel, 12-gauge minimum.

C. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063-T6 aluminum alloy.
2. Fittings fabricated from Alloy 5052-H32.

D. Nonmetallic Framing Channel:

1. Material: Fire retardant, fiber reinforced vinyl ester resin.
2. Channel fitting of same material as channel.
3. Nuts and bolts of long glass fiber reinforced polyurethane.

E. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

2.13 INTRINSIC SAFETY BARRIER

A. Provides a safe energy level for exposed wiring in a Class I, Division 1 or Division 2 hazardous area when circuit is connected to power source in nonhazardous area.

B. Rating: Power source shall be rated 24 volts dc, nominal, with not more than 250 volts available under fault conditions.

C. Contact Rating: 5 amps, 250 volts ac.

D. Mounting: Rail or surface.

E. Manufacturers and Products:

1. MTL, Inc.; Series 2000 or Series 3000.
2. R. Stahl, Inc.

2.14 SWITCHBOARD MATTING

A. Provide matting having a breakdown of 20 kV minimum.

B. Manufacturer: U.S. Mat and Rubber Company.

2.15 FIRESTOPS

A. General:

1. Provide UL 1479 classified hourly fire rating equal to, or greater than, the assembly penetrated.
2. Prevent the passage of cold smoke, toxic fumes, and water before and after exposure to flame.
3. Sealants and accessories shall have fire-resistance ratings as established by testing identical assemblies in accordance with ASTM E814, by Underwriters Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

B. Firestop System:

1. Formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
2. Fill, Void, or Cavity Material: 3M Brand Fire Barrier Caulk CP25, Putty 303, Wrap/Strip FS195, Composite Sheet CS195 and Penetration Sealing Systems 7902 and 7904 Series.
3. Two-Part, Foamed-In-Place, Silicone Sealant: Dow Corning Corp. Fire Stop Foam, General Electric Co. Pensil 851.
4. Fire Stop Devices: See Section 26 05 33, Raceway and Boxes, for raceway and cable fittings.

2.16 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer’s standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

D. Enclosure Selections:

1. Except as shown otherwise, provide electrical enclosures according to the following table:

Enclosures			
Location	**Finish**	**Environment**	**NEMA 250 Type**
Indoor	Unfinished	Industrial Use	12
Indoor and Outdoor	Any	Wet or Corrosive	4X 316 Stainless Steel
Indoor and Outdoor	Any	Hazardous Gas	7

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, unless otherwise shown.

B. Install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas, unless otherwise shown.

3.03 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type:

1. Interior, Corrosive (Wet or Dry) Locations:
   a. Aluminum Raceway: Extruded aluminum.
   b. PVC Conduit: Type 316 stainless steel or nonmetallic.
   c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.

2. Outdoor Locations:
   a. PVC Conduit: Type 316 stainless steel or nonmetallic.
   b. Aluminum Raceway: Aluminum or carbon steel with neoprene material isolators.
   c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.
3. Aluminum Railings: Devices mounted on aluminum railing shall use aluminum framing channel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.
2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
3. Nonmetallic Channel: Epoxy resin sealer.
4. PVC-Coated Channel: PVC patch.

3.04 INTRINSIC SAFETY BARRIERS

A. Install in compliance with ISA RP12.06.01.

B. Arrange conductors such that wiring from hazardous areas cannot short to wiring from nonhazardous area.

C. Stencil “INTRINSICALLY SAFE CIRCUIT” on all boxes enclosing barriers.

3.05 SWITCHBOARD MATTING

A. Install 36-inch width at switchgear, switchboard, motor control centers, and panelboards.

B. Matting shall run full length of all sides of equipment that have operator controls or afford access to devices.

3.06 FIRESTOPS

A. Install in strict conformance with manufacturer’s instructions. Comply with installation requirements established by testing and inspecting agency.

B. Sealant: Install sealant including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs.

END OF SECTION

SECTION 26 05 05
CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

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

1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV Through 500 kV.
   b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500000 V.
4. Insulated Cable Engineer's Association, Inc. (ICEA):
   a. S-58-679, Standard for Control Cable Conductor Identification.
   b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
   c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
5. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
   c. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   d. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.
   e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
7. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
8. Underwriters Laboratories Inc. (UL):
   a. 13, Standard for Safety for Power-Limited Circuit Cables.
   b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety for Flexible Cord and Cables.
   d. 486A-486B, Standard for Safety for Wire Connectors.
   e. 486C, Standard for Safety for Splicing Wire Connectors.
   f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   g. 854, Standard for Safety for Service-Entrance Cables.
   h. 1072, Standard for Safety for Medium-Voltage Power Cables.
   i. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   j. 1569, Standard for Safety for Metal-Clad Cables.
   k. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Wire and cable.
   b. Wire and cable accessories.

B. Informational Submittals: Certified Factory Test Report for conductors 600 volts and below.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

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

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type:

1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

D. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.02 600-VOLT RATED CABLE

A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
   a. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-1.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.

2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Southwire.

C. Type 2, Multiconductor Power Cable:

1. General:
   a. Meet or exceed UL 1581 for cable tray use.
   b. Meet or exceed UL 1277 for direct burial and sunlight-resistance.
   c. Overall Jacket: PVC.
2. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically cross-linked ethylene-propylene or cross-linked polyethylene.
   c. UL rated VW-1 or listed Type XHHW-2.
   d. Color Code:
      1) Conductors, size 8 AWG and smaller, colored conductors, ICEA S-58-679, Method 1, Table 1.
      2) Conductors, size 6 AWG and larger, ICEA S-73-532, Method 4.
3. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.

4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45
10	10	2 3 4	0.54 0.58 0.63	60
8	10	3 4	0.66 0.75	60
6	8	3 4	0.74 0.88	60
4	6	3 4	0.88 1.04	60 80
2	6	3 4	1.01 1.16	80
1	6	3 4	1.10 1.25	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.53	80
3/0	4	3 4	1.40 1.60	80
4/0	4	3 4	1.56 1.78	80 110

5. Manufacturers:
   a. Okonite Co.
   b. Southwire.

D. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.

4. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    b. 20 AWG, seven-strand tinned copper drain wire.
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nominal nylon.
    e. Color Code: Pair conductors, black and red.
5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.
    c. Belden.

E. Type 4, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
3. Dimension: 0.32-inch nominal OD.
4. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    b. 20 AWG, seven-strand, tinned copper drain wire.
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nylon.
    e. Color Code: Triad conductors black, red, and blue.
5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.
    c. Belden.

F. Type 8, Multiconductor Adjustable Frequency Drive Power Cable:

1. Conductors:
    a. Class B, stranded coated copper.
    b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW-2.
    c. Grounding Conductors: Insulated stranded copper.
2. Sheath:
    a. UL 1277 Type TC, 90 degrees C.
    b. Continuous shield, A1/polyester foil, drain wires, overall copper braid.
3. Outer Jacket: Polyvinyl chloride (PVC) per UL 1569.

4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size (AWG)	No. of Insulated Conductors	Max. Outside Diameter (Inches)	Minimum Jacket Thickness (Mils)
12 AWG	12	4	0.655	50
10 AWG	10	4	0.769	50
8 AWG	8	4	0.940	50
6 AWG	6	4	1.038	50
4 AWG	4	4	1.180	50
2 AWG	2	4	1.351	50

5. Manufacturers and Products:
   a. Alpha Wire; Series V.
   b. Belden; Series 29500.
   c. LAPP USA; OLFLEX VFD Slim.

2.03 SPECIAL CABLES

A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6 requirements.
2. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.
3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
4. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
6. Manufacturer and Product: Belden; 7852A.

2.04 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.05 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer.
   b. Manufacturers and Products:
      1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve:
   a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturers and Products:
      1) Raychem; Type D-SCE or ZH-SCE.
      2) Brady, Type 3PS.
2. Heat Bond Marker:
   a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
   b. Self-laminating protective shield over text.
   c. Machine printed black text.
   d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-On Cable Marker Tags:
   a. Chemical-resistant white tag.
   b. Size: 1/2 inch by 2 inches.
   c. Manufacturer and Product: Raychem; Type CM-SCE.
5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulug.
      3) ILSCO.

2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Seamless.
   c. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO; ILSCONS.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. UL 486C.
   b. Plated steel, square wire springs.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
4. Self-Insulated, Set Screw Wire Connector:
   a. Two piece compression type with set screw in brass barrel.
   b. Insulated by insulator cap screwed over brass barrel.
   c. Manufacturers:
      1) 3M Co.
      2) Thomas & Betts.
      3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Manufacturers and Products:
      1) Thomas & Betts; Color-Keyed.
      2) Burndy; Hydent.
      3) ILSCO.
4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Manufacturers and Products:
      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
   a. Thomas & Betts; SHRINK-KON.
   b. Raychem; RNF-100 and ES-2000.

2.06 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:

1. Ideal Co.
2. Polywater, Inc.
3. Cable Grip Co.

2.07 WARNING TAPE

A. As specified in Section 26 05 33, Raceway and Boxes.

2.08 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors and aluminum conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue

System	Conductor	Color
240/120 Volts, Three-Phase, Four-Wire, Delta, Center Tap, Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
Note: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    b. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Insulate uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Where connections of cables installed under this section are to be made under Section 40 90 00, Instrumentation and Control for Process Systems.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data for the following:
      1) Exothermic weld connectors.
      2) Mechanical connectors.
      3) Compression connectors.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by UL:
   a. Confirm conformance with UL standards.
   b. Supply with an applied UL listing mark.

PART 2 PRODUCTS

2.01 GROUND ROD

A. Material: Copper or Copper-clad.

B. Diameter: Minimum 5/8 inch.

C. Length: 10 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Use low-smoke, low-emission process.
3. Manufacturers:
    a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
    b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers:
    a. Burndy Corp.; Hyground Irreversible Compression.
    b. Thomas and Betts Co.
    c. ILSCO.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
    a. Burndy Corp.
    b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast-iron riser ring and traffic cover marked "GROUND ROD".

B. Manufacturers and Products:

1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding: In compliance with NFPA 70 and IEEE C2.

B. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.

C. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.

D. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.

E. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

F. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

G. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Use furnished ground lug in motor connection box. If none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Use furnished ground lug in motor connection box. If none furnished, tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing. Install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

C. Space multiple ground rods by one rod length.

D. Install to 8 feet below local frost depth.

3.05 GROUNDING WELLS

A. Install for ground rods located inside buildings, asphalt and paved areas, and where shown on Drawings.

B. Install riser ring and cover flush with surface.

C. Place 9 inches of crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Engineer prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer’s recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each manhole and handhole larger than 24-inch by 24-inch inside dimensions.

B. Ground Rod Floor Protrusion: 4 inches to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts and any metallic raceway grounding bushings to ground rod with 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network and to any additional indicated grounding electrodes.

3.10 LIGHTNING PROTECTION SYSTEMS

A. Bond lightning protection system ground terminals to building or structure grounding electrode system.

3.11 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. National Electrical Contractor's Association, Inc. (NECA): Installation standards.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C80.1, Electrical Rigid Steel Conduit (ERSC).
   c. C80.3, Steel Electrical Metallic Tubing (EMT).
   d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
   e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
   f. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   g. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
   h. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   i. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.

j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
k. VE 1, Metallic Cable Tray Systems.

6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
   a. 1, Standard for Safety for Flexible Metal Conduit.
   b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
   c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
   d. 6A, Standard for Safety for Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless.
   e. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
   f. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
   g. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
   h. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
   i. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
   j. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
   k. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
   l. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
   m. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   n. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s Literature:
   a. Rigid galvanized steel conduit.
   b. Rigid aluminum conduit.
   c. PVC Schedule 40 conduit.
   d. PVC-coated rigid galvanized steel, submittal to include copy of manufacturer’s warranty.
   e. Flexible metal, liquid-tight conduit.
   f. Flexible, nonmetallic, liquid-tight conduit.
   g. Conduit fittings.
   h. Wireways.
   i. Device boxes for use in hazardous areas.

j. Junction and pull boxes used at or below grade.
k. Large junction and pull boxes.
l. Terminal junction boxes.

2. Precast Manholes and Handholes:
   a. Dimensional drawings and descriptive literature.
   b. Traffic loading calculations.
   c. Accessory information.

B. Informational Submittals: Manufacturer's certification of training for PVC-coated rigid galvanized steel conduit installer.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

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

B. PVC-Coated, Rigid Galvanized Steel Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):

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

B. Rigid Aluminum Conduit:

1. Meet requirements of NEMA C80.5 and UL 6A.
2. Material: Type 6063, copper-free aluminum alloy.

C. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.
3. Furnish without factory-formed bell.

D. PVC-Coated Rigid Galvanized Steel Conduit:

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

E. Flexible Metal, Liquid-Tight Conduit:

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

F. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.
2. UL 1660 listed for:
   a. Dry Conditions: 80 degrees C insulated conductors.
   b. Wet Conditions: 60 degrees C insulated conductors.
3. Manufacturers and Products:
   a. Carlon; Carflex or X-Flex.
   b. T & B; Xtraflex LTC or EFC.

G. Innerduct:

1. Resistant to spread of fire, per requirements of UL 2024.
2. Textile Manufacturer: Maxcell.

2.02 FITTINGS

A. Rigid Galvanized Steel Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.

2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers and Products:
      1) Appleton; Series BU-I.
      2) O-Z/Gedney; Type HB.
3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers and Products:
      1) Appleton; Series GIB.
      2) O-Z/Gedney; Type HBLG.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. UL listed for use in wet locations.
   c. Manufacturers and Products:
      1) Appleton, Series HUB-B.
      2) O-Z/Gedney; Series CH.
      3) Meyers; ST Series.
5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers and Products (For Normal Conditions):
      1) Appleton; Form 35 threaded unilets.
      2) Crouse-Hinds; Form 7 or Form 8 threaded condulets.
      3) Killark; Series O electrolets.
      4) Thomas & Betts; Form 7 or Form 8.
   c. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Manufacturers and Products:
      1) Appleton; Series SCC bolt-on coupling or Series EC three-piece union.
      2) O-Z/Gedney; Type SSP split coupling or Type 4 Series, three-piece coupling.
8. Conduit Sealing Fitting:
   a. Manufacturers and Products:
      1) Appleton; Type EYF, EYM, or ESU.
      2) Crouse-Hinds; Type EYS or EZS.
      3) Killark; Type EY or Type EYS.

9. Drain Seal:
    a. Manufacturers and Products:
        1) Appleton; Type EYD.
        2) Crouse-Hinds; Type EYD or Type EZD.
10. Drain/Breather Fitting:
    a. Manufacturers and Products:
        1) Appleton; Type ECDB.
        2) Crouse-Hinds; ECD.
11. Expansion Fitting:
    a. Manufacturers and Products:
        1) Deflection/Expansion Movement:
            a) Appleton; Type DF.
            b) Crouse-Hinds; Type XD.
        2) Expansion Movement Only:
            a) Appleton; Type XJ.
            b) Crouse-Hinds; Type XJ.
            c) Thomas & Betts; XJG-TP.
12. Cable Sealing Fitting:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2 inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers and Products:
        1) Appleton; CG-S.
        2) Crouse-Hinds; CGBS.

B. Rigid Aluminum Conduit:

1. General:
    a. Meet requirements of UL 514B.
    b. Type: Threaded, copper-free. Set screw fittings not permitted.
2. Insulated Bushing:
    a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
    b. Manufacturer and Product: O-Z/Gedney; Type AB.
3. Grounding Bushing:
    a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
    b. Manufacturer and Product: O-Z/Gedney; Type ABLG.
4. Conduit Hub:
    a. Material: Cast aluminum, with insulated throat.
    b. UL listed for use in wet locations.
    c. Manufacturers and Products:
        1) O-Z/Gedney; Type CHA.
        2) Thomas & Betts; Series 370AL.
        3) Meyers; Series SA.

5. Conduit Bodies:
   a. Manufacturers and Products (For Normal Conditions):
      1) Appleton; Form 85 threaded unilets.
      2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      3) Killark; Series O electrolets.
   b. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting:
   a. Manufacturers and Products:
      1) Appleton; Type EYF-AL or EYM-AL.
      2) Crouse-Hinds; Type EYS-SA or EZS-SA.
      3) Killark; Type EY or Type EYS.
8. Drain Seal:
   a. Manufacturers and Products:
      1) Appleton; Type EYDM-A.
      2) Crouse-Hinds; Type EYD-SA or Type EZD-SA.
9. Drain/Breather Fitting:
   a. Manufacturers and Products:
      1) Appleton; Type ECDB.
      2) Crouse-Hinds; ECD.
10. Expansion Fitting:
    a. Manufacturers and Products:
       1) Deflection/Expansion Movement: Steel City; Type DF-A.
       2) Expansion Movement Only: Steel City; Type AF-A.
11. Cable Sealing Fittings:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. Bushing: Neoprene at connector entry.
    c. Manufacturer and Product: Appleton; CG-S.

C. PVC Conduit:

1. Meet requirements of NEMA TC 3.
2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.

4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
5. Overlapping pressure-sealing sleeves.
6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
7. Manufacturers:
    a. Robroy Industries.
    b. Ocal.
8. Expansion Fitting:
    a. Manufacturer and Product: Ocal; OCAL-BLUE XJG.

E. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Manufacturers and Products:
    a. Thomas & Betts; Series 5331.
    b. O-Z/Gedney; Series 4Q.

F. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Meet requirements of UL 514B.
2. Type: High strength plastic body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
3. Body/compression nut (gland) design to ensure high mechanical pullout strength and watertight seal.
4. Manufacturers and Products:
    a. Carlon; Type LT.
    b. O-Z/Gedney; Type 4Q-P.
    c. Thomas & Betts; Series 6300.

G. Flexible Coupling, Hazardous Locations:

1. Approved for use in atmosphere involved.
2. Rating: Watertight and UL listed for use in Class I, Division 1 and 2 areas.
3. Outer bronze braid and an insulating liner.
4. Conductivity equal to a similar length of rigid metal conduit.
5. Manufacturers and Products:
    a. Crouse-Hinds; Type ECGJH or Type ECLK.
    b. Appleton; EXGJH or EXLK.

H. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer and Product: O-Z/Gedney; Type FSK or Type WSK, as required.
2. Cored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Manufacturer and Product: O-Z/Gedney; Series CSM.

2.03 OUTLET AND DEVICE BOXES

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

B. Cast Metal:

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

C. Cast Aluminum:

1. Material:
   a. Box: Cast, copper-free aluminum.
   b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.
2. Hubs: Threaded.
3. Lugs: Cast mounting.
4. Manufacturers and Products, Nonhazardous Locations:
   a. Crouse-Hinds; Type FS-SA or Type FD-SA.
   b. Appleton; Type FS or Type FD.
   c. Killark.
5. Manufacturers and Products, Hazardous Locations:
   a. Crouse-Hinds; Type GUA-SA.
   b. Appleton; Type GR.

D. PVC-Coated Cast Metal:

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

E. Nonmetallic:

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer and Product: Carlon; Type FS or Type FD, with Type E98 or Type E96 covers.

2.04 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Large Sheet Steel Box:

1. NEMA 250, Type 1.
2. Box: Code-gauge, galvanized steel.
3. Cover: Full access, screw type.
4. Machine Screws: Corrosion-resistant.

D. Large Cast Metal Box:

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

7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.
8. Manufacturers and Products, Recessed Type:
   a. Crouse-Hinds; Type WJBF.
   b. O-Z/Gedney; Series YR.

E. Large Cast Metal Box, Hazardous Locations:

1. NEMA 250 Type 7 or Type 9 as required for Class, Division, and Group involved.
2. Box: Cast ferrous metal, electro-galvanize finished or copper-free aluminum with drilled and tapped conduit entrances.
3. Cover: Hinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers and Products:
   a. Crouse-Hinds; Type EJB.
   b. Appleton; Type AJBEW.

F. Large Cast Aluminum Box:

1. NEMA 250 Type 4X.
2. Box: Cast copper-free aluminum, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Nonhinged.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Type:
   a. Crouse-Hinds; Series W-SA.
   b. O-Z/Gedney; Series YS-A, YL-A.
   c. Killark.

G. Large Stainless Steel Box:

1. NEMA 250 Type 4X.
2. Box: 14-gauge, ASTM A240/A240M, Type 316 stainless steel.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.
   c. Wiegman.

H. Large Steel Box:

1. NEMA 250 Type 1and 12.
2. Box: 12-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces..
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.
   c. Wiegman.

I. Large Nonmetallic Box:

1. NEMA 250 Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers and Products:
   a. Crouse-Hinds; Type NJB.
   b. Carlon; Series N, C, or H.
   c. Robroy Industries.

J. Concrete Box, Nontraffic Areas:

1. Box: Reinforced, cast concrete with extension.
2. Cover: Steel diamond plate with locking bolts.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Size: 10 inches by 17 inches, minimum.
5. Manufacturers and Products:
   a. Utility Vault Co.; Series 36-1017.
   b. Christy, Concrete Products, Inc.; N9.
   c. Quazite; “PG” Style.

2.05 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks:

1. Separate connection point for each conductor entering or leaving box.
2. Spare Terminal Points: 25 percent, minimum.

2.06 SURFACE METAL RACEWAY

A. General:

1. Meet requirements of UL 5.
2. Material: Two-piece, code-gauge steel.
3. Finish: Factory applied rust inhibiting primer and gray semi-gloss finish suitable for field painting.
4. Configuration: Single, 1-17/32-inch by 2-3/4-inch section, unless otherwise indicated.

B. Fittings and Accessories:

1. Wire clips at 30 inches on center.
2. Couplings, cover clips, supporting clips, ground clamps, and elbows as required; to comply with manufacturer's recommendations.

C. Outlets:

1. Provide bracket or device covers as required to support wiring devices indicated.
2. Wiring Devices and Device Plates: In accordance with Section 26 27 26, Wiring Devices.
3. Manufacturers:
   a. The Wiremold Co.
   b. Walker.

2.07 METAL WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, lay-in type.

C. Cover: Hinged with friction latch.

D. Rating: Outdoor raintight.

E. Finish: Rust inhibiting phosphatizing primer and gray baked enamel.

F. Hardware: Plated to prevent corrosion; screws installed toward the inside protected by spring nuts or otherwise guarded to prevent wire insulation damage.

G. Knockouts: Without knockouts, unless otherwise indicated.

H. Manufacturers:

1. Circle AW.
2. Hoffman.
3. Square D.

2.08 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6-inch or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and a minimum 4-inch outlet and outlet pipe.

E. Raceway Entrances:

1. Provide on all four sides.
2. Provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:
   a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
   b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.

2. Wall Attachment:
    a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
    b. Insert Spacing: Maximum 3 feet on center for inside perimeter of manhole.
    c. Arrange in order that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 36-1/2 inch.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.
5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
    a. 600 Volts and Below: ELECTRIC LV.
    b. TELEPHONE.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt-on, of checkered design.
3. Cover Loading: AASHTO H-20.
4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
    a. 600 Volts and Below: ELECTRIC LV.
    b. TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

2.09 ACCESSORIES

A. Duct Bank Spacers:

1. Modular Type:
   a. Nonmetallic, interlocking, for multiple conduit sizes.
   b. Suitable for all types of conduit.
   c. Manufacturers:
      1) Underground Device, Inc.
      2) Carlon.
2. Template Type:
   a. Nonmetallic, custom made one-piece spacers.
   b. Suitable for all types of conduit.
   c. Material: HDPE or polypropylene, 1/2-inch minimum thickness.
   d. Conduit openings cut 1 inch larger than conduit outside diameter.
   e. Additional openings for stake-down, rebar, and concrete flow through as required.
   f. Manufacturer and Product: SP Products; Quik Duct.

B. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, nonferrous metal.
   b. Raceway Designation: Pressure stamped, embossed, or engraved.
   c. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge with detectable strip.
   b. Color: Red.
   c. Width: Minimum 3 inches.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.
   f. Manufacturers and Products:
      1) Panduit; Type HTDU.
      2) Reef Industries; Terra Tape.
3. Buried Raceway Marker:
   a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
   b. Designation: Engrave to depth of 3/32 inch; ELECTRIC CABLES, in letters 1/4-inch high.
   c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Raceway Coating: Clean and paint in accordance with Section 09 90 00, Painting and Coating.

D. Heat Shrinkable Tubing:

1. Material: Heat-shrinkable, cross-linked polyolefin.
2. Semi-flexible with meltable adhesive inner liner.
3. Color: Black.
4. Manufacturers:
   a. Raychem.
   b. 3M.

E. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Width: 50 mm minimum.
3. Manufacturer and Product: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and tubing sizes shown are based on use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.

B. Comply with NECA Installation Standards.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete. Install in PVC sleeve or cored hole through concrete walls and slabs.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

T. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

3.02 REUSE OF EXISTING CONDUITS

A. Where Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria.

1. Conduit is in useable condition with no deformation, corrosion, or damage to exterior surface.
2. Conduit is sized per the NEC.
3. Conduit is of the type specified in Contract Documents.
4. Conduit is supported as specified in Contract Documents.

B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4-inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

3.03 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum Cover: 2 inches, including fittings.

B. Conduit placement shall not require changes in reinforcing steel location or configuration.

C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Engineer.

E. Slabs and Walls (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of slab or wall thickness.
2. Install within middle two-fourths of slab or wall.
3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.04 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed: PVC-coated rigid galvanized steel.

C. Interior, Exposed:

1. Rigid galvanized steel.
2. PVC-coated rigid galvanized steel.

D. Direct Earth Burial: PVC-coated rigid galvanized steel.

E. Concrete-Encased Ductbank: PVC Schedule 40 for ac circuits, PVC-Coated Rigid Galvanized Steel for AFD cables and dc circuits.

F. Under Slabs-On-Grade: PVC-coated rigid galvanized steel.

G. Transition from Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.

H. Under Equipment Mounting Pads: PVC-coated rigid steel conduit.

I. Exterior Light Pole Foundations: PVC-coated rigid steel conduit.

J. Corrosive Areas: PVC-coated rigid galvanized steel.

K. Hazardous Gas Areas: PVC coted rigid galvanized steel.

3.05 FLEXIBLE CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet or Corrosive Areas: Flexible, nonmetallic or flexible metal liquid-tight.
4. Dry Areas: Flexible, metallic liquid-tight.
5. Hazardous Areas: Flexible coupling suitable for Class I, Division 1 and 2 areas.

B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.06 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating as specified in Section 26 05 04, Basic Electrical Materials and Methods.

D. Apply heat shrinkable tubing or single layer of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
    a. Provide a watertight seal.
    b. Without Concrete Encasement: Install watertight entrance seal device on each side.
    c. With Concrete Encasement: Install watertight entrance seal device on accessible side.
    d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
    e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
3. Heating, Ventilating, and Air Conditioning Equipment:
    a. Penetrate equipment in area established by manufacturer.
    b. Terminate conduit with flexible metal nonmetallic conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
    c. Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
4. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.

5. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
    a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
    b. Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.
6. Manholes and Handholes:
    a. Metallic Raceways: Provide insulated grounding bushings.
    b. Nonmetallic Raceways: Provide bell ends flush with wall.
    c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.07 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 10 feet in any application. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 50 percent extra space for future conduit.

C. Application/Type of Conduit Strap:

1. Aluminum Conduit: Aluminum or stainless steel.
2. Rigid Steel Conduit: Zinc coated steel, pregalvanized steel or malleable iron.
3. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
4. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
2. Steelwork: Machine screws.
3. Location/Type of Hardware:
    a. Dry or Wet, Noncorrosive Areas: Stainless steel.
    b. Corrosive Areas: Stainless steel.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

F. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

3.08 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30 Degrees and Larger: Provide factory-made elbows.
2. 90-Degree Bends: Provide rigid steel elbows, PVC-coated where direct buried.
3. Use manufacturer’s recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.09 EXPANSION/DEFLECTION FITTINGS

A. Provide on raceways at structural expansion joints and in long tangential runs.

B. Provide expansion/deflection joints for 25 degrees F maximum temperature variation.

C. Install in accordance with manufacturer’s instructions.

3.10 PVC CONDUIT

A. Solvent Welding:

1. Apply manufacturer recommended solvent to joints.
2. Install in order that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belled-End Conduit: Bevel unbelled end of joint prior to joining.

3.11 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.

C. Provide PVC boot to cover exposed threading.

3.12 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

C. Applications:

1. Metal wireway in indoor dry locations.
2. Nonmetallic wireway in indoor wet, outdoor, and corrosive locations.

3.13 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Install manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Nonmetallic, Cabinets, and Enclosures:

1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. General:
   a. Install insulated bushing on ends of conduit where grounding is not required.
   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.

c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.

2. Rigid Galvanized or Aluminum Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.

D. Motor Control Center, Switchgear, and Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
2. Terminate PVC conduit entering bottom with bell end fittings.

3.14 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Transition from Underground to Exposed: PVC-coated rigid steel conduit.

I. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.

K. Provide expansion/deflection fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.

L. Concrete Encasement:

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

M. Backfill:

1. As specified in Section 31 23 23.15, Trench Backfill. Controlled low strength fill is an acceptable bedding and pipe zone material. Backfill material to within 12 inches of surface.
2. Do not backfill until inspected by Engineer.

3.15 UNDER SLAB RACEWAYS

A. Make routing changes as necessary to avoid obstructions or conflicts.

B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.

C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.

D. Raceway spacing, in a single layer or multiple layers:

1. 3 inches clear between adjacent 2-inch or larger raceway.
2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.

E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone, as specified in Section 31 23 23.15, Trench Backfill.

F. Individual Raceways and Single Layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.

G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.

H. Fittings:

1. Union type fittings are not permitted.
2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be PVC-coated rigid steel.
3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

3.16 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
    a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.

2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.
3. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
   c. Do not straddle CMU block or other construction joints.
2. Light Switch:
   a. 48 inches above floor.
   b. When located next to door, install on lock side of door.
3. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. Outdoor Areas: 24 inches above finished grade.
4. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.

E. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

F. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

G. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

3.17 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. Mounting Hardware:

1. Noncorrosive Dry Areas: Stainless steel.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

C. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

D. At or Below Grade:

1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

E. Install Drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.18 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

B. Do not install until final raceway grading has been determined.

C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.

D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.19 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.20 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.
2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
3. Install tags at each terminus for concealed raceways.

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

C. Buried Raceway Marker:

1. Install at grade to indicate direction of underground raceway.
2. Install at bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.21 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.

C. Touchup painted conduit threads after assembly to cover nicks or scars.

D. Touchup coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

END OF SECTION

SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
   d. 1584, Guide for Performing Arc Flash Hazard Calculations.
3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety in the Workplace.
5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

1.02 SUBMITTALS

A. Action Submittals:

1. Short circuit study.
2. Protective Device Coordination Study: Submit within 90 days after approval of short circuit study.
3. Arc Flash Study: Submit initial study with protective Device Coordination Study. Submit final study prior to equipment energization.
4. Arc flash warning labels; submit sample with initial study.
5. Electronic files on thumb drive of final studies including all engineering software input files, output reports, and libraries.

1.03 QUALITY ASSURANCE

A. Short circuit and protective device coordination and arc flash studies shall be prepared by manufacturer furnishing Motor Control center or a professional electrical engineer registered in the State of Florida.

1.04 SEQUENCING AND SCHEDULING

A. Initial complete short circuit study shall be submitted and reviewed before Engineer will review Shop Drawings for Motor control center or Panelbaords equipment.

B. Initial complete protective device coordination and arc flash studies shall be submitted within 90 days after approval of initial short circuit study.

C. Initial complete arc flash study shall be submitted and accepted prior to energization of the electrical equipment.

D. Revised short circuit, protective device coordination, and arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.

E. Final short circuit, protective device coordination, and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as-installed equipment, materials, and parameter data or settings entered into equipment based on study.

F. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

1.05 GENERAL STUDY REQUIREMENTS

A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on Drawings.

B. Perform studies using one of the following electrical engineering software packages:

1. SKM Power Tools for Windows.
2. ETAP.
3. Paladin.
4. Easy Power.

C. Perform complete fault calculations for each existing source combination.

1. Source combination may include present and future power company supply circuits, large motors, or generators.

D. Utilize proposed and existing load data for study obtained from field investigation of system configuration, wiring information, and equipment.

E. Existing System and Equipment:

1. Extent of existing system to be included in study is all of the existing system and equipment.
2. Include fault contribution of existing motors and equipment in study.
3. Include impedance elements that affect new system and equipment.
4. Include protective devices in series with new equipment.

F. Device coordination time-current curves for low voltage distribution system; include individual protective device time-current characteristics.

1.06 SHORT CIRCUIT STUDY

A. General:

1. Prepare in accordance with IEEE 399.
2. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
3. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
4. Use cable and bus resistances calculated at 25 degrees C.
5. Use medium-voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation levels.
6. Use 600-volt cable reactances based on use of typical dimensions of XHHW conductors.
7. Use transformer impedances 92.5 percent of “nominal” impedance based on tolerances specified in IEEE C57.12.00.

B. Provide:

1. Calculation methods and assumptions.
2. Typical calculation.
3. Tabulations of calculated quantities.
4. Results, conclusions, and recommendations.
5. Selected base per unit quantities.
6. One-line diagrams.
7. Source impedance data, including electric utility system and motor fault contribution characteristics.
8. Impedance diagrams.
9. Zero-sequence impedance diagrams.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Electric utility’s supply termination point.
2. Low-voltage switchgear.

3. Motor control centers.
4. Standby generators.
5. Branch circuit panelboards.
6. Future load contributions as shown on one-line diagram.

D. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

E. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.

F. Verify:

1. Equipment and protective devices are applied within their ratings.
2. Adequacy of switchgear and motor control centers bus bars to withstand short circuit stresses.
3. Adequacy of transformer windings to withstand short circuit stresses.
4. Cable and busway sizes for ability to withstand short circuit heating, in addition to normal load currents.

G. Tabulations:

1. General Data:
   a. Short circuit reactances of rotating machines.
   b. Cable and conduit material data.
   c. Bus data.
   d. Transformer data.
   e. Circuit resistance and reactance values.
2. Short Circuit Data (for each source combination):
   a. Fault impedances.
   b. X to R ratios.
   c. Asymmetry factors.
   d. Motor contributions.
   e. Short circuit kVA.
   f. Symmetrical and asymmetrical fault currents.
3. Equipment Evaluation:
   a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
   b. Maximum fault current available.

H. Written Summary:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.

3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit study.
6. Comments or suggestions.

I. Suggest changes and additions to equipment rating and/or characteristics.

J. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.

K. Revise data for “as-installed” condition.

1.07 PROTECTIVE DEVICE COORDINATION STUDY

A. General:

1. Prepare in accordance with IEEE 242.
2. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.
   a. Provide separate curve sheets for phase and ground fault coordination for each scenario.
   b. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet. Limit number of devices shown to four to six.
   c. Identify device associated with each curve by manufacturer type, function, and, if applicable, recommended tap, time delay, instantaneous and other settings recommended.
   d. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
   e. Apply motor protection methods that comply with NFPA 70.

B. Plot Characteristics on Curve Sheets:

1. Electric utility’s relays.
2. Electric utility’s fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
3. low-voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
4. Low-voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
5. Pertinent transformer full-load currents at 100 percent.
6. Transformer magnetizing inrush currents.
7. Transformer damage curves; appropriate for system operation and location.

8. ANSI transformer withstand parameters.
9. Significant symmetrical and asymmetrical fault currents.
10. Motor overload relay settings for motors greater than 40 hp.
11. Ground fault protective device settings.
12. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

C. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within transformer's characteristics curve, including a point equal to 58 percent of IEEE C57.12.00 withstand point.
2. Secondary Line-to-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

D. Tabulate Recommended Protective Device Settings:

1. Relays:
   a. Current tap.
   b. Time dial.
   c. Instantaneous pickup.
   d. Electronic settings data file.
2. Circuit Breakers:
   a. Adjustable pickups.
   b. Adjustable time-current characteristics.
   c. Adjustable time delays.
   d. Adjustable instantaneous pickups.
   e. I^2t In/Out.
   f. Zone interlocking.
   g. Electronic settings data file.

E. Written Summary:

1. Scope of studies performed.
2. Summary of protective device coordination methodology.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of coordination study.
6. Appendix of complete relay and circuit breaker electronic setting files.
7. Comments or suggestions.

1.08 ARC FLASH STUDY

A. Perform arc flash hazard study after short circuit and protective device coordination study has been completed, reviewed and accepted.

B. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

C. Base Calculation: For each major part of electrical power system, determine the following:

1. Flash hazard protection boundary.
2. Limited approach boundary.
3. Restricted approach boundary.
4. Incident energy level.
5. Glove class required.

D. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.

1. Bus name.
2. Bus voltage.

E. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:

1. Bus name.
2. Upstream protective device name, type, and settings.
3. Bus line-to-line voltage.

F. Produce arc flash evaluation summary sheet listing the following additional items:

1. Bus name.
2. Upstream protective device name, type, settings.
3. Bus line-to-line voltage.
4. Bus bolted fault.
5. Protective device bolted fault current.
6. Arcing fault current.
7. Protective device trip/delay time.
8. Breaker opening time.
9. Solidly grounded column.
10. Equipment type.
11. Gap.
12. Arc flash boundary.
13. Working distance.
14. Incident energy.

G. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 40 cal/cm2. Propose approaches to reduce energy levels.

H. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:

1. Equipment manufacturer's information used to prepare study.
2. Assumptions made during study.
3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
4. Arc flash evaluations summary spreadsheet.
5. Bus detail sheets.
6. Arc flash warning labels printed in color on thermally bonded adhesive backed UV and weather-resistant labels.

PART 2 PRODUCTS

2.01 ARC FLASH WARNING LABELS

A. Arc flash warning labels printed in color on thermally bonded adhesive backed, UV- and weather-resistant labels. An example label is located following end of section in Figure 1.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust relay and protective device settings according to values established by coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Engineer in writing of required major equipment modifications.

D. Provide laminated one-line diagrams (minimum size 11 inches by 17 inches) to post on interior of electrical room doors.

E. Provide arc flash warning labels on equipment as specified in this section.

3.02 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of this Specification:

1. Figure 1: Example Arc Flash Label.

END OF SECTION

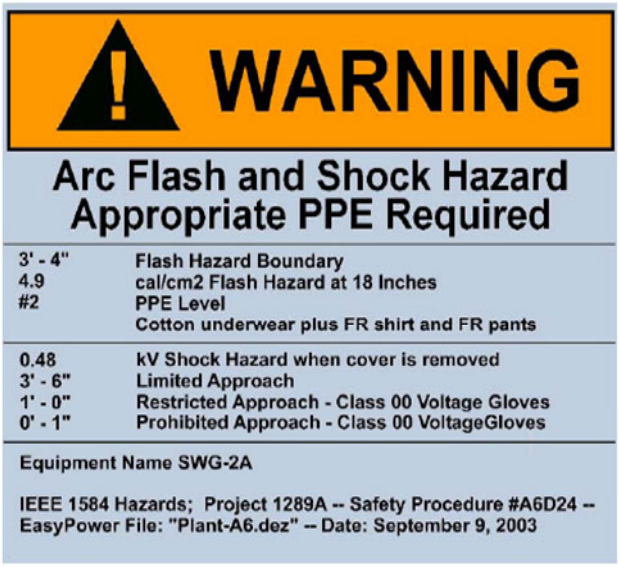

Figure 1
Example Arc Flash Label

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D877/D877M, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   b. D923, Standard Practices for Sampling Electrical Insulating Liquids.
   c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   f. D1298, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
   i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
   j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulation Resistance of Electric Machinery.
   b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.

e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low-Voltage (1,000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
   a. Testing firm qualifications.
   b. Schedule for performing inspection and tests.
   c. List of references to be used for each test.
   d. Sample copy of equipment and materials inspection form(s).
   e. Sample copy of individual device test form.
   f. Sample copy of individual system test form.
2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
   a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
   b. Staged sequence of initial energization of electrical equipment.
   c. Lock-Out-Tag-Out plan for each stage of the progressive energization.
   d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data.
   b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
5. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
   a. Protective relays.
   b. Intelligent overload relays.
   c. Adjustable frequency drives.
   d. Power metering devices.
   e. Uninterruptible power supplies.
   f. Electrical communications modules.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.

2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test Instrument Calibration: In accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

1. Scheduled with Engineer prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Notify Engineer at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate, circuit breakers, fuses power monitoring meters, and other applicable devices in accordance with values established by short circuit, coordination, and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis.

E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

H. Realign equipment not properly aligned and correct unlevelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform Engineer of working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch up scratches and mars.
    b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Unbalance Corrections:
    a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
    b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Each phase of each bus section.
   c. Phase-to-phase and phase-to-ground for 1 minute.
   d. With breakers open.
   e. With breakers closed.
   f. Control wiring except that connected to solid state components.
   g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Ground continuity test ground bus to system ground.

3.04 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.

8. Cleanliness and improper blockage of ventilation passages.
9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.05 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 6 and larger for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer’s minimum allowable bending radius where applicable.
   d. Color coding conformance with specification.
   e. Proper circuit identification.
2. Mechanical Connections for:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables for:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.

4. Control Cables for:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

3.06 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.

c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.

c. Ground fault pickup and delay.
d. Instantaneous pickup by run-up or pulse method.
e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.08 LOW VOLTAGE POWER CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Proper mounting, cell fit, and element alignment.
2. Proper operation of racking interlocks.
3. Check for damaged arc chutes.
4. Proper contact condition.
5. Bolt torque level in accordance with NETA ATS, Table 100.12.
6. Perform mechanical operational and contact alignment tests in accordance with manufacturer's instructions.
7. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.
8. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.
9. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.
10. Check operation of electrically operated breakers in accordance with manufacturer's instructions.
11. Check for adequate lubrication on contact, moving, and sliding surfaces.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.

2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristic when adjusted to setting sheet parameters shall be within manufacturer's published time-current tolerance band.

3.09 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
   b. Polarity test.
   c. Ratio and accuracy test.
2. Potential Transformer Tests:
   a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
   c. Ratio and accuracy test.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.10 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.11 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center, panelboard and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in motor control center, panelboard, and switchgear assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system’s resistance.
   b. Main ground electrode system resistance to ground to be no greater than 5 ohm(s).
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.12 GROUND FAULT SYSTEMS

A. Inspection and testing limited to:

1. Zero sequence grounding systems.
2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral main bonding connection to ensure:
   a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
   b. Ground strap sensing system is grounded through sensing device.
   c. Neutral ground conductor is solidly grounded.
2. Verify control power has adequate capacity for system.
3. Manually operate monitor panels for:
   a. Trip test.
   b. No trip test.
   c. Nonautomatic rest.
4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
5. Relay check for pickup and time under simulated ground fault conditions.
6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed; minimum 1 megohm.
2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.
3. Test relay timing by injecting 300 percent of pick-up current or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
4. Test system operation at 55 percent rated control voltage, if applicable.
5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.13 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 1 horsepower and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.

d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.

5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
      1) Motors above 200 horsepower for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
      2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 seconds and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.14 LOW-VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
   a. Closure attempt of device when door is in OPEN position.
   b. Opening attempt of door when device is in ON or CLOSED position.
8. Check nameplates for proper identification of:
   a. Equipment title and tag number with latest one-line diagram.
   b. Pushbuttons.
   c. Control switches.
   d. Pilot lights.

e. Control relays.
f. Circuit breakers.

9. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify current and potential transformer ratios conform to Contract Documents.
11. Check bus connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to bolted joints:
12. Ohmic value to be zero.
    a. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
13. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
14. Verify performance of each control device and feature furnished as part of motor control center.
15. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
16. Exercise active components.
17. Inspect contactors for:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of connections.
18. Compare overload heater rating with full-load current for proper size.
19. Compare motor protector and circuit breaker with motor characteristics for proper size.
20. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.

d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
e. Test values to comply with NETA ATS, Table 100.1.

2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
   a. Trip time in accordance with manufacturer's published data.
   b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
   a. Apply secondary voltage to control power and potential circuits.
   b. Check voltage levels at each point on terminal board and each device terminal.
   c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1 megohm minimum insulation resistance.
4. Operational test by initiating control devices to affect proper operation.

3.15 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground electrode.

B. Electrical Tests:

1. Varistor Type Arrestors:
   a. Clamping voltage test.
   b. Rated RMS voltage test.
   c. Rated dc voltage test.
   d. Varistor arrestor test values in accordance with IEEE C62.33, Section 4.4 and Section 4.9.

END OF SECTION

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies to low-voltage AC induction motors, whether or not referenced by a motor-driven equipment specification. If equipment specification section deviates from this section in requirements such as, application, horsepower, enclosure type, mounting, shaft type, or synchronous speed, then those listed requirements shall take precedence over this section.

1.02 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
   b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
   c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. EXP: Explosion-proof enclosure.

C. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

D. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

E. TEFC: Totally enclosed, fan-cooled enclosure.

F. TENV: Totally enclosed, nonventilated enclosure.

G. VPI: Vacuum pressure impregnated.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
    a. Service factor.
    b. Locked rotor current.
    c. No load current.
    d. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
    e. Guaranteed minimum full load efficiency and power factor.
4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.
6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Bearing lubrication.
9. Bearing life.
10. Space heater voltage and watts.
11. Description, ratings, and wiring diagram of motor thermal protection.
12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.

B. Informational Submittals:

1. Factory test reports, certified.
2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.
2. Siemens Energy and Automation, Inc., Motors and Drives Division.
3. U.S. Electrical Motors.
4. WEG Electric Motors Corp.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. For motors used in hazardous (classified) locations, Class I, Division 1, Groups B, C, and D, and Class II, Division 1, Groups E, F, and G provide motors that conform to UL 674 and have an applied UL listing mark.

E. Provide motors specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

F. Lifting lugs on motors weighing 100 pounds or more.

G. Operating Conditions:

1. Maximum ambient temperature not greater than 40 degrees C.
2. Provide motors suitable for operating conditions without reduction in nameplate rated horsepower or exceeding rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specification.

B. Constant Speed Applications: Brake horsepower of driven at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor, Inverter Ready Motor): Driven equipment brake horsepower at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

A. Inverter-Duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	**Voltage**	**Phase**
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3

C. Suitable for full voltage starting.

D. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
   b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.
2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe Stall Time: 12 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: VPI windings in accordance with NEMA MG 1.

C. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class B or Class F at nameplate horsepower and designated operating conditions except provide Class B with Class B rise insulation for EXP motors.

2.09 ENCLOSURES

A. Conform to NEMA MG 1.

B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):

1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group D hazardous locations.
2. Drain holes with drain and breather fittings.

3. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
4. Terminate thermostat leads in terminal box separate from main terminal box.

D. Submersible: In accordance with paragraph Special Motors.

E. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	**Horsepower**	**Percentage**
Below 600	15 through 125	500
Below 600	150 through 300	275
Below 600	350 through 600	225
Above 600	All sizes	200

E. Terminal for connection of equipment grounding wire in each terminal box.

F. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on Drawings.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

3. For Direct Drive Equipment: Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
4. For Belt Driven Equipment: Minimum 30,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer's standard lubrication 100 hp and smaller.
   c. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer's standard bearing type.
   b. Manufacturer's standard lubrication 200 hp and smaller.
   c. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.
3. Provisions for necessary oil circulation and cooling.

E. Inverter Duty Rated Motors Larger than 50 hp, Bearing Isolation: Provide electrically isolated bearings to prevent stray current damage.

2.12 NOISE

A. Measured in accordance with NEMA MG 1.

B. Maximum Sound Level for Motors Controlled by Adjustable Frequency Drive Systems: 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. Protect Motor for Service Conditions: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Thermostats:
   a. Install on motors where motor data sheet or control diagram requires them.
   b. Bi-metal disk or rod type thermostats embedded in stator windings.
   c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
   d. Leads extending to separate terminal box for motors 100 hp and larger.

C. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

D. Anchor Bolts: Provide meeting manufacturer’s recommendations and of sufficient size and number for specified seismic condition.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):

1. In accordance with IEEE 841.
2. TEFC in accordance with NEMA MG 1.
3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.

4. Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.
5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
6. Drain and Breather Fittings: Stainless steel.
7. Nameplate: Stainless steel.
8. Gaskets between terminal box halves and terminal box and motor frame.
9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
10. Double shielded bearings.
11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
12. External Finish: Double-coated epoxy enamel.
13. Coated rotor and stator air gap surfaces.
14. Insulation System, Windings, and Connections:
    a. Class F insulation, Class B rise or better at 1.0 service factor.
    b. Multiple dips and bakes of nonhygroscopic polyester varnish.
15. Service Factor:
    a. At 40 Degrees C Ambient: 1.15.
    b. At 65 Degrees C Ambient: 1.00.
16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.

C. Severe-duty Explosion-proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Severe-duty, Dust-ignition-proof: Meet requirements for DIP enclosures and CISD-TEFC motors.

E. Inverter Duty Motor:

1. Motor Supplied Power by Adjustable Voltage and Adjustable Frequency Drives: Inverter duty rated in accordance with NEMA Parts 30 and 31.
2. Provide winding insulation rated 1,600 peak volts, minimum.
3. Meet or exceed NEMA MG 1 corona inception voltage rating.
4. Provide one insulated bearing.
5. Suitable for operation over entire speed range indicated.
6. Provide forced ventilation where speed ratio is greater than published range for motor provided.
7. When installed in Division 1 hazardous (classified) location, provide motor identified by manufacturer as suitable use with a variable speed drive in a Division 1 location.
8. When installed in Division 2 hazardous (classified) locations, provide motor identified by manufacturer as suitable for use with a variable speed drive in a Division 2 location.

9. Shaft Grounding Device, Motors Larger than 20 hp: Furnish with shaft grounding brush or conductive micro fiber shaft grounding ring solidly bonded to grounded motor frame in accordance with manufacturer's recommendations.
    a. Manufacturers:
        1) Grounding Brush: Sohre Turbomachinery, Inc.
        2) Grounding Ring: EST-Aegis.

2.17 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
    a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
    b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
4. Provide certified test reports for all polyphase motors 100 hp and larger.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-11.
3. Efficiency and power factor by Test Method F, IEEE 112, Forms F-1, F-2, and F-3.
4. Temperature Test: IEEE 112, Form A-2.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 100 hp.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

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

1. Code of Federal Regulations (CFR): 10 CFR Part 431, DOE 2016 efficiency.
2. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
3. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ST 20, Dry-Type Transformers for General Applications.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc. (UL):
   a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensions and weight.
3. Transformer nameplate data, including efficiency.
4. Schematic and connection diagrams.
5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

2. Test Report: Sound test certification for dry type power transformers (0 volt to 600 volt, primary).

PART 2 PRODUCTS

2.01 GENERAL

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Dry-type, self-cooled, two-winding, with copper windings.

C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Efficiency: Meet or exceed DOE 2016 efficiency requirements.

E. Maximum Sound Level per NEMA ST 20:

1. 40 decibels for 0 kVA to 9 kVA.
2. 45 decibels for 10 kVA to 50 kVA.
3. 50 decibels for 51 kVA to 150 kVA.
4. 55 decibels for 151 kVA to 300 kVA.
5. 60 decibels for 301 kVA to 500 kVA.

F. Overload capability: Short-term overload per IEEE C57.96.

G. Wall Bracket: For single-phase units, 15 kVA to 37-1/2 kVA, and for three-phase units, 15 kVA to 30 kVA.

H. Vibration Isolators:

1. Rated for transformer’s weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

I. Manufacturers:

1. General Electric Co.
2. Square D Co.
3. Eaton/Cutler-Hammer.

2.02 MINI-POWER CENTER (MPC)

A. General: Transformer, primary, and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, Type 4X, 316 stainless steel enclosure.

B. Transformer:

1. Insulation Class and Temperature Rise: Manufacturer's standard.
2. Efficiency: Manufacturer's standard (DOE 2016 efficiency).
3. Core and Coil: Encapsulated.
4. Full capacity, 5 percent voltage taps, two below normal voltage.
5. Primary Voltage: 480 three-phase.
6. Secondary Voltage: 208/120 volts**,** three-phase, four-wire.

C. Panelboard: Full, UL 489, short-circuit current rated.

1. Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case circuit breakers.
2. Number and Breaker Ampere Ratings: Refer to Panel Schedule.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA and manufacturer's instructions.

B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

C. Provide moisture-proof, flexible conduit for electrical connections.

D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

E. Provide wall brackets for single-phase units, 15 kVA to 167-1/2 kVA, and three-phase units, 15 kVA to 30 kVA.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

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

1. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. 289, Application Guide for Ground Fault Circuit Interrupters.
   c. KS 1, Enclosed Switches.
   d. PB 1, Panelboards.
   e. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL):
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
   g. 943, Ground-Fault Circuit-Interrupters.
   h. 1699, Standard for Arc-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
   a. Protective devices with factory settings.
   b. Provisions for future protective devices.
   c. Space for future protective devices.

d. Voltage, frequency, and phase ratings.
e. Enclosure type.
f. Bus and terminal bar configurations and current ratings.
g. Provisions for circuit terminations with wire range.
h. Short circuit current rating of assembled panelboard at system voltage.
i. Features, characteristics, ratings, and factory settings of auxiliary components.
j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's recommended installation instructions.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eaton/Cutler-Hammer.
2. General Electric Co.
3. Square D Co.
4. Siemens.

B. Panelboards shall be of the same manufacturer as equipment furnished under Section 26 24 19, Low-Voltage Motor Control.

2.02 GENERAL

A. Provide low voltage panelboards for application at 600V or less in accordance with this section.

B. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.

C. Wire Terminations:

1. Provide panelboard assemblies, including protective devices, suitable for use with 75 degrees C or greater wire insulation systems at NFPA 70, 75 degrees C conductor ampacity, and in accordance with UL 486E.
2. Lugs for termination of conductors shall comply with Section 26 05 05, Conductors.
3. Lugs for termination of copper feeder phase and neutral conductors shall be replaceable, bolted mechanical or crimp compression type.

D. Load Current Ratings:

1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
2. Where indicated “continuous” or “100 percent”, selected components and protective devices shall be rated for continuous load current at value shown.

E. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the following:

1. Minimum SCCR at 208Y/120 or 120/240 volts shall be 18,000 amperes rms symmetrical.
2. Minimum SCCR at 480Y/277 volts shall be 50,000 amperes rms symmetrical.

F. Series-Connected Short Circuit Current Ratings: Panelboards shall be fully rated; application of series-connected device ratings is unacceptable.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overcurrent Device Mounting and Arrangement: Design panelboards to accommodate device installation and replacement without disturbing adjacent devices and without removing main bus.

B. Overcurrent Protective Devices: In accordance with NEMA KS 1, UL 98, and UL 489. Protective devices shall be adapted to panelboard installation.

C. Provisions for Future Overcurrent Device:

1. Provide space, mountings and bus connections such that like device may be installed without additional hardware.

2. Panel openings shall be closed with individual removable cover for each provision for future device.
3. Unless otherwise indicated, “spaces” in panelboards shall be fully equipped provision for future like devices.
4. Provisions for future devices shall be suitable devices rated no less than 60 amperes.

D. Protective Device Locking: Furnish provisions for handle padlocking for main, subfeed, and branch devices where indicated.

E. Branch Protective Devices:

1. Provide Wire Lug Load Connections: Mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
2. Provide a nameplate for each circuit, blanks for spares.

2.04 CIRCUIT BREAKERS

A. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle. Circuit breakers shall comply with Section 26 05 04, Basic Electrical Materials and Methods.

B. Bus Connection: Bolt-on circuit breakers in 480Y/277-volt, and plug-in circuit breakers in 208Y/120 and 240/120-volt panelboards.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.

D. Unacceptable Substitution:

1. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
2. Do not use tandem or dual circuit breakers in normal single-pole spaces.

E. Specialty Breakers: Where indicated, provide breakers with the following features:

1. Ground Fault Circuit Interrupter (GFCI): Rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel). Ground fault sensor shall be rated same as circuit breaker. Breaker shall include push-to-test and reset buttons.
2. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

2.05 ENCLOSURES

A. General:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Type 1, Type 3R, and Type 3S material code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Provide surface-mount panelboard from trim with same dimensions as box front.

B. Finish: Rust inhibitor prime followed by manufacturer's standard gray baked enamel or lacquer. NEMA Type 1 enclosure box may be unfinished galvanized sheet steel.

C. NEMA 250 Type 1 Branch Panelboard Enclosure:

1. Secure front trim to box with concealed trim clamps.
2. Overlap flush panelboards front trims with box nominal 3/4 inch on all sides.
3. Provide door in panelboard front trim, with concealed hinges, to access protective device operating handles.
4. Provide multi-point latching for doors over 30 inches in height.
5. Door Lock: Secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
6. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.

2.06 BUSSING AND TERMINAL BARS

A. Bus:

1. Material: Tin-plated copper full sized throughout length.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

B. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.

C. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other neutral conductors.

D. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

2.07 SPECIAL FEATURES

A. General: Where indicated on Drawings or schedules, provide special features as specified.

B. Surge Arresters:

1. Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer's recommendation.
2. Provide factory mounting within panelboard utilizing UL-recognized mounting device.

C. Fire Alarm Circuits: Identify all branch circuits feeding fire detection and alarm panels and equipment with a red, engraved to white core, plastic nameplate attached to the individual branch circuit breakers. Engrave nameplates with "FIRE ALARM CIRCUIT".

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with NECA 407, NEMA PB 1.1, and manufacturers' written installation instructions.

B. Install securely, plumb, in-line and square with walls.

C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.

D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle and wrap with nylon wire ties.

G. Mount flush panels uniformly flush with wall finish.

H. Provide typewritten circuit directory for each panelboard.

I. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future. Stub four 1-inch empty conduits into raised floor space or to accessible location below slab above grade.

J. Provide engraved identification for each protective device.

END OF SECTION

SECTION 26 24 19
LOW-VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which shall be followed for this section:

1. Institute of Electrical and Electronics Engineers (IEEE):
   a. C2, National Electrical Safety Code (NESC).
   b. C37.20.7, Guide for Testing Metal Enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults.
2. National Electrical Contractors Association (NECA): 402, Standard for Installing and Maintaining Motor Control Centers.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
   b. ICS 1, Industrial Control and Systems: General Requirements.
   c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.
   d. ICS 2.3, Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600V.
   e. ICS 18, Motor Control Centers.
   f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 98, Enclosed and Dead-Front Switches.
   b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 845, Motor Control Centers.

1.02 DEFINITIONS

A. LCD: Liquid Crystal Display.

B. N.C.: Normally Closed.

C. N.O.: Normally Open.

D. SPD: Surge Protection Device.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Itemized Bill of Material.
3. Dimensional drawings.
4. Front Panel Elevations.
5. Conduit entrance locations.
6. Bus data.
7. Protective Devices: Copies of time-current characteristics.
8. Anchoring instructions and details.
9. Anchoring instructions and details.
10. Typed Tabulation:
    a. Motor name; tag (equipment) numbers as shown on Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Overload model number and setting.
    f. Protective device trip settings.
    g. Manufacturer's solid state starter switch or dip switch or program settings.
    h. Attach above typed, tabulated data to a copy of starter manufacturer's overload relay or setting selection tables for starters provided.
11. Control diagrams.
12. One-line diagrams.
13. Schematic (elementary) diagrams.
14. Outline diagrams.
15. Interconnection diagrams.

B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Factory test reports, certified.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Provide products manufactured within scope of UL that conform to UL Standards and have applied UL Listing Mark.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping Splits: Established by Contractor to facilitate ingress of equipment to final installation location within building.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide materials, equipment, and accessories specified in this section manufactured by:

1. Eaton Electrical/Cutler-Hammer.
2. GE Industrial Systems.
3. Schneider Electric/Square D Services.
4. Allen-Bradley.

2.02 GENERAL

A. Like Items of Equipment: End product of one manufacturer and same manufacturer as panelboards for standardization.

B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.

D. Control Transformer:

1. Two winding, 120-volt secondary, primary voltage to suit.
2. Two current-limiting fuses for primary circuit.
3. One fuse in secondary circuit with blown fuse indicator.
4. Mount within starter unit.

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

F. Lifting lugs on equipment and devices weighing over 100 pounds.

G. Anchor Bolts: Type 316 stainless steel 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

H. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Altitude 200 feet above sea level.
3. Equipment to be fully rated.

I. Enclosures: In accordance with NEMA 250.

J. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.
2. Exterior Color: Manufacturer's standard.

2.03 SEPARATELY MOUNTED MOTOR CONTROL

A. Combination Full-Voltage, Magnetic Starter:

1. Rating: Horsepower rated at 600 volts, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
2. Three-phase, nonreversing, full voltage.
3. Control: As shown on Drawings.
4. Disconnect Type: Motor circuit protector or Circuit breaker.
5. Enclosure: NEMA 250, Type 1, unless shown otherwise.
6. Padlockable operating handle, capable of up to three locks.

B. Combination Reduced Voltage, Solid State Starter:

1. Rating: Horsepower rated at 600 volts, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
2. Three-phase, nonreversing with bypass run contactor.
3. Control: As shown on Drawings.
4. Disconnect Type: Circuit breakers.
5. Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
6. Kick start, with adjustable torque and time settings.
7. Ramp start, selectable current or torque, and adjustable time.
8. Smooth stop ramp, adjustable time.
9. Phase loss unbalance and phase reversal protection.
10. LED display or LCD of fault, N.O. contact to communicate fault conditions.
11. Enclosure: As shown.
12. Padlockable operating handle, capable of up to three locks.

C. Reversing, Magnetic Starter:

1. Rating: Horsepower rated at 600 volts, UL labeled with overload protection.
2. Three-phase, reversing, full voltage.
3. Control: As shown on Drawings.
4. Suitable for squirrel cage motors.
5. Enclosure: As shown on Drawings.
6. Padlockable operating handle, capable of up to three locks.

D. Solid State Motor Overload Protection:

1. Inverse-time-limit characteristic.
2. Phase loss, phase unbalanced and Class II ground fault protection.
3. Current operated electronic circuitry with adjustable trip.
4. Class 10/20/30 relay trip, switch selectable.
5. N.O. auxiliary contact for remote monitoring.
6. Manual reset.
7. Provide in each ungrounded phase.
8. Mount within starter unit.

2.04 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 18, and UL 845.
2. Voltage Rating: As shown.
3. Short Circuit Rating: 65,000 amperes rms symmetrical at 480 volts for entire motor control center as a complete assembly.
4. Main and branch circuit breakers, controllers, wire connections, and other devices to be front mounted and accessible, unless otherwise noted.
5. NEMA ICS 18, Part 3.
    a. Class: I.
    b. Type: B.
    c. Provide blank spaces on interconnection diagrams to add control conductor code designations during installation of equipment.

B. Enclosure:

1. Type: NEMA 250 Type 1, indoor.
2. Vertical Section Standard Indoor Dimensions for NEMA 1 Type:
    a. Nominal, 90 inches high, 20 inches wide, 21 inches deep.
    b. Alternative width dimensions of 24 inches and 30 inches are acceptable for oversize devices or panels.

c. Do not exceed space shown.

3. Construction:
   a. Sheet steel reinforced with channel or angle irons.
   b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
   c. Removable top cover plates and bottom cover plates.
   d. Removable plates on end panels for future bus extension.
4. Section Mounting: Removable formed-steel channel sills and lifting angles.
5. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
6. Vertical Wiring Compartment:
   a. Full height, isolated from unit starters with separate hinged door and tie supports.
   b. No terminal blocks allowed in vertical wireway compartment.
7. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.
8. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
9. Door Interlocking: Mechanically interlock starter and feeder doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access and energizing at any time by qualified individual.
10. External disconnect handles with ON/OFF and trip positions showing, padlockable in OFF position with up to three-lock capability.
11. Cable Entrance: Main leads enter from top; control and feeder circuits enter from top.

C. Bus:

1. Horizontal Power Bus:
   a. Three-phase tin-plated copper, entire width of control center, rated as shown.
   b. Tin or silver-plated at joints.
   c. Construct to allow future extension of additional sections.
   d. Pressure type solderless lugs for each incoming line cable.
   e. Isolated from top horizontal wireway.
2. Vertical Power Bus:
   a. Three-phase tin-plated copper, full height of section, rated 300 amperes.
   b. Tin-plated at joints.
   c. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
   d. Insulated and isolated barrier, complete with shutters.

3. Ground Bus: Copper, bare, rated 300 amperes, entire width of control center and in each vertical wireway.
4. Bus Bracing: 65,000 amperes rms symmetrical.

D. Motor Controller Unit:

1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Construction:
   a. Drawout combination type with stab connections for starters NEMA ICS, Size 5 and smaller.
   b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 6 and larger.
   c. Readily interchangeable with starters of similar size.
   d. Pull-apart unit control wiring terminal boards capable of accepting up to 2#14 AWG wires minimum on all units.
3. Starters:
   a. NEMA ICS 18, standard rating, except none smaller than NEMA ICS, Size 1.
   b. Rating: Horsepower rated at 600 volt, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
   c. Three-phase, nonreversing, unless specified otherwise.
   d. Disconnect Type: Motor circuit protector or Circuit breaker.
   e. Combination Full Voltage, Magnetic Starter:
      1) Control: As shown on Drawings.
   f. Combination Reduced Voltage, Solid State Starter:
      1) Control: As shown on Drawings.
      2) Bypass contactor.
      3) Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
      4) Kick start, with adjustable torque and time settings.
      5) Ramp start, selectable current or torque, and adjustable time.
      6) Smooth stop ramp, adjustable time.
      7) Phase loss unbalance and phase reversal protection.
      8) LED display or LCD of fault, N.O. contact to communicate fault condition.
   g. Combination Reversing, Magnetic Starter:
      1) Control: As shown on Drawings.
      2) Suitable for squirrel cage motors.
   h. Combination Adjustable Frequency Drive, Solid State Starter: Drives as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

i. Padlockable operating handle when de-energized with up to three-lock capability.
j. Unit door interlocked to prevent opening when disconnect is in closed position.
k. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.
l. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

4. Disconnecting Device:
   a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.
   b. Padlockable in OPEN position for up to three locks.
5. Circuit Breaker:
   a. Meet requirements of UL 489.
   b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
   c. Thermal-magnetic trip or magnetic trip only as shown.
   d. Tripping indicated by operating-handle position.
   e. Interrupting capacity required for connection to system with short-circuit capacity indicated.
6. Solid State Motor Overload Protection:
   a. Inverse-time-limit characteristic.
   b. Phase loss, phase unbalance and Class II ground fault protection.
   c. Current operated electronic circuitry with adjustable trip.
   d. Class 10/20/30 relay trip, switch selectable.
   e. One N.O. auxiliary contact for remote monitoring.
   f. Manual reset.
   g. Provide in each ungrounded phase.
   h. Mount within starter unit.
7. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.
8. Ground Fault Protection: Where indicated and as specified in Paragraph Main Protective Device and Feeder Units, except provide instantaneous operation device.

E. Control Unit:

1. Disconnecting Device: Pull-apart terminal blocks capable of de-energizing external source control circuits in unit.
2. Control Devices: As indicated and as specified in Section 26 05 04, Basic Electrical Materials and Methods.
3. Control Wiring:
   a. Copper, 14 AWG, minimum.

b. Permanent sleeve type markers with wire numbers applied to each end of wires.
c. Terminate wires using insulated locking fork or ring type crimp terminals.
d. Terminate current transformer leads on shorting type terminal blocks.

F. Incoming Line Terminal:

1. Construction: As specified in Paragraph, Motor Controller Unit.
2. Incoming Service Feeder: As shown on Drawing.
3. Mechanical type CU-/AL lugs for 75 degrees C cable.

G. Main Protective Device and Feeder Unit:

1. Construction: As specified in Paragraph Motor Controller Unit.
2. Incoming Service Feeder: Cable.
3. Instantaneous Trip Mode Selector Switch: Provide switch on main circuit breaker for bypassing long and short time trip settings, and lowered instantaneous trip settings for incident energy reduction during maintenance. In addition, provide the following:
   a. Mode Status Light.
   b. Output contact, rated 5A at 120V ac, for remote Mode status to Plant Control System.
4. Solid State Trip Circuit Breaker:
   a. In accordance with UL 489.
   b. Main protective device.
   c. Insulated or molded case breakers with ambient insensitive solid-state trips and having current sensors and logic circuits integral in breaker frame.
   d. Solid-state current control with adjustable ampere setting, adjustable long-time delay, adjustable short-time trip and delay band, fixed or adjustable instantaneous trip, and adjustable ground fault trip and delay band.
   e. Setting adjustments to be covered by a sealable, tamper-proof, transparent cover (insulated case breakers only) or by compartment door for other breakers).
   f. Locate trip button on front cover of breaker to permit mechanical simulation overcurrent tripping for test purposes and to trip breaker quickly in emergency situation.
5. Molded Case Circuit Breaker:
   a. In accordance with UL 489.
   b. Main and feeder protective device.
   c. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.

d. Indicate tripping by operating-handle position.
e. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

6. Phase Monitoring Relay:
   a. Three-phase monitoring relay to protect against low voltage, voltage unbalance, and phase reversal.
   b. Manufacturer and Product: Schneider Electric/Square D; Class 8430 Type MPS or Class 8430 Type MPD.

H. Pushbuttons, Indicating Lights, Selector Switches, Elapsed Time Meters, Control Relays, Time-Delay Relays, and Reset Timers: As specified in Section 26 05 04, Basic Electrical Materials and Methods.

I. Nameplates:

1. Laminated plastic; white, engraved to black core.
2. Provide for each motor control center and each unit.
3. Engrave with inscription shown on single-line diagram.
4. Provide blank nameplates on spaces for future units.
5. Attach with stainless steel panhead screws on face of control center.

J. Space Heaters: Thermostatically controlled. Locate in bottom of each vertical section for operation from 120-volt power source derived internal to MCC.

2.05 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Applicable Standards: NEMA ICS 18, UL 845, and NEC Article 430, Part VIII.
2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.
3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.
4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.
5. Control Circuits and Devices:
   a. Energize circuit at rated voltage.
   b. Operate control devices.
   c. Perform continuity check.
6. Instruments, Meters, Protective Relays, and Equipment:
   a. Verify devices functioned by energizing potential to rated values with connection to devices made at outgoing terminal blocks.

b. Verify protective relays operated for functional checks and trips manually initiated to verify functioning of operation for indicator and associated circuits.

7. Perform dielectric tests on primary circuits and equipment, except potential transformers.
   a. Tests: Phase-to-phase and phase-to-around with 60-cycle test voltages applied for 1 second at 2,640 volts.
8. Verify equipment passed tests and inspection.
9. Provide standard factory inspection and test checklists, and final certified and signed test report.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer's written instructions and recommendations.
2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
3. Install equipment plumb and in longitudinal alignment with pad or wall.
4. Coordinate terminal connections with installation of secondary feeders.
5. Grout mounting channels into floor or mounting pads.
6. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.
7. Motor Data: Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
   a. Motor served by tag number and equipment name.
   b. Nameplate horsepower.
   c. Motor code letter.
   d. Full load amperes.
   e. Service factor.
   f. Installed overload relay catalog number.

B. Circuit Breakers:

1. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.
2. Adjust to approximately 11 times motor rated current.
3. Determine motor rated current from motor nameplate following installation.

C. Thermal Overload Relay:

1. Select and install overload relays and apply settings after actual nameplate full-load current rating of motor has been determined.
2. Initial Settings: In accordance with manufacturer's recommendation.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at Job Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1/2 person-day for installation assistance, and inspection of installation.
2. 1/2 person-day for functional and performance testing.
3. 1 person-day for plant startup.
4. 1 person-day for training of Owner's personnel.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. Federal Specifications (FS):
   a. W-C-596G, General Specification for Connector, Electrical, Power.
   b. W-S-896F, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. Institute of Electrical and Electronic Engineers, Inc. (IEEE):
   a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1,000V and less) AC Power Circuits.
   b. C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000V and less) AC Power Circuits.
4. National Electrical Contractors Association (NECA): 1, Standard Practice of Good Workmanship in Electrical Contracting.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. FB 11, Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
   c. WD 1, General Color Requirements for Wiring Devices.
   d. WD 6, Wiring Devices – Dimensional Specifications.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 498, Standard for Safety for Attachment Plugs and Receptacles.
   b. 508, Standard for Safety for Industrial Control Equipment.
   c. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
   d. 1010, Standard for Safety for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
   e. 1436, Standard for Safety for Outlet Circuit Testers and Similar Indicating Devices.
   f. 1449, Standard for Safety for Surge Protective Devices (SPD).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's product data for wiring devices.

PART 2 PRODUCTS

2.01 SWITCHES

A. Switch, General Purpose:

1. NEMA WD 1 and FS W-S-896F.
2. Totally enclosed, ac type, with quiet tumbler switch and screw terminal.
3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contact.
4. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
5. Rating: 20 amps, 120/277 volts.
6. Automatic grounding clip and integral grounding terminal on mounting strap.
7. Special Features: Provide the following features in comparable devices where indicated
   a. Three-way and four-way.
8. : Manufacturers and Products, Industrial Grade:
   a. Cooper Arrow Hart; AH1220 Series.
   b. Bryant; 4901 Series.
   c. Hubbell; 1221 Series.
   d. Leviton; 1221 Series.

B. Switch, Motor Rated:

1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
2. UL 508 listed.
3. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts.
4. Minimum General Purpose Rating: 30 amperes, 600V ac.
5. Minimum Motor Ratings:
   a. 2 horsepower for 120V ac, single-phase, two-pole.
   b. 3 horsepower for 240V ac, single-phase, two-pole.
   c. 15 horsepower for 480V ac, three-phase, three-pole.
6. Screw-type terminal.
7. Manufacturers and Products:
   a. Cooper Arrow Hart.
   b. Hubbell Bryant: HBL78 Series.
   c. Leviton.

2.02 RECEPTACLES

A. Receptacle, General Purpose:

1. NEMA WD 1 and FS W-C-596G.
2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
3. Impact resistant nylon cover and body, with finder grooves in face, unless otherwise indicated.
4. One-piece mounting strap with integral ground contact (rivetless construction).
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, unless otherwise indicated.
7. Size: For 2-inch by 4-inch outlet box.
8. Industrial Grade Manufacturers and Products:
   a. Cooper Arrow Hart; 5362 Series.
   b. Hubbell Bryant; HBL5362 Series.
   c. Leviton; 5362 Series.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Meet requirements of general-purpose receptacle.
2. Listed Class A to UL 943, tripping at 5 mA.
3. Rectangular smooth face with push-to-test and reset buttons.
4. Listed weather-resistant per NEC 406.8 for installation in damp or wet locations.
5. Feed-through Capability: 20 amps.
6. Manufacturers and Products:
   a. Hubbell Bryant; GFTR20 Series.
   b. Cooper Arrow Hart WRVGF20 Series.
   c. Leviton; 7899 Series.

2.03 HAZARDOUS (CLASSIFIED) LOCATION DEVICES

A. Wiring devices for hazardous (classified) locations shall comply with NEMA FB 11 and UL 1010.

B. Switch:

1. Industrial grade, totally enclosed, ac type, with tumbler switch.
2. Capable of three-way or four-way operation where indicated on Drawings.
3. Rating: 20 amps at 120/277 volts.
4. Material: Cast aluminum back body and cover.

5. Hazardous Area Ratings: NEMA 7D suitable for Class I, Group locations.
6. Manufacturers and Products:
   a. Killark: XS Series.
   b. Appleton: EDS Series.

C. Switch, Motor Rated:

1. Enclosed manual motor starter-type, three-pole, non-reversing without overloads.
2. Minimum Motor Rating: 10 horsepower, 480V ac, three-phase, three-pole.
3. Enclosure: NEMA 250, Type 7.
4. Operator: External handle with padlocking provisions.
5. Manufacturer and Product: Eaton, Type B101.

D. Receptacles, General:

1. Contain integral switch which must be closed to energize circuit.
2. Design shall permit only an approved plug to be energized.
   a. Actuation of switch shall require plug be inserted and rotated approximately 45 degrees.
   b. Plug shall lock into this position preventing unintended disengagement.
   c. To remove, plug shall be turned opposite direction as engagement and pulled straight out.

2.04 DEVICE PLATES

A. Sectional type plate not permitted.

B. Nylon:

1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
2. Color: To match associated wiring device.
3. Mounting Screw: Oval-head metal, color matched to plate.

C. Stainless Steel:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.
2. Screw: Oval-head stainless steel.

E. Sheet Steel:

1. Finish: Zinc electroplate.
2. Screws: Oval-head stainless steel.
3. Manufacturers:
   a. Appleton.
   b. Crouse-Hinds.

F. Weatherproof:

1. Receptacle, Weatherproof Type 2:
   a. UL listed for wet location while in use.
   b. Polycarbonate or Die cast metal cover.
   c. Manufacturer and Product: TayMac; Type Multi-Mac.
2. Switch:
   a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
   b. Mounting Screw: Stainless steel.
   c. Manufacturers and Products:
      1) Crouse-Hinds; DS-181 or DS-185.
      2) Appleton; FSK-1VTS or FSK-1VS.

G. Raised Sheet Steel: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel box.

2.05 FINISHES

A. Wiring device catalog numbers specified in this section do not designate device color. Unless otherwise indicated, or required by code, provide colors as specified below.

B. Wiring Device: Gray.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with NECA 1.

B. Coordination with Other Trades:

1. Ensure device and its box are protected. Do not place wall finish materials over device box and do not cut holes for box with router that is guided by riding against outside of box.
2. Keep outlet box free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
3. Install device box in brick or block wall such that cover plate does not cross a joint, unless otherwise indicated. Where indicated or directed to cross joint, trowel joint flush with face of wall.
4. Install wiring device after wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction or that show signs they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (150 mm) in length.

5. Use torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than 12 AWG are installed on 15-amp or 20-amp circuits, splice 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on device.
8. Device Plates:
    a. Do not use oversized or extra deep plate.
    b. Repair wall finishes and remount outlet box when standard device plate does not fit flush or does not cover rough wall opening.

3.02 SWITCH INSTALLATION

A. Switch, General Purpose:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switch such that toggle is in up position when switch is on.

B. Switch, Motor Rated:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position such that toggle is in up position when ON.
3. Install within sight of motor when used as disconnect switch.

3.03 RECEPTACLE INSTALLATION

A. Duplex Receptacle:

1. Ground receptacle to box with grounding wire only.
2. Weatherproof Receptacle:
    a. Install in cast metal box.
    b. Install such that hinge for protective cover is above receptacle opening.
3. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

3.04 DEVICE PLATE INSTALLATION

A. Securely fasten to wiring device; ensure tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surface without use of mat or similar material. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plate has no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Label with designated title.

1. Printed:
   a. Character Height: 1/8 inch.
   b. Text: Black.
   c. Background: White Clear.

F. Type (Exterior):

1. Switch: Weatherproof.
2. Receptacle in Wet Location: Weatherproof Type 2.

G. Type (Interior):

1. Surface Mounted, Metal Box:
   a. General Purpose Areas (Dry, Non-process): Sheet Steel.
   b. Other Areas: Cast metal.
2. Surface Mounted, Aluminum Box:
   a. General Purpose Areas: Stamped.
   b. Other Areas: Cast metal.
3. Surface Mounted, Sheet Steel Box: Raised sheet steel.
4. Surface Mounted, Cast Box: Cast.
5. Surface Mounted, Nonmetallic Box: Manufacturer’s standard.
6. Receptacle Shown as Weatherproof on Drawings: Weatherproof Type 2.

3.05 IDENTIFICATION

A. Use tape labels for identification of individual wall switches and receptacles in dry indoor locations.

1. Degrease and clean device plate surface to receive tape labels.
2. Use 3/16-inch Kroy black letters on white background, unless otherwise indicated.
3. Identify panelboard and circuit number from which item is served on face of plate.

B. Identify conductors with durable wire markers or tags inside outlet boxes where more than one circuit is present.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

B. Test Instrument for 125-Volt 20-Amp Receptacle: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

C. Using test plug, verify device and its outlet box are securely mounted.

D. Line Voltage Range: 105 volts to 132 volts.

E. Percent Voltage Drop under 15-Amp Load: Less than 6 percent; 6 percent or higher is not acceptable.

F. Ground Impedance: 2 ohms, maximum.

G. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

H. Tests shall be diagnostic, indicating damaged conductors, high resistance at circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 29 23
LOW-VOLTAGE ADJUSTABLE FREQUENCY DRIVE SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. Electronic Industries Alliance (EIA): 359-A-1, Special Colors.
2. Hydraulic Institute Standards (HIS).
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   c. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. National Electrical Manufacturer's Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. CP 1, Shunt Capacitors.
   c. MG 1, Motors and Generators.
   d. WC 57, Standard for Control, Thermocouple Extensions, and Instrumentation Cables.
5. National Fire Protection Association (NFPA): 79, Electrical Standard for Industrial Machinery.

1.02 DEFINITIONS

A. Terms that may be used in this section:

1. AFD: Adjustable frequency drive.
2. CMOS: Complementary metal oxide semiconductor.
3. GTO: Gate turn-off thyristor.
4. MPR: Motor protection relay.
5. MTBF: Mean time between failure.
6. PWM: Pulse width modulation.
7. ROM: Read only memory.
8. Rated Load: Load specified for equipment.
9. Rated Speed: Nominal rated (100 percent) speed specified for equipment.
10. TDD: Total demand distortion.
11. THD: Total harmonic distortion.
12. TTL: Transistor transistor logic.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Rated Continuous Operation Capacity: Not less than 1.15 times full load current rating of driven motor, as indicated on motor nameplate, and suitable for continuous operation at continuous overload which may be imposed on motor by driven pump operating over specified speed range.

B. Design Requirements:

1. Drive system consisting of adjustable frequency controller, drive motor, auxiliary items, and components necessary for complete operating system.
2. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal and emergency conditions.
3. Furnish AFDs rated on basis of actual motor full load nameplate current rating times the service factor.
4. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using pulse-width-modulation (PWM) technique to produce adjustable frequency output.
5. System rated for continuous industrial duty and suitable for use with NEMA MG 1, Design B motors.
6. Incoming Line Circuit Breaker: Provide positive means of disconnecting incoming power, and overcurrent protection for drive system.
7. Incoming Line Reactor: Design to minimize harmonic distortion on incoming power feeder.

1.04 SUBMITTALS

A. Action Submittals:

1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.
2. Individual and total harmonic content (voltage and current) reflected in system normal source supply at driven equipment actual load at 70 percent and 100 percent of rated speed at locations specified in Simplified Plant One-Line Diagram and load conditions specified. Normal source system short-circuit available at drive shall be calculated

from data furnished in Supplements to this section. Use TDD and THD factors as defined in IEEE 519 to designate total harmonic content.

3. AFD output pulse maximum peak voltage, pulse rise time, and pulse rate of rise including justification for proposed deviation from specified values. Include motor manufacturer's certification motor insulation will withstand long-term overvoltages caused at motor terminals due to specified output pulse data or proposed deviation from this data.
4. Data on shelf life of "dc link" capacitor.
5. Complete system rating, including nameplate data, continuous operation load capability throughout speed range of 0 percent to 120 percent of rated speed.
6. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list controller special features being supplied.
7. Controller, reactor, harmonic filter, and isolating transformer (if applicable) dimensional drawings; information on size and location of space for incoming and outgoing conduit.
8. Maximum heat dissipation from enclosure.
9. Layout of controller face showing pushbuttons, switches, instruments, and indicating lights.
10. Complete system operating description.
11. Complete system schematic (elementary) wiring diagrams.
12. Complete system interconnection diagrams between controller, drive motor, and related components or controls external to system, including wire numbers and terminal board point identification.
13. One-line diagram of system, including component ratings.
14. Description of diagnostic features being provided.
15. Descriptive literature for control devices such as relays and timers.
16. Itemized bill-of-materials listing system components.
17. Specific description of provisions, such as filtering and harmonic suppression, being made to ensure proper system operation when power factor correction capacitors are included in system and system is supplied from standby engine generator.

B. Informational Submittals:

1. Statement of Supplier qualifications.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Factory functional test reports.

6. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE 112, Test Method B, showing rated load, rated speed efficiency meeting or exceeding specified values; motors not as specified will be rejected.
7. Field test reports.
8. Suggested spare parts list to maintain equipment in service for period of 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
9. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
10. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
11. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.05 QUALITY ASSURANCE

A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

1.06 EXTRA MATERIALS

A. Furnish for each drive unit: Complete set of components likely to fail in normal service.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Components and accessories specified in this section shall be products of:

1. Eaton Cutler Hammer.
2. Allen-Bradley.
3. ABB.
4. Square D.

2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.03 SERVICE CONDITIONS

A. Ambient Operating Temperature: 32 degrees F to 104 degrees F.

B. Storage Temperature: Minus 40 degrees F to 158 degrees F.

C. Humidity: 0 percent to 95 percent relative (noncondensing).

D. Altitude: 0 foot to 3,300 feet.

E. Frequency Stability: Plus or minus 0.1 percent of maximum frequency.

2.04 COMPONENTS

A. Drive Units:

1. Incorporate switching power supply operating from dc bus, to produce PWM output waveform simulating sine wave and providing power loss ride through of 2 milliseconds at full load, full speed.
2. Current-limiting semiconductor fuses for protection of internal power semiconductors.
3. Employ diode bridge rectifier providing constant displacement power factor of 0.95 minimum at all operating speeds and loads.
4. Use transistors for output section, providing a minimum 97 percent drive efficiency at full speed, full load.
5. Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50 volts dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.
6. Operate with open circuited output.
7. Input Voltage: 480V ac plus or minus 10 percent.
8. Output Voltage: 0 to 480 volts, three-phase, 0 to 66-Hz, minimum.
9. Maximum peak voltage of PWM AFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and maximum rate of rise of 500 volts per microsecond. Maximum frequency of PWM AFD output pulse (carrier) frequency of 3,000-Hz. Should magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish insulation systems on motors suitable for proposed values.
10. Short-Time Overload Capacity: 125 percent of rated load in rms current for 1 minute following full load, full speed operation.
11. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source three-phase, bolted fault, short-circuit available of amps rms symmetrical at volts.
12. Furnish drives with dv/dt output filter or sine wave filter mounted within equipment enclosure. Vendor to select type of output filter is based on motor cable size and cable length.
13. Diagnostics: Comprehensive for drive adjustment and troubleshooting:
    a. Memory battery backup; 100-hour minimum during power loss.
    b. Status messages will not stop drive from running but will prevent it from starting.

c. Fault Condition Messages and History: First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults numerically:
   1) Overcurrent (time and instantaneous).
   2) Overvoltage.
   3) Undervoltage (dc and ac).
   4) Overtemperature (drive, motor windings, motor bearing, pump bearing).
   5) Serial communication fault.
   6) Short-circuit/ground fault (motor and drive).
   7) Motor stalled.
   8) Semiconductor fault.
   9) Microprocessor fault.
   10) Single-phase voltage condition.

14. Drive Protection:
   a. Fast-acting semiconductor fuses.
   b. Overcurrent, instantaneous overcurrent trip.
   c. Dc undervoltage protection, 70 percent dropout.
   d. Dc overvoltage protection, 130 percent pickup.
   e. Overtemperature, drive, inverter, converter, and dc link components.
   f. Overtemperature, motor, and pump.
   g. Single-phase protection.
   h. Reset overcurrent protection (manual or automatic reset).
   i. Active current limit/torque limit protection.
   j. Semiconductor fault protection.
   k. Short-circuit/ground fault protection.
   l. Serial communication fault protection.
   m. Microprocessor fault.
   n. Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per IEEE C62.41).
   o. Visual display of specific fault conditions.
15. Operational Features:
   a. Use manufacturer’s standard unless otherwise indicated.
   b. Sustained power loss.
   c. Momentary power loss.
   d. Power interruption.
   e. Power loss ride through (0.1 second).
   f. Start on the fly.
   g. Electronic motor overload protection.
   h. Stall protection.
   i. Slip compensation.
   j. Automatic restart after power return (ability to enable/disable function).

k. Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
l. Drive maintenance system software for complete programming and diagnostics.
m. Ground fault protection, drive, and motor.
n. Operate with no motor connected to output terminals.

B. Rectifier: Three-phase 6-pulse full wave diode bridge rectifier to provide constant dc voltage to drive's dc bus.

C. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.

D. Controller: Microprocessor-controller PWM inverter to convert to dc voltage to variable voltage, adjustable frequency, three-phase ac output. Output voltage shall vary proportionally with frequency to maintain constant ratio of volts to hertz up to 60-Hz; above 60-Hz, voltage shall remain constant with drive operating in constant horsepower output mode.

E. Enclosure:

1. NEMA 250, Type 1, gasketed, freestanding, enclosure for mounting against wall, completely front accessible, and hinged doors. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure not to exceed dimensions shown on Drawings.
2. Cable termination compartment door interlocked main circuit breaker, defeatable (lockable in the open position), emergency stop pushbutton, alphanumeric keypad and display, and operator's controls. Components and controls specified in Section 26 05 04, Basic Electrical Materials and Methods.
3. Wire drive from below for power and control wiring.
4. Size forced-ventilation for periodic operation to cool each unit with maximum room ambient temperature of 95 degrees F. Furnish redundant fans such that if one fan fails remaining fans furnish adequate ventilation for drive when operating at maximum capacity. Furnish filters on ventilation intakes.
5. Wiring:
   a. Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding.
   b. Label each terminal for permanent identification of leads.
   c. Identify each wire at each end with imprinted mylar adhesive-back wire markers.

d. Incorporate in as-installed wiring diagrams for wire and terminal numbers shown.
e. Wiring across door hinge, use 19-strand, NEMA WC 57 Class C stranding looped for proper twist rather than bending at hinge.
f. Wire connections internal to panels by crimp-on terminal types.
g. For multiple enclosure systems, complete interconnection wiring with gasketed enclosure openings for wiring.
h. Multipoint plug receptacles for control wiring crossing equipment shipping splits.

6. Selector switches, indicating lights, potentiometers, instruments, protective devices, and major system components identified by means of mechanically attached, engraved, laminated nameplates.

F. Operator Interface:

1. Controls: Mount drive local control on front door of enclosure and include control switch and membrane type keypad for the following operator functions:
   a. Start (when in local mode).
   b. Stop (when in local mode).
   c. Speed increase (when in local mode).
   d. Speed decrease (when in local mode).
   e. Parameter mode selection (recall programmed parameters).
   f. LOCAL/OFF/REMOTE control selection (in remote, furnish for remote RUN command digital input and speed increase/decrease via remote 4 mA to 20 mA analog signal).
   g. Fault reset, manual for faults, except loss of ac voltage which is automatic upon return.
   h. RUN/preset speed.
   i. Parameter lock, password or key switch lockout of changes to parameters.
   j. Start disable, key switch or programmed code.
2. Control circuit disconnect shall de-energize circuits in units that are not de-energized by main power disconnect device.
3. 120 volts, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer. Where shown on motor control diagrams, furnish power for motor space heaters rated 120 volts.
4. Arrange component and circuit such that failure of a single component cannot cause cascading failure(s) of other component(s).
5. Alphanumeric Display: During normal operation and routine test, the following parameters shall be available:
   a. Motor current (percent of drive rated current).
   b. Output frequency (Hertz).
   c. Output voltage.

d. Running time.
e. Local/remote indicator.
f. Status of digital inputs and outputs.
g. Analog input and output values.
h. Output motor current per leg.
i. All test points.

6. Adjustable Parameters: Set drive operating parameters and indicate in numeric form. Potentiometers may not be used for parameter adjustment. Minimum setup parameters available:
   a. Frequency range, minimum, maximum.
   b. Adjustable acceleration/deceleration rate.
   c. Volts per Hertz (field weakening point).
   d. Active current limit/torque limit, 0 percent to 140 percent of drive rating.
   e. Adjustable voltage boost (IR compensation).
   f. Preset speed (adjustable, preset operating point).
   g. Provision for adjustment of minimum and maximum pump speed to be furnished as function of 4 mA to 20 mA remote speed signal.

G. Signal Interface:

1. Digital Input:
   a. Accept a remote RUN command contact closure input.
   b. High temperature contact closure input from field mounted motor temperature monitoring relay.
2. Digital Output: Furnish three discrete output dry contact closures rated 5 amps at 120 volts ac.
   a. DRIVE RUNNING.
   b. DRIVE FAULT (with common contact closure for all fault conditions).
   c. DRIVE IN REMOTE MODE.
3. Analog Input: When LOCAL/OFF/REMOTE switch is in REMOTE, control drive speed from remote 4 mA to 20 mA dc signal.
   a. Make provisions for adjustment of minimum and maximum motor speed which shall result from this signal.
   b. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications.
   c. Frequency resolution shall be 0.1 percent of base speed.
4. Analog Output: Furnish two 4 mA to 20 mA dc signals for actual frequency, actual load.
5. Serial Communication Interface: RS232/RS 422, compatible with MODBUS as an RTU.

H. Accessories:

1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer and as specified in Section 05 50 00, Metal Fabrications.

2.05 FACTORY FINISHING

A. Enclosure:

1. Primer: One coat of rust-inhibiting coating.
2. Finish:
   a. Interior: One coat white enamel.
   b. Exterior: One coat manufacturer's standard gray enamel or EIA 359-A-1, No. 61.
3. Manufacturer's standard baked enamel finish.

2.06 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test one control panels identical to the furnished.

C. Record test data for report.

D. Functional Test: Perform manufacturer's standard.

E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

PART 3 EXECUTION

3.01 INSTALLATION

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

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each controller.
2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.

3. Vibration Test:
    a. Complete assembly, consisting of motor, load, and flexible shafting, connected and in normal operation shall not develop amplitudes of vibration exceeding limits recommended by HIS.
    b. Where loads and drives are separated by intermediate flexible shafting, measure vibration both at top motor bearing and at two points on top pump bearing, 90 degrees apart.
4. Record test data for report.

B. Performance Test:

1. Conduct on each controller.
2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 12-hour period without malfunction.
4. Demonstrate performance by operating continuous period while varying application load, as input conditions allow, to verify system performance.

3.03 MANUFACTURERS' SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1/2 person-day for installation assistance and inspection.
2. 1/2 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1/2 person-day for facility startup.
4. 1 person-day for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner and Engineer.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 26 41 00
FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.01 REFERENCES

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

1. Lightning Protection Institute (LPI): 175, Standard of Practice.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 780, Standard for the Installation of Lightning Protection Systems.
3. UL:
   a. 96, Standard for Lightning Protection Components.
   b. 96A, Standard for Installation Requirements for Lightning Protection Systems.

1.02 DESIGN REQUIREMENTS

A. Provide lightning protection system design for the following structures:

1. Dewatering Building.

B. Design lightning protection system to comply with applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

1.03 SUBMITTALS

A. Action Submittals:

1. Reproducible Mylar Drawings:
   a. Lightning protection system layout.
   b. Component locations.
   c. Detailed plans.
2. Down conductor.
3. Connecting conductor.
4. Bond strap.
5. Air terminals.
6. Fittings.
7. Connectors.
8. Ground rods.

B. Informational Submittals:

1. Field test report.
2. Ground Witness Certification-Form LPI-175A.
3. Post-Installation Certification-Form LPI-175B.

1.04 QUALITY ASSURANCE

A. Designer: Lightning protection system design shall be prepared by an LPI-certified master designer. Shop drawings shall be stamped by the designer.

B. System components shall be the product of a manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with UL 96.

C. Lightning protection system shall be installed under direct supervision of an LPI 175 Certified Master Installer.

D. Inspection of final installation and grounding connection shall be performed by an LPI-certified inspector.

E. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.

F. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Thompson Lightning.
2. IPC Protection.
3. Erico Eritech Lightning Protection Systems.
4. VFC, Inc.

2.02 GENERAL

A. Complete system shall bear UL 96 Master Label C.

B. System Material: Copper or high copper content, heavy-duty bronze castings unless otherwise specified.

C. Material shall comply in weight, size, and composition for the class of structure to be protected as established by NFPA 780.

2.03 COMPONENTS

A. Air Terminal:

1. Material: Solid copper rods with tapered or blunt points as required for application.
2. Length: Sufficient to extend minimum 10 inches above object being protected.
3. UL 96 Label B applied to each terminal.

B. Conductors:

1. Lightning System Conductors: Bare medium hard-drawn stranded copper, or stranded aluminum as required for the application**.**
2. Main Down Conductor: Smooth twist stranding.
3. Connecting Conductor: Concentric stranding.
4. Bonding Conductor: Flexible strap.
5. Main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.
6. Grounding Conductors: Stranded bare copper.

C. Cable Fastener and Accessories: Capable of withstanding minimum pull of 100 pounds.

D. Fittings:

1. Heavy-duty.
2. Bolts, Screws, and Related Hardware: Stainless steel.

E. Ground Rods:

1. Material: Copper or Copper-clad.
2. Diameter: 5/8.

F. Grounding Connections:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Hardware: Silicone bronze.

G. Cable Connections and Splicers:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Through-Roof Connectors: Straight or right angle with bronze and lead seal flashing washer.

H. Conduit: Schedule 40 PVC, as specified in Section 26 05 33, Raceway and Boxes.

PART 3 EXECUTION

3.01 GENERAL

A. Workmanship to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

B. Aluminum materials shall be used where required to meet the galvanic corrosion requirements of UL 96A.

C. Provide pitchpockets or method compatible with roofing to waterproof roof penetrations.

D. Install system in inconspicuous manner so components blend with building aesthetics.

3.02 EXAMINATION

A. Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

3.03 INSTALLATION

A. Air Terminals:

1. Supports: Brackets or braces.
2. Parapet Bracket Attachment: Lag or expansion bolts.
3. Secure base to roof surface with adhesive or pitch compatible with roofing bond.

4. Provide terminal flashing at roof penetrations.
5. Perimeter Terminals:
   a. Maximum Spacing: 20 feet.
   b. Maximum Distance From Outside Edge of Building: 2 feet.
6. Roof Ridge Terminals: Maximum spacing 20 feet.
7. Mid-Roof Terminals: Maximum spacing 50 feet.
8. Provide blunt point air terminals for applications exposed to personnel.

B. Conductors:

1. Conceal whenever practical.
2. Provide 1-inch PVC conduit in building walls or columns for main downleads and roof risers.
3. Support: Maximum spacing for exposed conductors.
   a. Vertical: 3 foot.
   b. Horizontal: 4 foot.
4. Maintain horizontal and vertical conductor courses free from dips or pockets.
5. Bends: Maximum 90 degrees, with minimum 8-inch radius.
6. Install air terminal conductors on the structural roof surface before roofing composition is applied.

C. Bonding:

1. Bond to Main Conductor System:
   a. Roof-mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
   b. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
2. Bond each steel column or major framing members to grounding system.
3. Bond each main down conductor to grounding system.

D. Grounding System:

1. Grounding Conductor:
   a. Completely encircle building structure.
   b. Bury minimum 1 foot below finished grade.
   c. Minimum 2 feet from foundation walls.
2. Interconnect ground rods by direct-buried copper cables.
3. Maximum Resistance: 5 ohms when connected to ground rods.

4. Connections:
    a. Install ground cables continuous between connections.
    b. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
    c. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
    d. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
    e. Provide interconnections with electrical and telephone systems and all underground water and sewer, and metal pipes.
    f. Provide electric service arrestor ground wire to building water main.

3.04 FIELD QUALITY CONTROL

A. Field Testing:

1. Isolate lightning protection system from other ground conditions while performing tests.
2. Resistance: Test ground resistance of grounding system by the fall-of-potential method.
    a. Test Resistance to Ground: Maximum 5 ohms.
    b. Install additional ground rods as required to obtain maximum allowable resistance.
3. Test Report:
    a. Description of equipment tested.
    b. Description of test.
    c. Test results.
    d. Conclusions and recommendations.
    e. Appendix, including appropriate test forms.
    f. Identification of test equipment used.
    g. Signature of responsible test organization authority.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. Department of Defense: MIL-STD-220C, Test Method Standard – Method of Insertion Loss Measurement.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
   b. C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and less) AC Power Circuits.
   c. C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and less) AC Power Circuits.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 497A, Standard for Secondary Protectors for Communications Circuits.
   b. 1283, Standard for Electromagnetic Interference Filters.
   c. 1449, Standard for Surge Protective Devices.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
2. Electrical single-line diagram showing location of each SPD.
3. Manufacturer’s UL certified test data and nameplate data for each surge protective device (SPD).

1.03 QUALITY ASSURANCE

A. UL Compliance and Labeling:

1. SPDs for Power and Signal Circuits: Comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units listed and labeled by UL.
2. SPDs for Telephone Circuit Protection: Comply with UL 497A.

B. ANSI Compliance: Use SPD devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Eaton, SPD Series.

B. General Electric, Tranquell.

C. Square D, Surelogic.

D. Advanced Protection Technologies, Inc.

E. CITEL, MDS Series.

2.02 GENERAL

A. Unless indicated otherwise, provide direct bus-connected and factory-installed SPDs inside distribution equipment.

B. SPD Operating Conditions: Capable of performing at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.

C. Connect SPDs through a fused switch or circuit breaker as selected by manufacturer. Provide overcurrent protection to allow full surge handling capabilities and afford safety protection from thermal overloads and short circuits.

D. SPD Short Circuit Current Rating (SCCR): No less than the SCCR of distribution equipment.

E. Design SPD devices to protect all modes (L-L, L-N, L-G, N-G) of electrical system being used.

F. Power Filter: Include a high-frequency extended range power filter for each SPD complimentary listed to UL 1283 as an electromagnetic interference filter.

G. Provide SPDs with the following monitoring and diagnostics:

1. LED-type indication lights to show normal and failed status of each protected phase.
2. Surge event counter.
3. Form C dry contact which operates when unit fails.

H. Provide UL Type 2 SPDs.

I. EMI/RFI Noise Suppression: -50dB attenuation at 100 kHz, tested per MIL-STD 220C.

J. Voltage Protection Rating (VPR):

Voltage Rating	L-N	N-G	L-G	L-L
208Y/120	800	800	800	1200
480Y/277	1200	1200	1200	2000
240 Δ	--	--	1200	1200
480 Δ	--	--	2000	2000

2.03 SERVICE ENTRANCE AND DISTRIBUTION SPD

A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.

B. Surge Current Capacity:

1. Distribution:
   a. 160 kA per phase.
   b. 80 kA per mode.

C. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system voltage.

D. Nominal Discharge Current (I_N): 20kA.

2.04 PANELBOARD SPD

A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category B.

B. Surge Current Capacity:

1. Distribution: 160 kA per phase; 80 kA per mode.
2. Branch: 120 kA per phase; 60 kA per mode.

C. Maximum Continuous Operating Voltage (MCOV): Not less than 125 percent of the nominal system voltage.

D. Nominal Discharge Current (I_N): 10kA.

2.05 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Use bi-polar 1,500-watt silicon avalanche diodes between protected conductor and earth ground.

C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).

D. Breakdown voltage shall not exceed 36 volts.

2.06 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Design Requirements: A hybrid design with a minimum of three stages, using solid-state components and operating bi-directionally.

C. Meet or exceed the following criteria:

1. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform); 2,000 occurrences.
3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of normal applied signal voltage by 200 percent.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

A. Provide SPDs when indicated on Drawings or in the equipment specifications.

B. Provide factory-installed SPDs as integral components to new switchgear, switchboards, motor control centers, panelboards and transfer switches. Externally mounted SPDs are not acceptable for new distribution equipment.

C. Externally mounted SPDs are acceptable for SPDs added to existing equipment as described below.

D. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.

1. Use secondary protectors on lines that do not exit the structure.
2. Use primary protectors on lines that exit and enter the structure.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install suppressors according to manufacturer’s recommendations.

B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

C. Provide connecting wires as short as possible with gently twisted conductors, tied together, to prevent separation.

1. Maximum Length: 24 inches.

D. Field Installed Conductors: As specified for building wire, not smaller than 8 AWG and not larger than 4 AWG. Provide device leads not longer than the maximum length recommended by manufacturer, unless specifically reviewed and approved by manufacturer.

E. Provide dedicated disconnecting means for SPD devices installed at main service entrance location, switchgear, and motor control centers. Provide dedicated 30-60-ampere circuit breakers (size dependent upon wire size used) with number of poles as required, as disconnecting means for SPD devices. Provide circuit breakers with interrupting capacity equal to that specified for other breakers at that location.

END OF SECTION

SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 REFERENCES

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

1. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Surge Voltages in Low-Voltage AC Power Circuits.
2. International Fire Code (IFC).
3. International Building Code (IBC).
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 72, National Fire Alarm and Signaling Code.
   c. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   d. 101, Code for Safety to Life from Fire in Buildings and Structures.
   e. 820, Fire Protection in Wastewater Treatment and Collection Facilities.
   f. 1221 Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems.
5. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
6. National Institute for Certification in Engineering Technologies (NICET).
7. Telecommunications Industry Association (TIA):
   a. 232, Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange.
   b. 485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.
8. UL:
   a. 217, Single and Multiple Station Smoke Alarms.
   b. 228, Door Closures-Holders, With or Without Integral Smoke Detectors.
   c. 268, Smoke Detectors for Fire Protective Signaling Systems.
   d. 286A, Smoke Detectors for Duct Application.
   e. 464, Audible Signal Appliances.
   f. 497B, Protectors for Data Communication and Fire Alarm Circuits.
   g. 864, Control Units for Fire-Protective Signaling Systems.

h. 1449, Standard for Transient Voltage Surge Suppressors.
i. 1480, Speakers for Fire-Protective Signaling Systems.
j. 1604, Electrical Equipment for Use in Class I and Class II, Division 2, and Class III Hazardous (Classified) Locations.
k. 1638, Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.
l. 1971, Signaling Devices for the Hearing Impaired.

1.02 DEFINITIONS

A. Addressable: A fire alarm system component with a unique identification that can have its status individually identified or that is used to individually control other functions.

B. AHJ: Authority Having Jurisdiction.

C. CAD: Computer-Aided Design.

D. Coded: Audible or visible signal that conveys information about alarm event. Examples are, number of rings of a bell or flashes of a strobe. This could be used to convey location or type of alarm.

E. dB: Decibels.

F. DXF: Drawing Interchange Format.

G. ECP: Environmental Control Panel.

H. FACP: Fire Alarm Control Panel.

I. HVAC: Heating, Ventilating, and Air Conditioning.

J. I/O: Input/Output.

K. IDC: Initiating Device Circuit.

L. LCD: Liquid Crystal Display.

M. LED: Light-Emitting Diode.

N. MOV: Metal Oxide Varistor.

O. NAC: Notification Appliance Circuit.

P. RAM: Random Access Memory.

Q. SLC: Signaling Line Circuit.

R. SOM: Sequence of Operations Matrix.

S. Zone: A defined area within the protected premises. A zone can define an area from which an alarm signal can be received or an area to which a signal can be sent. The term zone is typically used when describing conventional, nonaddressable systems.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Contract Drawings show the location of the fire alarm panel.
   a. Other Component Locations and Quantities: Determined by fire alarm system installer and included as part of installer's design.
   b. Other components include, but are not limited to, smoke detectors, heat detectors, manual pull stations, and notification appliances.
   c. Design and Installation: Meet requirements of local AHJ.
   d. Component locations and quantities of fire alarm devices shall be determined by a Professional Fire Protection Engineer registered in the state of Florida and shall be part of their design. This includes, but is not limited to, smoke detectors, heat detectors, manual pull stations and notification devices. Design and installation shall meet all requirements of the local authority having jurisdiction.
2. Design, coordinate, and provide system in accordance with building codes indicated in Section 01 61 00, Common Product Requirements.
3. Design conduit layout and wiring interconnection of devices specified herein.
4. Coordinate, and include in design, requirements for interfacing with HVAC system.
5. Equipment suitable for addressable fire alarm system.
6. Fire Alarm Control Panel and System: Listed for use.

B. Performance Requirements:

1. Actuation of alarm (smoke or heat detector, or other normally open initiating device contact) or trouble (trouble or supervisory switch) shall cause the following operations:
   a. Audible and visual indications of alarmed devices on fire alarm control panel display, and on remote annunciator.
   b. Closure of doors held open by electromagnetic devices.
   c. For remote buildings with subpanels, transmit common alarm or trouble signal to light appropriate zone lamp at master fire alarm control panel.

d. Master fire alarm control panel shall transmit common alarm or trouble signal to plant control panel.

2. Actuation of duct smoke detectors shall, send signal (contact closure) to environmental control panel (ECP) to shut off HVAC equipment and send a Supervisory Alarm to the fire control panel. Contact output to ECP shall be rated for no less than 5A, 250V ac.
3. Sequence of Operations Matrix located with the drawings describes functions of fire alarm system.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive product information for each individual system component.
2. Dimensional drawings of panels and associated equipment.
3. Itemized bill of material.
4. Operating and programming instructions.
5. Control panel configuration and module data.
6. Complete point to point wiring diagrams of system and device interconnection. Identify spare connection points.
7. Alarm initiating, indicating, and supervisory device electrical data.
8. Annunciator configuration and module data.
9. Plans showing device and panel locations as well as conduit and cable sizes. Prepare drawings and diagrams on drawing sheets of uniform size without extraneous information. Marked up electrical, HVAC, lighting or similar drawings or copies of catalog data sheets are not acceptable in lieu of required drawings or diagrams.
10. Sequence of Operation Matrix.
11. Battery sizing calculations.
12. Supervisory power requirements for equipment.
13. Alarm power requirements for equipment.
14. Power supply rating justification showing power requirements for system power supplies.
15. Voltage drop calculations for wiring runs, demonstrating worst case condition.
16. Conduit fill calculations.
17. Sample warranty.
18. Recommended types and quantities for spare parts.
19. For each system’s control panel, provide written schedule of active and spare addresses provided on each addressable circuit.
20. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Experience and qualifications of firm(s) proposed to design and install system.
2. Certifications documenting service technician's training. Certification shall indicate name of individual, training, dates, systems qualified, and current status.
3. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
4. Copy of design documents, Shop Drawings, and calculations submitted to code-enforcement authorities.
5. Code-enforcement authority approval letter.
6. Factory test reports.
7. Detailed program and schedule for testing, inspection, and maintenance of fire alarm system that satisfies requirements of NFPA 72, manufacturer's recommendations, and local authority having jurisdiction.
8. Documentation of system voltage, current, and resistance readings taken during installation, testing, and ATP phases of system installation.
9. System record drawings and wiring details including one set of reproducible masters and drawings in electronic file in a DXF format suitable for use in a CAD drafting program.
10. NFPA 72, Record of Completion: Submit to Owner and code-enforcement authorities.
11. NFPA 72, Inspection and Testing Form: Submit to Owner and code enforcement authorities.
12. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Provide names of projects, locations, and telephone numbers of persons to contact for at least two installations where Contractor or Subcontractor has installed detection and alarm systems that are similar in size and scope to the Work.
2. Licensed Firm Responsible for System Design, Installation and Testing: Document established reputation in fire alarm system industry having 10 years' experience in design, installation, and testing of fire alarm systems.
3. System Shop Drawings for code enforcement authority approval shall be prepared by a technician with minimum of NICET Level IV Certification for fire alarm systems, or a professional engineer registered in State of Florida.

4. Technician with minimum of NICET Level III Certification for fire alarm systems shall provide general supervision of project execution and shall perform final testing and certification of the system.
5. Technician with minimum of NICET Level II Certification for fire alarm systems shall directly supervise all onsite installation activities.
6. Service technician shall be formally trained by manufacturer.

B. Regulatory Requirements: Submit Shop Drawings and system design calculations for approval to the following code enforcement authorities.

1. Municipal/County Departments.
2. Fire Departments.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 1 year after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1.07 MAINTENANCE

A. Maintenance Service: For 2 years after Correction Period, provide maximum of two service calls, at Owner's request, to make adjustments or repairs required to keep system in satisfactory, full operation.

1.08 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and material:

Item	Quantity
Printer Paper	Quantity to cover 1 year of typical operation
Special tools required to maintain or dismantle	One complete set for each different size unit

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Siemens Building Technologies.
2. Simplex Grinnell.
3. Gamewell-FCI.
4. Notifier.
5. GE-EST.
6. Honeywell.

B. Notification appliances, initiating devices, and accessories of fire alarm systems specified in this section shall be products of:

1. Siemens Building Technologies.
2. Simplex Grinnell.
3. Gamewell-FCI.
4. Notifier.
5. GE-EST.
6. Honeywell.
7. Gentex.
8. System Sensor.
9. Wheelock.

2.02 GENERAL

A. Material and Equipment:

1. Standard products of their respective manufacturers.
2. Models produced for not less than 3 years.
3. Equipment: Supported by a service organization that is, in the opinion of Owner, reasonably convenient to Site.

B. Review details of Project prior to start of the Work, verify dimensions in field, and revise conduit and equipment locations to avoid obstructions and allow installation of new equipment.

C. Do not begin system installation prior to receiving written approval of Shop Drawings from Engineer.

2.03 UL COMPLIANCE

A. Products manufactured within scope of UL: Conform to UL Standards and have an applied UL listing mark.

B. Provide equipment UL listed in accordance with requirements of NFPA.

2.04 SERVICE CONDITIONS

A. Altitude: Not greater than 3,300 feet above sea level.

B. Ambient Temperature:

1. Maximum 40 degrees C.
2. Minimum 0 degrees C.

C. Provide equipment fully rated without derating for these conditions.

2.05 POSTED OPERATING INSTRUCTIONS (POI)

A. Prepare POIs on full size drawing sheets.

B. Provide POIs framed in extruded metal frames, mounted under glass, water-resistant, and weather-resistant. Permanently mount instructions on reserved wall area in space shown on Drawings.

C. POIs Include:

1. Facility floor plans showing location of fire equipment and devices with coordinated identification. Show items such as firewalls, fire dampers, and fire alarm devices.
2. Fire alarm wiring diagrams and schematics, with zone identification and device address list.

2.06 FIRE ALARM CONTROL PANELS

A. General:

1. Control panel circuit for 24V dc, power limited, initiating circuits in accordance with NFPA 70, Article 760.
2. Assembled panel UL 864 listed Product Category UOJ2, as an integrated control system.
3. Enclosure:
   a. NEMA 250 Type suitable for location installed.
   b. Color: Red.

4. Internally Mounted Module with:
    a. Transformer with 120V ac input and 21.5V ac output.
    b. Solid state rectifier for 21.5V ac input and fuse protected, filtered, and regulated 26V dc no-load output.
    c. Solid state transfer switch, minimum 8 amp-hours.
    d. Standby sealed, gelled electrolyte (lead acid) batteries sized for system operating period of 24 hours of standby and 5 minutes in alarm mode operation.
    e. Solid state battery charger.
    f. Over/under voltage monitor supervisory circuit.
    g. LEDs for status of normal power, battery trouble, and power supply module trouble.
    h. Alarm mode of 5 minutes after standby operation.
5. Local differentiating audible sound device for alarm, trouble, and supervisory conditions.
6. Full digital transmission protocol.
7. Addressable signal transmission protocol to be either digital pole/response protocol or proprietary communication protocol, with all antilog sensing device signals digitally transmitted to control panel.
8. Digital alarm communicator output circuitry for remote alarm control panel.
9. MOV/gas discharge transient protection for power supply module.
10. For addressable systems provide additional 20 percent capacity for future indicating and initiating devices.
11. EMI/RF Protection:
    a. Protect control equipment, devices, and wiring against unwanted radiated electro-magnetic interference (EMI) and from effects of audio and radio frequencies (RF) that can cause transmission of spurious alarms.
    b. Design system and install to be unaffected (with control cabinet faceplates installed) by operation of handheld, portable radios of up to 5 watts, or portable cellular telephones up to 1 watt, within 12 inches of system components.

2.07 INITIATING DEVICE

A. Pull Station, Fire:

1. Double-action station for general alarm.
2. Constructed of die-cast metal with baked red enamel finish weatherproof housing, and raised white letters stating “FIRE.”
3. Surface-mounted with hinged front cover having keyed or allen-wrench reset lock.
4. Where required, rated for use in hazardous environments.

5. Recessed pull handle for single action push plate and pull handle for double action operating station with plastic break rod.
6. Activated station pull handle, latched in protruding position until reset by key.
7. Stations keyed alike with fire alarm control panel.
8. Screw terminal for field connections.
9. Normally open, Double -pole contacts rated 3 amperes, 30V dc for resistive loads.
10. Manual Pull Station: Dip switch selectable address, and compatible with fire alarm control panel.

B. Heat Detector:

1. Combination rate-of-rise and fixed, Nonplug-intemperature elements with 57 degrees C trip setting, complete with addressable mounting base.
2. Nonrestorable fixed temperature elements and self-restoring rate-of-rise temperature elements.
3. Dangling disk indicator for activated fix temperature element and LED indicator for activated rate-of-rise temperature element.
4. Attach detector bases on surface mounted octagon boxes.
5. Double-screw terminals for supervised connection.
6. Normally open, single -pole contacts, rated 3 amperes, 30 V dc.
7. Provide remote LED alarm indicators for above ceiling mounted detectors.

C. Smoke Detector:

1. Photoelectric type with plug-in, twist-lock addressable base in accordance with UL 268.
2. Solid state circuitry, unipolar, single source, dual sensing chamber, suitable for device releasing service.
3. Concealed, field adjustable, sensitivity test switch.
4. LED; pulsed indication for power availability and steady indication for activated detectors.
5. Self-Compensating Circuitry:
   a. Voltage Range: 15V dc to 30V dc, 24V dc nominal.
   b. Temperature Range: 0 degree C to 38 degrees C.
   c. Operating Temperature Range: Minus 10 degrees C to 50 degrees C.
   d. Humidity Range: 0 percent to 95 percent relative humidity.

6. Normally open, single -pole contacts, rated 3 amperes, 30V dc for resistive loads.
7. Provide remote LED alarm indicators for above ceiling mounted detectors.
8. Detectors equipped with insect screen.
9. Photoelectric sensors adjusted to within 3 percent of UL 217 window obturation sensitivity value.

D. Air Duct Smoke Detector:

1. Duct mounted housing with prealigned sampling and exhaust tubes, analog sensing, solid state circuitry, and plug-in, twist-lock addressable base for photoelectric detector in accordance with UL 286A, NFPA 72, NFPA 90A, and NFPA 101.
2. Sampling tubes to extend full width of branch air return duct.
3. Self-Compensating Circuitry:
   a. Voltage Range: 15V dc to 30V dc, 24V dc nominal.
   b. Temperature Range: 0 degrees C to 38 degrees C.
   c. Humidity Range: 10 percent to 90 percent relative humidity.
   d. Velocity Range: 400 feet to 4,000 feet per minute.
4. Front mounted LED with pulsed indication for alarm condition.
5. Normally open, single-pole, double-throw auxiliary relay with 2 amperes, 28V dc rated contacts for resistive loads.

E. Detector Accessories: Remote test station and power-on indicator with LED alarm indicator and two-position, key-operated switch for air duct smoke detectors.

2.08 NOTIFICATION APPLIANCES

A. Combination Audible and Visual Alarm:

1. Audible/visible base housing with visual alarm and front mounted horn as specified.
2. Semi-flush mounting on recessed 4-gauge square electrical box or surface mounted on backbox with adapter.
3. Audibility: In accordance with NFPA 72 and local requirements.
4. Synchronous audible/visible output.

2.09 PRINTER

A. Features:

1. Automatic type; printing code, time, date, location, category, and condition.
2. Provide hard-copy printout of changes in status of system.

3. Time-stamp printouts with the current time-of-day and date.
4. Standard carriage with 80-characters per line.
5. Use standard pin-feed paper.
6. Enclosed in a separate cabinet suitable for placement on a desktop or table.
7. Able to communicate with control using an interface complying with TIA 232.
8. Power: 120V ac, 60-Hz.
9. Thermal printers are not acceptable.

B. System shall have strip printer capable of being mounted directly in main FACP enclosure. Print alarms in easy-to-read red, print other messages, such as trouble notification, in black. This printer shall receive power from system power supply and shall operate via battery back-up if AC mains are lost. Strip printer shall be UL 864 listed.

2.10 WIRING

A. AC power wiring shall meet requirements of Section 26 05 05, Conductors.

B. Low voltage wiring shall be solid copper or bunch tinned (bonded) stranded copper, minimum 14 AWG, and shall meet NEC Article 760 for nonpower limited service.

C. Network or addressable loop cables shall be as recommended by manufacturer for installation of their system and UL Listed for Fire Alarm Systems.

2.11 RACEWAYS

A. Conduit used for installation of Fire Alarm system shall follow requirements as identified in Section 26 05 33, Raceway and Boxes.

2.12 END-OF-LINE RESISTORS

A. Ohmic value and power rating as determined by manufacturer based upon number of circuit devices supplied and circuit configuration as installed.

B. Single-gang, stainless steel plate mounted in recessed box. Loose resistors at last device in circuit.

2.13 SURGE SUPPRESSORS

A. Transient Voltage Surge Suppressors (TVSS): In accordance with Section 26 43 00, Transient Voltage Suppression.

B. Transient Voltage Surge Suppressors (TVSS):

1. Provide to suppress voltage transients that might damage fire alarm panel/transmitter components. Unit shall wire in series to power supply of protected equipment with screw terminations.
2. Unit shall be UL 1449 listed with a 330-volt suppression level and have a maximum response time of 5 nanoseconds.
3. Unit shall meet IEEE C62.41 Category B tests for surge capacity.
4. Features:
   a. Multi-stage construction that includes inductors and silicon avalanche zener diodes.
   b. Long life indicator lamp (LED or neon lamp) which extinguishes upon failure of protection components. Fusing shall be externally accessible when this feature is available.
5. Manufacturer and Product: Edco of Florida, Ocala, FL; Model HSP-121BT2.

2.14 INTRINSICALLY SAFE MODULE

A. Fused, resistor/zener diode barrier module with output currents limited for NFPA 70, Class I, Class II, Class III, Division 1, Groups A, B, C, D, E, F, and G atmospheres.

B. Surface-mounted backbox with secured, full-hinged access door and baked red enamel finish.

PART 3 EXECUTION

3.01 GENERAL

A. Coordinate with other trades for mounting and interfacing with fire alarm system related devices.

B. Install control panels, initiating and alarm devices, conduit, and wiring for interconnection of devices specified herein for complete and operable system.

3.02 INSTALLATION

A. Install and connect fire detection and alarm equipment in accordance with manufacturer’s instructions and recommendations, and in accordance with applicable codes and standards.

B. Mount devices in accordance with manufacturer’s instructions.

C. Provide outlet and junction boxes that are compatible with raceway system.

D. Mount detector LEDs so they are readily visible from floor.

E. Arrange sampling tubes and duct detectors to monitor duct area and point of duct penetration sealed and reinsulated.

F. Program or configure panels and devices, as required to operate as defined by Sequence of Operations Matrix

G. Install conductors in accordance with Section 26 05 05, Conductors, and NFPA 70, Article 760.

H. Install initiating alarm, signal, and communication conductors in separate and independent raceway system.

I. Circuit wiring color-code, as established by installer, to be maintained throughout installation.

J. Size conductors in accordance with device manufacturer's recommendations. Increase AWG size of alarm conductors, if necessary, to maintain terminal voltage drop within acceptable level required by NEC and NFPA.

K. Do not install detectors until after construction cleanup is complete, in accordance with requirements of NFPA. If earlier installation is required by AHJ for protection during construction, clean or replace detectors installed prior to final clean-up.

L. Duct Smoke Detector: Furnish, wire, and connect to fire alarm system in accordance with this Specification. Install in accordance with Section 23 09 13, HVAC Controls, Field Components, and Instruments.

M. HVAC Equipment: Wire and connect fire alarm system to air handling system, smoke exhaust fan and smoke damper control circuits, and fan status contacts. Coordinate work with Section 23 09 00, Instrumentation and Control Devices for HVAC.

N. Suppression Sprinkler System: Wire and connect to fire alarm system to suppression sprinkler system.

3.03 CONDUIT, ELECTRICAL ENCLOSURES, TERMINAL CABINETS, PULL BOXES, AND BACKPLATES

A. Conduit Systems: Dedicated to fire alarm system and containing no unrelated conductors.

B. Fire Alarm System Conduits: Size and type specified under Section 26 05 33, Raceway and Boxes.

1. Conduit: As specified in Section 26 05 33, Raceway and Boxes.
    a. Flexible Metallic Conduit: Allowable for whips to devices only.
        1) Maximum Length: 6 feet.
        2) Minimum Diameter: 3/4-inch.
        3) Set screw type couplings or connectors are specifically prohibited.
2. Size conduits according to conductors contained therein.
3. Maximum Cross Sectional Area Percentage Fill for Fire Alarm System Conduits: 40 percent.

C. Route and install conduit to minimize potential for physical damage, either mechanical or by fire; avoid interference with existing building systems, facilities or equipment; and to facilitate service and minimize maintenance. Coordinate installation between different trades to avoid conflicts.

1. Solidly attach conduit to building structural members or permanent walls, except flexible conduit whips to devices. Do not attach conduit to existing conduit, ductwork, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, evacuation signaling, or auxiliary function devices.
2. Route conduit either parallel or perpendicular to building structural members.
3. Install conduit at a height to avoid obstructing any portion of a window, doorway cable tray, stairway, or passageway. Do not interfere with operation of existing mechanical or electrical equipment.
4. Locate conduit, junction boxes, pull boxes, terminal cabinets, electrical enclosures, and device backboxes to be readily accessible for inspection, testing, service, and maintenance.
5. Arrange conduit to minimize possibility of water in those conduits draining through control panels.
    a. Arrange conduit, except nipples between control panels, to enter control cabinets from below.
    b. Provide three 1/4-inch drain holes in conduit at horizontal low point beneath each control cabinet.
6. Provide bushings at termination of conduit, prior to wire installation.
7. Install junction boxes as necessary. Pull conductors through junction boxes, without splices.
8. Install pullboxes in each conduit at intervals not to exceed 100 feet.
9. Minimum Pullbox Size: 4-inch square, minimum.

10. Size device backboxes and junction boxes to accommodate number of conductors contained. Extension rings or extension boxes are prohibited.
11. Provide junction boxes, pull boxes, terminal cabinets, device backboxes, and raceways gasketed and weather-tight in accordance with requirements of Section 26 05 33, Raceway and Boxes.

D. Installation Requirements:

1. Conduit, Junction Boxes, Panels, Electrical Enclosures, Relays and Device Backboxes in Unfinished Areas: Exposed.
2. Conduit and Device Backboxes in Finished Areas: Concealed in walls, ceiling spaces, electrical shafts or closets, in finished areas, except as noted on Drawings.
3. Provide escutcheon plates on either side of the wall at exposed conduit wall penetrations.

E. Seal penetrations of walls, floors, and ceilings around conduit(s) in accordance with Section 07 92 00, Joint Sealants, restoring walls, floors, and ceilings to their original condition, fire resistance, and integrity.

F. Paint pull boxes, junction boxes, conduit bodies, and terminal cabinets “fire engine red” prior to installation. Provide touch-up painting, of normally visible pull boxes, junction boxes, and terminal cabinets prior to final acceptance testing.

G. Ground conduit by approved ground clamps, and in accordance with NEC requirements.

H. Mount end-of-line resistors on terminal blocks.

I. Install detection and alarm wire in separate conduits. Route outgoing and return conductors for each supervised circuit separately as required by NFPA 72.

J. Minimum Separation of Outgoing and Return Conduits: 1-foot vertically and 4 feet horizontally.

3.04 IDENTIFICATION

A. Paint junction, terminal, and pulling box covers red and identify with engraved labels by loop number and circuit that it contains.

B. Provide engraved alphanumeric identification for detection and terminal devices keyed to posted operations and maintenance instructions.

3.05 CONDUCTORS

A. Requirements apply to fire alarm system conductors, including all signaling line, initiating device, indicating appliance, releasing function, remote signaling, ac and dc power and grounding/shield drain circuits.

B. Conductors:

1. New; do not use wire that has scrapes, nicks, gouges or crushed insulation.
2. Install in conduit.
3. Continuous between devices and between devices and intermediary terminal cabinets.
4. Low voltage conductors shall be minimum size 14 AWG.
5. In accordance with requirements of NEC, Article 760 for power limited service.

C. Splices in conductors are specifically prohibited.

D. Types:

1. Conductors, Except AC Power Conductors and Grounding Conductors: Solid copper or bunch tinned (bonded) stranded copper.
2. Stranded copper conductors are acceptable for ac power conductors and grounding conductors only.

E. Terminations, including field connections to supervisory resistors, diodes, relays or other devices shall be to numbered terminals or terminal strips and readily accessible for inspection, service, testing and maintenance.

1. Terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other suitable metal enclosures.
2. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.
3. Uniquely number each conductor termination with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. Show conductor numbers on Contractor’s Record Drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of conductor terminations.
4. Wire nuts are prohibited.
5. Where pigtail devices are factory provided with wires too short to be connected to terminal strips (such as, solenoids), provide soldered and taped connections.

F. Control Panel Wiring:

1. Fully dressed and bundled with nylon tie wraps at 3-inch intervals.
2. Route bundled wiring parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections.
3. Bundle AC power conductors and route separately from low voltage conductors. Maintain a minimum 2-inch separation between AC power conductors and low voltage conductors wherever possible.
4. Size control cabinets to accommodate the requirements of this section.
5. Do not use control panels as raceways. Do not route conductors that do not terminate within a control panel through that control panel.

G. Separate conductors into the following categories:

1. Low voltage circuits that serve devices.
2. AC power circuits.

H. Install each category of conductors in physically separated, dedicated conduits, and isolate each category except at common associated control equipment. Further segregate conductors as necessary to conform to fire alarm system manufacturer's recommendations and as necessary to prevent electrical crosstalk between conductors installed in common conduits.

I. Wiring: THHN or TFFN stranded. Use of multi-conductor twisted pair or similar wiring is not permitted.

J. Install as power limited circuits in accordance with NFPA 72, and NEC, Article 760.

K. Conductors looped around terminals are prohibited.

L. Wire nut splices are prohibited.

M. T-tapping of circuits is prohibited.

N. Circuits shall be megger tested to voltage rating of their insulation before final terminations are made.

3.06 OVERVOLTAGE AND SURGE PROTECTION

A. Install TVSS for fire alarm control panel in accordance with manufacturer's requirements.

3.07 REPAIR/RESTORATION

A. Touchup scratches, mars, and dents, incurred during shipment or installation of equipment.

B. If required because of extensive damage, as determined by Engineer, refinish entire assembly.

C. Keep covers on smoke detectors until areas have been thoroughly cleaned.

3.08 TESTS AND INSPECTION

A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup, and NFPA 72.

B. Demonstrate entire system meets performance requirements specified in paragraph System Description.

C. Perform tests in presence of code-enforcement authorities, Owner or Owner's Representative.

D. Individually field test each smoke detector prior to installing device at its designated location to confirm operating condition after shipping and storage. Maintain a dated log indicating system address, type of device, sensitivity and initials of technician performing test, using test equipment specifically designed for that purpose, and submit as part of final acceptance documentation. After testing detection devices, base shall be labeled with system address, date, and initials of installing technician. Labeling shall not be visible after installation is complete.

E. Test wiring runs for continuity, short circuits, and grounds before system is energized. Take resistance, current, and voltage readings as work progresses and document results.

1. Maintain a systematic record of all readings using schedules or charts of tests and measurements. Include readings, dates, and witnesses on the logging form.
2. Notify Fire Marshal and Owner before start of any required tests. Correct items found at variance with Drawings or Specification during testing or inspection.
3. Deliver test reports to Fire Marshal and Owner as completed.

F. Prepare final as-built Sequence of Operations Matrix (See Supplement at End of Section) referencing each alarm input to every output function affected as a result of an alarm, trouble, or supervisory condition on that. For outputs programmed using more complex logic functions involving “any”, “or”, “not”, “count”, “time”, and “timer” statements; reflect complete output equation in matrix.

G. Prepare complete listing of device labels for alphanumeric annunciator displays and logging printers prior to acceptance test.

1. Test system wiring to demonstrate correct system response and correct subsequent system operation in event of:
   a. Open, shorted, and grounded intelligent analog signaling line circuit.
   b. Open, shorted, and grounded network signaling line circuit.
   c. Open, shorted, and grounded conventional initiating device circuits.
   d. Primary power or battery disconnected.
2. Demonstrate system evacuation alarm indicating appliances as follows:
   a. Alarm notification appliances actuate as programmed.
   b. Audibility and visibility at required levels.
3. System indications shall be demonstrated as follows:
   a. Correct message display for each alarm input, at control panel, each remote alphanumeric LCD display.
   b. Correct annunciator light for each alarm input, at each annunciator and color graphic terminal.
   c. Correct printer logging for system activity.
4. Demonstrate system onsite and offsite reporting functions as follows:
   a. Correct alarm custom message display, address, device type, date and time transmitted, for each alarm input.
   b. Correct trouble custom message display, address, device type, date and time transmitted, for each alarm input.
   c. Trouble signals received for disconnect.
5. Demonstrate secondary power capabilities as follows:
   a. Disconnect system primary power for a period of time as specified herein; at end of period, confirm alarm condition shall be created and system performance as specified for required duration.
   b. Restore system primary power for 48 hours and confirm that system-charging current is normal trickle charge for fully charged battery bank.
   c. Check system battery voltages and charging currents at fire alarm control panel using test codes and LCD displays.

H. If system fails to perform as specified and programmed during acceptance test, test will be terminated at discretion of acceptance inspector.

1. Retest system, correcting deficiencies and providing test documentation to acceptance inspector.
2. If software changes are required during acceptance test, provide a utility program to compare edited program with original and furnish a printed list of changes and the system functions, inputs, and outputs affected by changes. Retest items listed as changed before resuming acceptance test. Submit printed list and log of successful retesting of changed elements before scheduling completion of acceptance test.
3. Acceptance inspector may elect to require complete acceptance test to be performed again if, in their opinion, modifications to system hardware or software warrant complete retesting.

I. Upon completion of tests, complete and provide the following:

1. NFPA 72, Record of Completion, and Inspection and Testing Form.
2. Certification that final system meets UL.

3.09 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional and performance testing.
3. 1 person-day for prestartup classroom or site training.

3.10 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Sequence of Operations Matrix.

END OF SECTION

SEQUENCE OF OPERATIONS MATRIX

SYSTEM OUTPUTS

	FACP ANNUNCIATION											NOTIFICATION											FIRE SAFETY			
SYSTEM INPUTS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1																										
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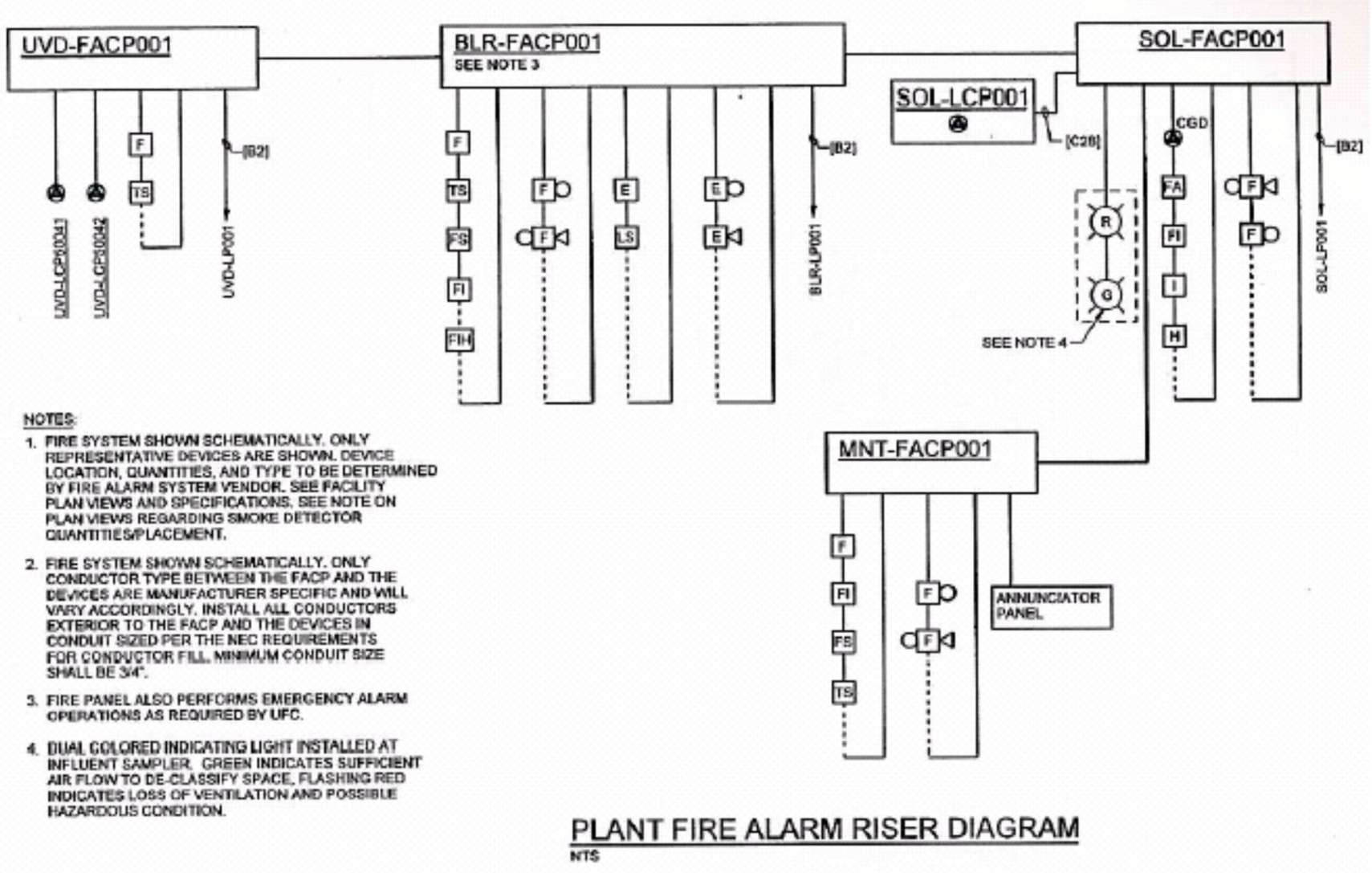

NOTES:

1. FIRE SYSTEM SHOWN SCHEMATICALLY. ONLY REPRESENTATIVE DEVICES ARE SHOWN. DEVICE LOCATION, QUANTITIES, AND TYPE TO BE DETERMINED BY FIRE ALARM SYSTEM VENDOR. SEE FACILITY PLAN VIEWS AND SPECIFICATIONS. SEE NOTE ON PLAN VIEWS REGARDING SMOKE DETECTOR QUANTITIES/PLACEMENT.
2. FIRE SYSTEM SHOWN SCHEMATICALLY. ONLY CONDUCTOR TYPE BETWEEN THE FACP AND THE DEVICES ARE MANUFACTURER SPECIFIC AND WILL VARY ACCORDINGLY. INSTALL ALL CONDUCTORS EXTERIOR TO THE FACP AND THE DEVICES IN CONDUIT SIZED PER THE NEC REQUIREMENTS FOR CONDUCTOR FILL. MINIMUM CONDUIT SIZE SHALL BE 3/4".
3. FIRE PANEL ALSO PERFORMS EMERGENCY ALARM OPERATIONS AS REQUIRED BY UFC.
4. DUAL COLORED INDICATING LIGHT INSTALLED AT INFLUENT SAMPLER. GREEN INDICATES SUFFICIENT AIR FLOW TO DE-CLASSIFY SPACE. FLASHING RED INDICATES LOSS OF VENTILATION AND POSSIBLE HAZARDOUS CONDITION.

PLANT FIRE ALARM RISER DIAGRAM

NTS

SEQUENCE OF OPERATIONS
FACP00X FIRE AND EMERGENCY ALARM SYSTEM

SYSTEM OUTPUTS

SYSTEM INPUTS	FACP ANNUNCIATION							NOTIFICATION					
	A ACTUATE COMMON ALARM INDICATOR	B ACTUATE AUDIBLE ALARM SIGNAL	C ACTUATE COMMON SUPV SIGNAL INDIC.	D ACTUATE AUDIBLE SUPERVISORY SIGNAL	E ACTUATE COMMON TROUBLE SIGNAL INDIC.	F ACTUATE AUDIBLE COMMON TROUBLE SIGNAL	G TEXT DISPLAY OF DEVICE LOCATION AND DESCRIPTION	H ACTUATE BLDG EVACUATION SIGNAL	I ACTUATE BLDG EMERGENCY EVACUATION SIGNAL	J TRANSMIT DESCRIPTION OF FIRE ALARM SIGNAL TO FACP001	K TRANSMIT DESCRIPTION OF SUPERVISORY SIGNAL TO FACP001	L TRANSMIT DESCRIPTION OF TROUBLE SIGNAL TO FACP001	M TRANSMIT DESCRIPTION OF EMERGENCY ALARM TO FACP001
1 MANUAL PULL STATION	X	X					X	X		X			
2 SMOKE DET ELECTRICAL ROOM	X	X					X	X		X			
3 SMOKE DETECTOR CHEMICAL STORAGE	X	X					X	X		X			
4 WATERFLOW SWITCH	X	X					X	X		X			
5 SPRINKLER CONTROL VALVE			X	X			X				X		
6 EMERGENCY MANUAL PULL STATION		X					X		X				X
7 CHEMICAL CONTAINMENT FLOAT (LS)		X					X		X				X
8 FACP AC POWER FAILURE			X	X							X		
9 FACP SYSTEM SILENCE			X								X		
10 FACP SYSTEM LOW BATTERY					X	X						X	
11 OPEN CIRCUIT					X	X						X	
12 GROUND FAULT					X	X						X	
13 NOTIFICATION APPLIANCE SHORT CIRCUIT					X	X						X	

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Stripping: Removal of topsoil remaining after applicable clearing and grubbing is completed.

E. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 2.0 acres.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation 5 feet beyond top of cut slopes.
2. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping: 2 feet beyond toe of permanent fill.
3. Structures: 5 feet outside of new structures.
4. Roadways: Clearing and grubbing, and stripping 5 feet from centerline.
5. Overhead Utilities:
   a. Clearing and Grubbing: Entire width of easements and rights-of-way.
   b. Stripping: Wherever grading is required.
6. Other Areas: As shown on Drawings.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing flush with ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

A. Grub areas within limits shown or specified or designated by Engineer

3.05 STRIPPING

A. Do not remove topsoil until after clearing and grubbing is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stockpile strippings separately from other excavated material.

3.06 TREE REMOVAL OUTSIDE CLEARING LIMITS

A. Remove Within Project Limits: Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.

B. Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.07 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite in accordance with local and state regulations.
2. When onsite burning is not prohibited by federal, state, or local authorities, debris may be burned onsite. Control burning to prevent fire from spreading.
3. During periods when burning is prohibited by federal, state, or local authorities, debris may be stockpiled until burning ban is rescinded, provided stockpiled material does not constitute a fire hazard or interfere with or delay Work. Stockpiled material shall not remain onsite in excess of 30 days.
4. Dispose of unburned and noncombustible debris offsite.
5. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
6. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM): D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Subgrade: Layer of existing soil after completion of clearing, grubbing, roadway structure or base for floor slab or foundations.

E. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

F. FDOT Specifications: Florida Department of Transportation, Standard Specifications for Road and Bridge Construction, latest edition.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 10 00, Site Clearing and Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under Earthfill: Compact upper 12 inches to minimum of 90 percent relative compaction as determined in accordance with ASTM D1557.

B. Under Pavement Structure, Floor Slabs, or Granular Fill Under Structures: Proof roll the subgrade with at least 15 overlapping passes using a vibratory roller having a minimum dynamic force of 10 tons. After proof rolling, compact the upper 12 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

C. Compaction under asphalt and concrete roadways shall be in accordance with Section 160, Stabilizing, and Section 911, Limerock Material for Base and Stabilized Base, of the FDOT Specifications.

3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material to Optimum Moisture Content uniformly throughout by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. The Contractor shall retain an independent soil testing company to determine in-place density and moisture content.

B. One test per every 3,000 square feet on every lift of subgrade; or one test per lift, whichever requires more tests.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact, or
2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill. Dispose unsuitable material off site.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

B. Monitor potential adverse impacts on adjacent facilities and completed work.

1.02 WEATHER LIMITATIONS

A. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.03 SEQUENCING AND SCHEDULING

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

B. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.

C. Excavation Safety: The Contractor shall be solely responsible for making all excavations in a safe manner. Provide appropriate measures to retain excavation side slopes to ensure that persons working in or near the excavation are protected.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Engineer.

C. Conduct excavation in accordance with OSHA Standards 29CFR Part 1926.650 Subpart P. Trenching and Excavation regulations and requirements.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 STRUCTURAL OVER-EXCAVATION

A. Over-excavate beneath the proposed Dewatering building to a depth of 5 feet below the existing ground elevation or to a depth indicated by Engineer, whichever is deeper. The bottoms of the over-excavation area shall be 5 feet beyond the perimeter of the structure's footprint.

B. The over-excavated organic material shall not be reused for backfill.

C. Compact the bottom of the excavation as specified in Section 31 23 13, Subgrade Preparation.

D. Bottom of over-excavation shall be inspected by a geotechnical engineer.

E. Backfill over-excavation as specified in Section 31 23 23, Fill and Backfill.

3.04 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Four-Inch and Greater Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between them, as shown on Drawings.

3.05 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.06 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.07 DISPOSAL OF SPOIL

A. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM 1557 to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, stripping of topsoil, excavation to grade, and subgrade preparation.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Lift: Loose (uncompacted) layer of material.

F. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

G. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1-foot outside outermost edge at base of foundations or slabs.
2. 1-foot outside outermost edge at surface of roadways or shoulder.
3. 0.5-foot outside exterior at spring line of pipes or culverts.

H. Imported Material: Materials obtained from sources offsite, suitable for specified use.

I. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

J. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

1.02 SUBMITTALS

A. Information Submittals: Certified test results from independent testing agency.

1.03 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.04 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 31 10 00, Site Preparation; 31 23 16, Excavation, and 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-In-Place Concrete. Obtain Engineer’s acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-In-Place Concrete.

D. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests: By Contractor's testing laboratory, as necessary to locate acceptable sources of imported material.

2.02 EARTHFILL

A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 GRANULAR FILL

A. One-inch minus crushed rock or sand.

B. Free from dirt, clay balls, and organic material. Free from organic material shall be interpreted as less than or equal to 2.5 percent organic material by weight and containing no roots with caliper greater then 1/2 inch.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.04 WATER FOR MOISTURE CONDITIONING

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

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure even.

D. If Pipe, Conduit, Duct Bank, or Cable is to be Laid within Fill or Backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this Section.

E. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

F. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Within influence area beneath structures, slabs, pavements, curbs, trenches for piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

B. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.

3.03 EARTHFILL

A. Outside influence areas and not beneath structures, pavements, curbs, slabs, piping, and other facilities: Unless otherwise shown, place earthfill as follows:

1. Allow for 4-inch thickness of topsoil where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of embankment.

4. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

A. Gradation:

1. One sample from each 100 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications. A minimum of two tests shall be conducted
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. Granular Fill and Earthfill: One test for every 3,000 square feet of each lift; or one test per lift, whichever requires more tests.

3.05 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Granular fill.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
   a. Unauthorized Overexcavation: Granular fill.
   b. Authorized Overexcavation: Granular fill.

5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
    a. Flat to Moderate Steep Slopes (3 to 1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
    b. Steep Slopes (Steeper than 3 to 1):
        1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
        2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.06 SUPPLEMENTS

A. The supplement listed below, following "End of Section", is part of this specification.

1. Geotech Report.

END OF SECTION

Geotech Report

Since 1976 | Geotechnical Engineering | Construction Materials Testing | Drilling Services

Summary | Project Info | Earthwork | Foundation | Borings | Lab | Appendix

Crestview WWTP Dewatering Building and Digesters #3 and #4

Crestview, Florida

LMJ File #: 21-157E

March 26, 2021

Prepared for

Jacobs

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Prepared by

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Florida Certificate of Authorization #2184

Keith V. Jacobs, PE

Principal Engineer

FL Reg. #66577

KEITH VICTOR JACOBS LICENSE No 66577 STATE OF FLORIDA PROFESSIONAL ENGINEER

This document has been electronically signed and sealed by Keith V. Jacobs (license # 66577) on March 26, 2021. Printed copies of this document are not considered signed and sealed, and the signature must be verified on any electronic copies.

Subsurface Conditions

- The borings encountered slightly silty sand in the upper 4-8 feet over layers of silty and slightly silty sand to 18-28 feet where these soils continued but were interbedded with sand and clayey silty sand layers to the bottom of the deeper borings at 41-61 feet.
- The soils were generally loose in the upper 13-18 feet and medium dense to the bottom of the borings at 16-61 feet with a dense zone around 55 feet in both of the deeper borings.
- A very loose zone was encountered in borings B-2 and B-8 from 2-4 and 4-6 feet respectively, and the soils in the upper 2 feet of the borings were loose and medium dense.
- Groundwater was estimated (due to drilling with mud) at 45 feet below grade at the time of drilling, and the 40-foot samples were all dry.
- Groundwater levels will vary with the amount of local rainfall and changes in site drainage characteristics and may be different at other times.

General Comments and Recommendations

- The soils encountered in the borings are suitable for supporting the proposed dewatering building on footings/thickened slabs if the recommendations in this report are followed.
- The upper loose and very loose soils are a settlement concern for the dewatering building.
- Proper compaction of the soils beneath the slab and footings will be critical to keeping settlement at normal levels.
- The borings encountered upper well-draining slightly silty sand soils that are fairly easy to work with and compact but will require ample moisture to achieve compaction.
- Excavated native soils can be used as fill in the building and tank areas.
- The conditions encountered in the digester tank borings are suitable for support of the proposed concrete tanks if the recommendations in this report are followed.

Note: The above summary is an overview of the report and should not be used by itself for planning, design, and/or construction. See the relevant sections for further details.

Existing Site Information

The site is the Crestview WWTP located at 5101 Arena Road in Crestview, Florida. At the time of drilling, the proposed building and tank areas were relatively level and grassed. The dewatering building is planned at the northwest end of the site north of the administration building. The ground elevation in the proposed dewatering building area is roughly 232-233 feet based on previous survey data.

The proposed digesters are planned at the northeast end of the site north of existing sludge drying beds and east of two existing digester tanks. Google Earth® historical imagery indicates that the proposed digester tank areas were previously occupied by rectangular digester tanks that have reportedly been completely removed. The elevation in the proposed tank areas slopes from the west at 228 feet down to the east at 225 feet based on previous survey data.

Proposed Construction

We understand the project includes the construction of a dewatering building and two concrete digester tanks. The proposed dewatering building is planned to be a 77x51-foot single-story pre-engineered metal building with an open area for an unloading drive-thru on the north side and a belt press on the south side. The provided plans indicate that the belt press is planned to be supported on a 16-inch reinforced slab with a thickened slab beneath interior columns and four spread footings planned along the south edge of the building beneath the slab. The open portion of the building is planned to be supported on an 8-inch reinforced slab with a thickened edge for the north columns. We understand that the maximum soil pressure for the dewatering building is roughly 1,000 psf.

The concrete digester tanks are planned to be CROM type tanks 60 feet in diameter. The digesters are planned to have a top-of-wall elevation of 242.3 feet and a top-of-slab elevation of 226.5 feet at the edge and 226.7 feet at the low-point. A sump is planned at the center of each tank with a top-of-slab elevation of 222.9 feet. We understand that the tanks have a planned side water depth of 12 feet, and the bearing pressure generated by each tank is roughly 900 psf.

Subsurface Exploration

Our subsurface exploration included eight SPT borings: one 61-foot and two 41-foot borings for each digester and two 21-foot borings for the dewatering building. The borings were drilled using a truck mounted drill rig and were advanced between sampling using solid-stem flight auger in the upper 30-40 feet and a mud jetting technique to the bottom of the borings at 41-61 feet. The subsurface conditions encountered in the borings can be found on the boring logs here.

The above information is the basis of our recommendations. If the information in this section changes or is incorrect, our office should be notified, and changes to our report may be needed.

Site Preparation

- The building and tank areas should be cleared and stripped of all vegetation, major roots, topsoil, and any other deleterious materials.
- Stripped vegetation, topsoil, and organic materials should be hauled offsite, or suitable topsoil could be stockpiled for use in landscaped areas after final grading.
- Any slabs, piping, etc. associated with the previous digester tanks should be completely removed from the proposed digester tank areas.
- After stripping, the top of subgrade in the building and tank areas should be compacted to the requirements in the tables below for a minimum depth of 12 inches.

Fill Material

- Fill material should be the soil types listed in the following table. Excavated native soils can be used as fill in the building and tank areas.
- All fill should be free of organic or deleterious materials and non-plastic.
- Samples of any imported fill material should be submitted to the geotechnical engineer for testing and evaluation prior to shipment to the site.

Fill Recommendations

Material Type	Lift Thickness (in)		Equipment Type	
	Large Equipment	Hand Operated Equipment	Large	Hand Operated
Slightly Silty Sand	10-12	6	Roller (non-vibratory)	Plate Tamper
Silty/Clayey Sand	6-8	4	Rubber Tire or Roller	Jumping Jack

Compaction

- Fill material should be moisture conditioned to within 2% of its optimum moisture content prior to compaction.
- The borings encountered upper well-draining slightly silty sand soils that are fairly easy to work with and compact but will require ample moisture to achieve compaction.
- Note that it is best to add water to dry soils before compaction operations.
- Fill should be compacted to the requirements in the following table. Compaction under structures should extend 5 feet beyond edges where practical.
- We *do not* recommend using a large vibratory roller for this project because the proposed building and tanks are very close to existing buildings/tanks (10-20 feet), and vibratory compaction could cause damage to these existing structures.

Compaction Recommendations

Site Element	Minimum Compaction (ASTM D1557)	Minimum Compaction Testing Frequency Per Lift
Top of Subgrade and Fill under Structures	95%	1 per 2,500 square feet
Utility Trench Backfill	95%	1 per 75 linear feet
Bottom of Footings (12 inches minimum)	95%	1 per 75 linear feet for continuous footings and ½ of the column footings

- Backfill for utility excavations or any excavations in the building and tank areas should be compacted per the above tables.
- Soils immediately beneath all structures, slabs-on-grade, and footings should be compacted to the requirements in the above table for a minimum depth of 12 inches.
- The bottom of all utility excavations should be evaluated by LMJ staff prior to the placement of utilities. Loose soils would need to be compacted per the above table or removed and replaced with compactable fill.

Dewatering Building Footing Recommendations

- The soils encountered in the borings are suitable for supporting the proposed dewatering building on footings/thickened slabs if the recommendations in this report are followed.
- The upper loose and very loose soils are a settlement concern for the dewatering building.
- Proper compaction of the soils beneath the slab and footings will be critical to keeping settlement at normal levels.
- The soils immediately beneath the bottom of all footings/thickened slabs should be compacted for a minimum depth of 12 inches to a minimum of 95% of the Modified Proctor Test (ASTM D1557) density.
- We recommend using the largest plate tamper that will fit in the footing excavation with a minimum width of 2 feet and minimum weight of 300 lb.
- Footings that are prepared in accordance with this report can be designed based on the parameters in the following table.

Footing Design Parameters

Minimum Width (in)	Minimum Embedment Depth (in)	Net Allowable Bearing Pressure (psf)	Estimated Settlement (in)	
			Total	Differential
18	18	1,000	1 or less	½ or less

- The estimated settlement is from the sand soils immediately beneath the footings.
- Settlement is expected to occur during construction or soon after initial loading.

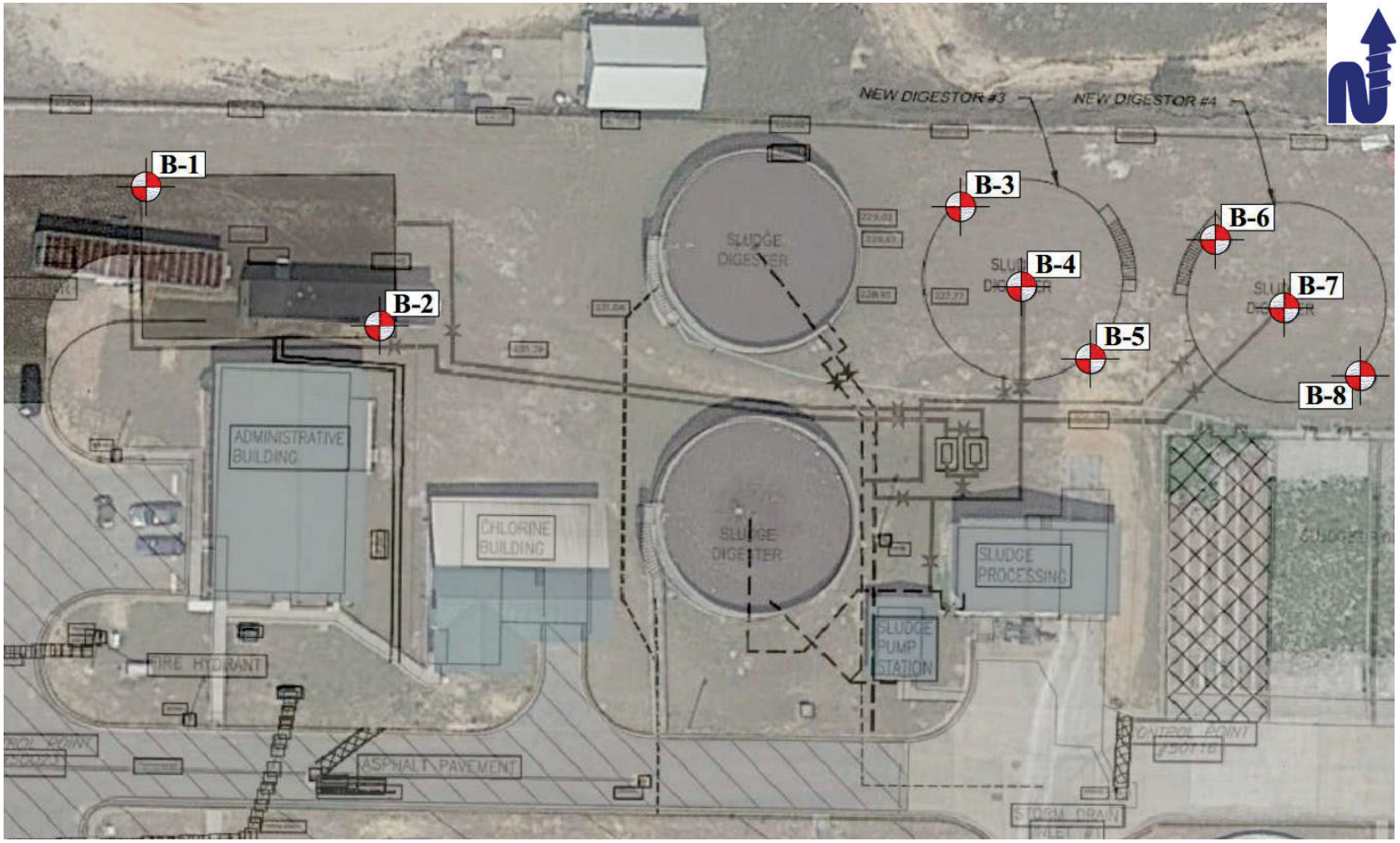
Digester Tank Estimated Settlement

- The conditions encountered in the digester tank borings are suitable for support of the proposed concrete tanks if the recommendations in this report are followed.
- We calculated settlement of the digester tanks using the results of our borings, the anticipated tank loading (900 psf), and the Schmertmann and Hartman (1978) method.
- Assuming the tank pad/slab is prepared in accordance with this report, we estimate maximum settlement of the tanks to be roughly **1-inch** at the center of the tanks.
- Maximum differential settlement between the center and edge of the tank is estimated to be roughly **⅔-inch**.
- This settlement is expected to occur during construction or soon after initial loading.

Footing/Slab Testing and Observations

- Footing/thickened slab excavations and the tank pad should be evaluated by the geotechnical engineer or authorized representative prior to steel or concrete placement.
- Compaction of soils immediately beneath footings/thickened slabs and the tank slab should be verified using in-place nuclear density testing.
- We recommend testing footing/thickened slab compaction at a minimum frequency of one test per 75 linear feet for continuous footings and one test on half of the column footings.
- We recommend running a minimum of 3 density tests for each tank slab.

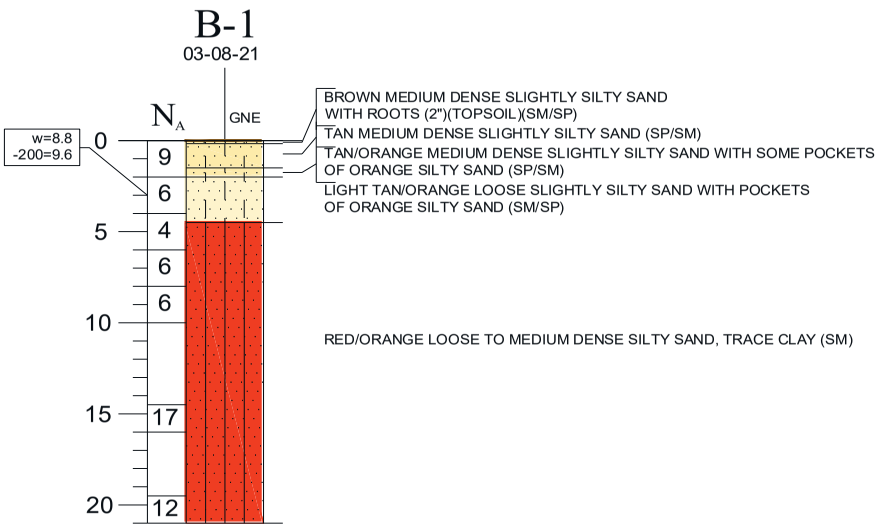
Boring Locations

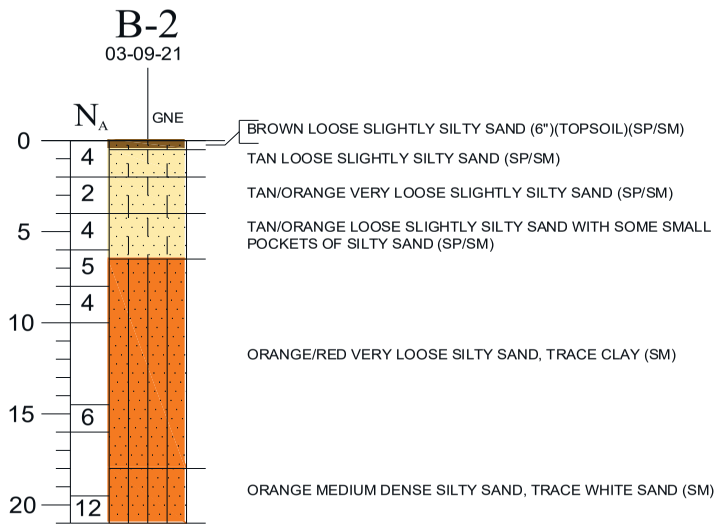


STANDARD PENETRATION TEST BORING

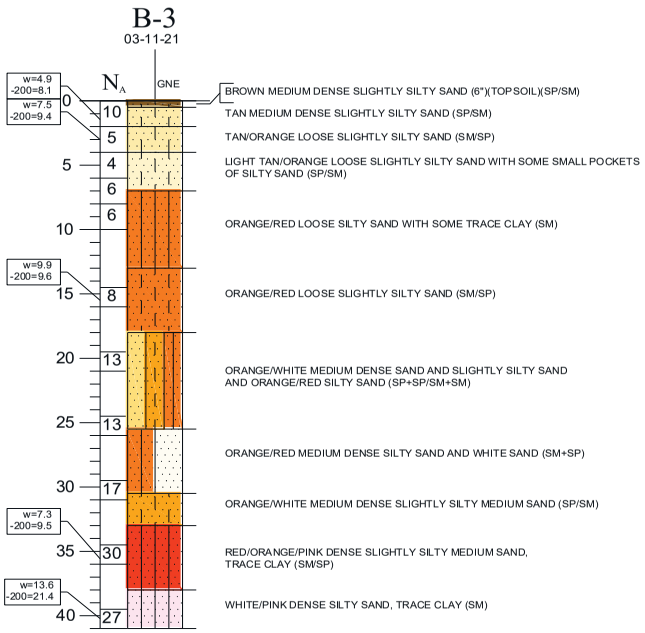
ALL BORING LOCATIONS ARE APPROXIMATE

Borings


B-1
03-08-21
N_A
GNE
w=8.8
-200=9.6
0
5
10
15
20
9
6
4
6
6
17
12
BROWN MEDIUM DENSE SLIGHTLY SILTY SAND WITH ROOTS (2")(TOPSOIL)(SM/SP)
TAN MEDIUM DENSE SLIGHTLY SILTY SAND (SP/SM)
TAN/ORANGE MEDIUM DENSE SLIGHTLY SILTY SAND WITH SOME POCKETS OF ORANGE SILTY SAND (SP/SM)
LIGHT TAN/ORANGE LOOSE SLIGHTLY SILTY SAND WITH POCKETS OF ORANGE SILTY SAND (SM/SP)
RED/ORANGE LOOSE TO MEDIUM DENSE SILTY SAND, TRACE CLAY (SM)


B-2
03-09-21
N_A
GNE
0
5
10
15
20
4
2
4
5
4
6
12
BROWN LOOSE SLIGHTLY SILTY SAND (6")(TOPSOIL)(SP/SM)
TAN LOOSE SLIGHTLY SILTY SAND (SP/SM)
TAN/ORANGE VERY LOOSE SLIGHTLY SILTY SAND (SP/SM)
TAN/ORANGE LOOSE SLIGHTLY SILTY SAND WITH SOME SMALL POCKETS OF SILTY SAND (SP/SM)
ORANGE/RED VERY LOOSE SILTY SAND, TRACE CLAY (SM)
ORANGE MEDIUM DENSE SILTY SAND, TRACE WHITE SAND (SM)

Borings


B-3
03-11-21
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GNE
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-200=9.6
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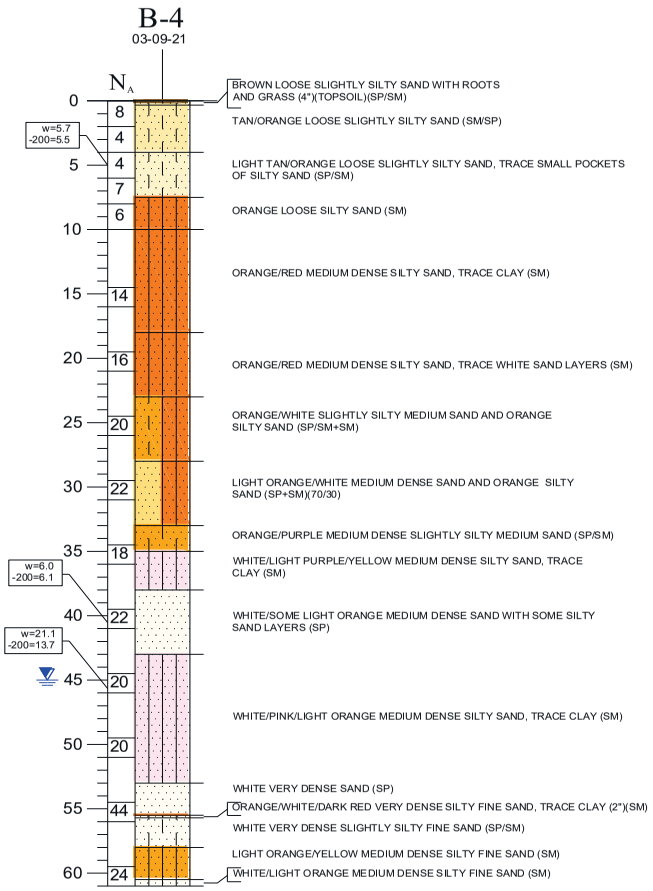
-200=9.5
w=13.6
-200=21.4
0
5
10
15
20
25
30
35
40
10
5
4
6
6
8
13
13
17
30
27
BROWN MEDIUM DENSE SLIGHTLY SILTY SAND (6")(TOPSOIL)(SP/SM)
TAN MEDIUM DENSE SLIGHTLY SILTY SAND (SP/SM)
TAN/ORANGE LOOSE SLIGHTLY SILTY SAND (SM/SP)
LIGHT TAN/ORANGE LOOSE SLIGHTLY SILTY SAND WITH SOME SMALL POCKETS OF SILTY SAND (SP/SM)
ORANGE/RED LOOSE SILTY SAND WITH SOME TRACE CLAY (SM)
ORANGE/RED LOOSE SLIGHTLY SILTY SAND (SM/SP)
ORANGE/WHITE MEDIUM DENSE SAND AND SLIGHTLY SILTY SAND AND ORANGE/RED SILTY SAND (SP+SP/SM+SM)
ORANGE/RED MEDIUM DENSE SILTY SAND AND WHITE SAND (SM+SP)
ORANGE/WHITE MEDIUM DENSE SLIGHTLY SILTY MEDIUM SAND (SP/SM)
RED/ORANGE/PINK DENSE SLIGHTLY SILTY MEDIUM SAND, TRACE CLAY (SM/SP)
WHITE/PINK DENSE SILTY SAND, TRACE CLAY (SM)


B-4
03-09-21
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-200=6.1
w=21.1
-200=13.7
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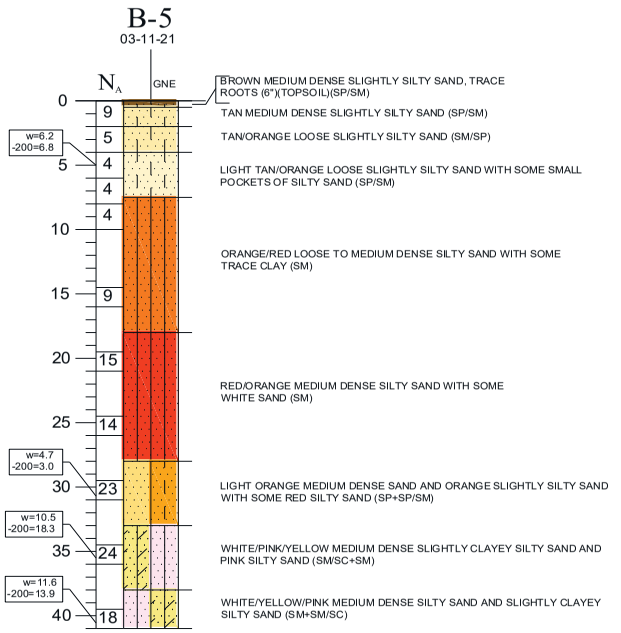
5
10
15
20
25
30
35
40
45
50
55
60
8
4
4
7
6
14
16
20
22
18
22
20
20
44
24
BROWN LOOSE SLIGHTLY SILTY SAND WITH ROOTS AND GRASS (4")(TOPSOIL)(SP/SM)
TAN/ORANGE LOOSE SLIGHTLY SILTY SAND (SM/SP)
LIGHT TAN/ORANGE LOOSE SLIGHTLY SILTY SAND, TRACE SMALL POCKETS OF SILTY SAND (SP/SM)
ORANGE LOOSE SILTY SAND (SM)
ORANGE/RED MEDIUM DENSE SILTY SAND, TRACE CLAY (SM)
ORANGE/RED MEDIUM DENSE SILTY SAND, TRACE WHITE SAND LAYERS (SM)
ORANGE/WHITE SLIGHTLY SILTY MEDIUM SAND AND ORANGE SILTY SAND (SP/SM+SM)
LIGHT ORANGE/WHITE MEDIUM DENSE SAND AND ORANGE SILTY SAND (SP+SM)(70/30)
ORANGE/PURPLE MEDIUM DENSE SLIGHTLY SILTY MEDIUM SAND (SP/SM)
WHITE/LIGHT PURPLE/YELLOW MEDIUM DENSE SILTY SAND, TRACE CLAY (SM)
WHITE/SOME LIGHT ORANGE MEDIUM DENSE SAND WITH SOME SILTY SAND LAYERS (SP)
WHITE/PINK/LIGHT ORANGE MEDIUM DENSE SILTY SAND, TRACE CLAY (SM)
WHITE VERY DENSE SAND (SP)
ORANGE/WHITE/DARK RED VERY DENSE SILTY FINE SAND, TRACE CLAY (2")(SM)
WHITE VERY DENSE SLIGHTLY SILTY FINE SAND (SP/SM)
LIGHT ORANGE/YELLOW MEDIUM DENSE SILTY FINE SAND (SM)
WHITE/LIGHT ORANGE MEDIUM DENSE SILTY FINE SAND (SM)


B-5
03-11-21
N_A
GNE
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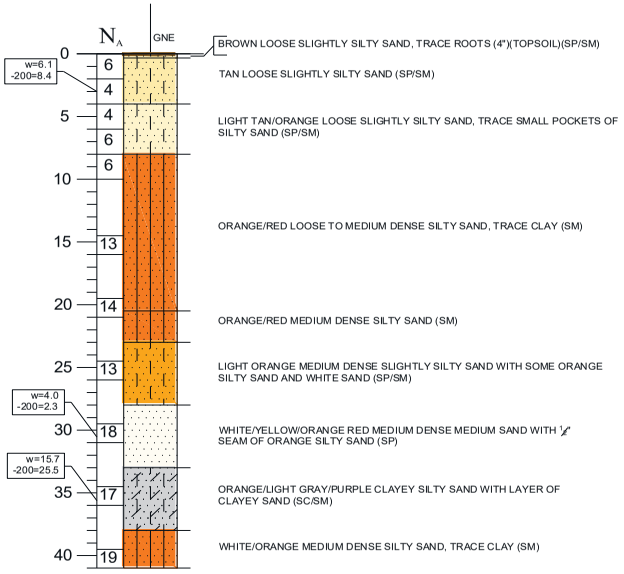
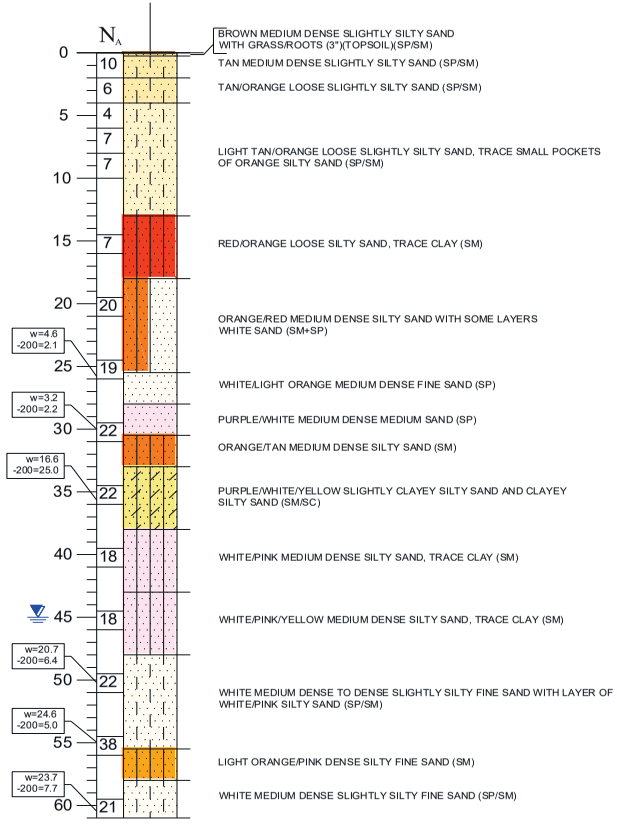
-200=18.3
w=11.6
-200=13.9
0
5
10
15
20
25
30
35
40
9
5
4
4
4
9
15
14
23
24
18
BROWN MEDIUM DENSE SLIGHTLY SILTY SAND, TRACE ROOTS (6")(TOPSOIL)(SP/SM)
TAN MEDIUM DENSE SLIGHTLY SILTY SAND (SP/SM)
TAN/ORANGE LOOSE SLIGHTLY SILTY SAND (SM/SP)
LIGHT TAN/ORANGE LOOSE SLIGHTLY SILTY SAND WITH SOME SMALL POCKETS OF SILTY SAND (SP/SM)
ORANGE/RED LOOSE TO MEDIUM DENSE SILTY SAND WITH SOME TRACE CLAY (SM)
RED/ORANGE MEDIUM DENSE SILTY SAND WITH SOME WHITE SAND (SM)
LIGHT ORANGE MEDIUM DENSE SAND AND ORANGE SLIGHTLY SILTY SAND WITH SOME RED SILTY SAND (SP+SP/SM)
WHITE/PINK/YELLOW MEDIUM DENSE SLIGHTLY CLAYEY SILTY SAND AND PINK SILTY SAND (SM/SC+SM)
WHITE/YELLOW/PINK MEDIUM DENSE SILTY SAND AND SLIGHTLY CLAYEY SILTY SAND (SM+SM/SC)

Borings

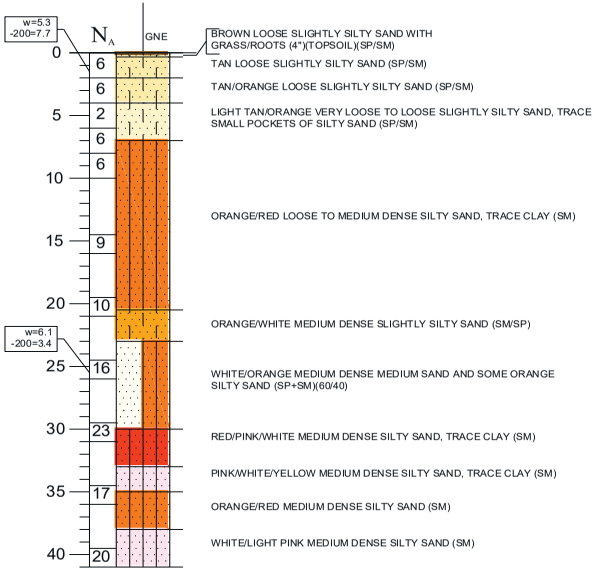
B-6
03-10-21



B-7
03-08-21



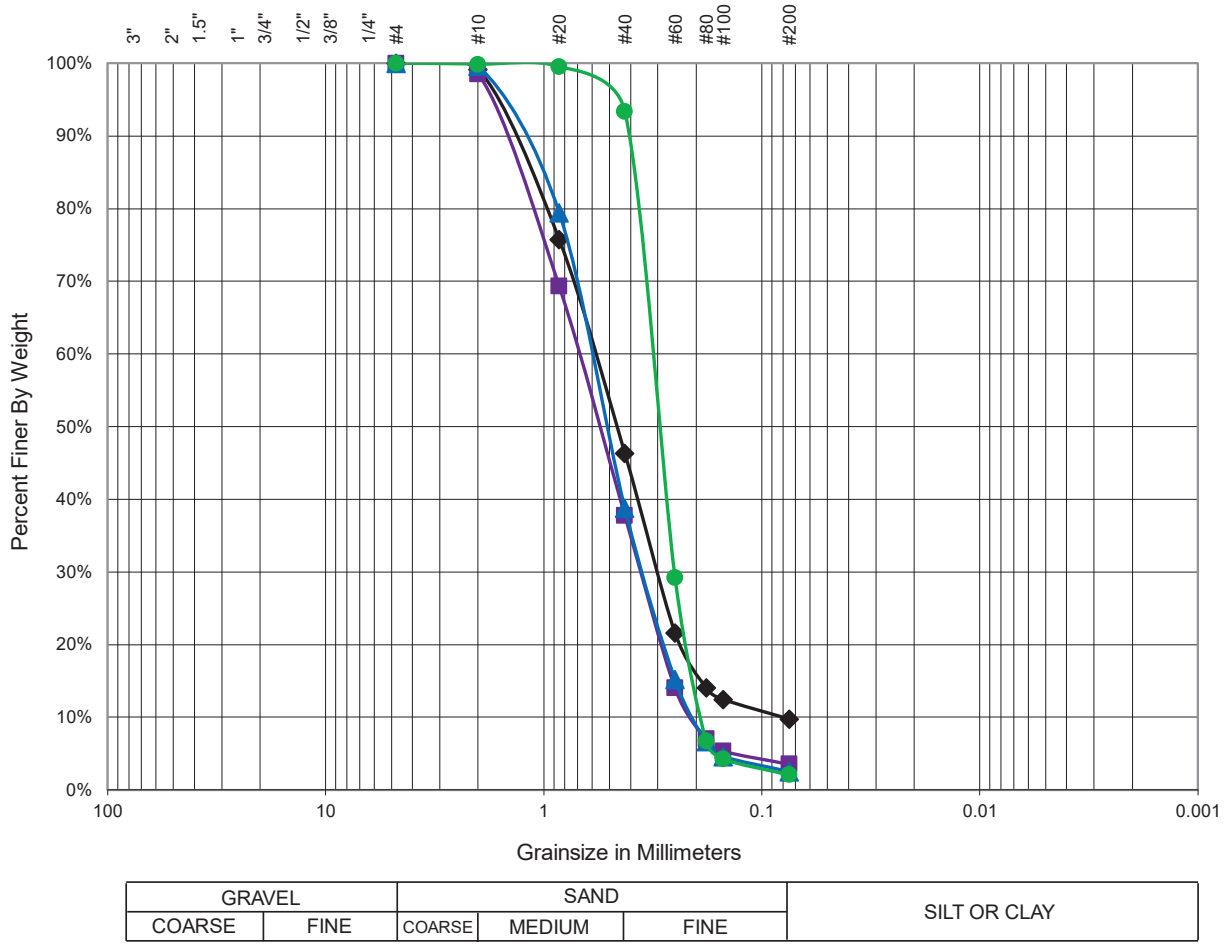
B-8
03-10-21



Test Results

Laboratory testing for this project included twenty wash #200 sieve and natural moisture content tests and four grainsize analysis tests to assist in soil classification and to evaluate and document soil properties. The results of the tests can be found on the borings logs adjacent to the samples tested. The grainsize curves are below.

Boring	Sample Depth (ft)	Soil Description	% Fines
◆ B-3	34.5-36	Orange/Red/Pink Slightly Silty Medium Sand, Trace Clay	9.7
■ B-8	24.5-26	White/Orange Medium Sand	3.6
▲ B-6	29.5-31	White/Yellow/Orange Medium Sand	2.5
● B-7	24.5-26	White/Light Orange Fine Sand	2.1



Basis of Recommendations

Recommendations rendered herein are based on assumed and/or design information available at the time of this report, the subsurface conditions encountered in the test borings, generally accepted geotechnical engineering principles and practices, and our experience with similar soil and groundwater conditions. Should final project information or existing conditions differ from the information used in this report, or should any soil conditions not discussed in this report be encountered during construction, our office should be notified and retained so that this report can be modified as needed. LMJ should be provided the final plans and specifications for review to determine if any changes to our report are needed based on the final design and that our recommendations have been properly interpreted.

This report and any correspondence are intended for the exclusive use of our client for the specific application to the project discussed. LMJ is not responsible for the interpretations, conclusions, or recommendations made by others based on the information in this report.

Regardless of the care exercised in performing a Geotechnical Exploration, the possibility always exists that soil and/or groundwater conditions will differ from those encountered at the specific boring locations. In addition, construction operations may alter the soil conditions. Therefore, it is recommended that a representative from LMJ be involved during the construction phases discussed in this report.

Test Methods

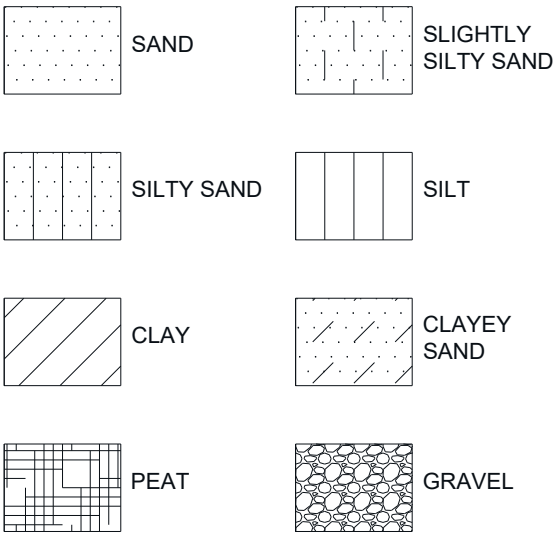
Standard Penetration Test

The Standard Penetration Test (SPT) consists of driving a 2-inch diameter split spoon sampler into the ground using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler one foot (after seating it 6 inches) is referred to as the blow count or “N” value and represents the relative density of subsurface soils. “N” values can be found on the boring logs. The SPT borings were drilled in general accordance with ASTM D1586 using a truck mounted drill rig and were sampled by driving back-to-back 2-foot split spoons to a depth of 10 feet followed by samples at 5-foot increments thereafter. Each sample was removed from the sampler, classified in the field by the driller, and packaged for visual classification by our engineering staff and laboratory testing. Boring logs noted with N_A were drilled using an automatic hammer.

Other Test Methods

Wash #200 Sieve (ASTM D1140), Moisture Content (ASTM D2216), and Sieve Analysis (ASTM C-136)

LEGEND



NOTES

1) SPT BORINGS PERFORMED IN GENERAL ACCORDANCE WITH ASTM D1586
2) SUBSURFACE CONDITIONS ARE AT BORING LOCATIONS AND ACTUAL CONDITIONSBETWEEN BORINGS MAY VARY
3) ALL CLASSIFICATIONS ARE BASED ON VISUAL EXAMINATION UNLESS ACCOMPANIED BY LABORATORY TEST RESULTS
4) BOUNDARIES BETWEEN SOIL LAYERS SHOULD BE CONSIDERED APPROXIMATE AS THE ACTUAL TRANSITION MAY BE GRADUAL
5) DEPTH OF BORING IS BELOW EXISTING GRADE AT TIME OF DRILLING
6) ELEVATIONS, IF SHOWN, WERE ESTIMATED FROM PROVIDED TOPOGRAPHIC SURVEY
7) COLORS USED FOR BORING HATCHING MAY NOT REPRESENT THE ACTUAL SOIL COLORS

SAFETY HAMMER

GRANULAR SOILS

SPT BLOWS/FOOT (N)	RELATIVE DENSITY
0-3	VERY LOOSE
4-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
> 50	VERY DENSE

COHESIVE SOILS

SPT BLOWS/FOOT (N)	RELATIVE DENSITY
0-1	VERY SOFT
2-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
> 30	HARD

AUTOMATIC HAMMER

GRANULAR SOILS

SPT BLOWS/FOOT (N)	RELATIVE DENSITY
0-2	VERY LOOSE
3-8	LOOSE
9-24	MEDIUM DENSE
25-40	DENSE
>40	VERY DENSE

COHESIVE SOILS

SPT BLOWS/FOOT (N)	RELATIVE DENSITY
<1	VERY SOFT
1-3	SOFT
4-6	MEDIUM STIFF
7-12	STIFF
13-24	VERY STIFF
>24	HARD

GNE
GROUNDWATER NOT ENCOUNTERED AT TIME OF DRILLING

N
STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT

N_A
STANDARD PENETRATION RESISTANCE USING AUTOHAMMER

ENCOUNTERED GROUNDWATER LEVEL

ENCOUNTERED PERCHED WATER LEVEL

50/2"
NUMBER OF BLOWS REQUIRED (50) TO ADVANCE SPLIT SPOON SAMPLER A SPECIFIC DISTANCE (2) INCHES

HW
SPLIT SPOON SAMPLE ADVANCED UNDER WEIGHT OF ROD AND HAMMER

HA
HAND AUGER

SHELBY TUBE SAMPLER

w
NATURAL MOISTURE CONTENT (%)

-200
FINES PASSING #200 SIEVE (%)

O.C.
ORGANIC CONTENT (%)

LL
LIQUID LIMIT

PL
PLASTIC LIMIT

LI
LIQUIDITY INDEX

$C\approx$
APPROXIMATE COHESION VALUE (PSF) BASED ON POCKET PENETROMETER READINGS

K_v
SATURATED VERTICAL HYDRAULIC CONDUCTIVITY (FT/DAY)

γ_d
DRY UNIT WEIGHT (PCF)

γ_m
ESTIMATED MOIST UNIT WEIGHT (PCF)

γ_b
ESTIMATED BUOYANT UNIT WEIGHT (PCF)

ϕ
ESTIMATED ANGLE OF INTERNAL FRICTION (DEGREES)

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 DEFINITIONS

A. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

B. Imported Material: Material obtained by Contractor from source(s) offsite.

C. Lift: Loose (uncompacted) layer of material.

D. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

E. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

F. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

G. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.02 SUBMITTALS

A. Shop Drawings: Manufacturer’s descriptive literature for marking tapes.

B. Quality Control Submittals:

1. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Plastic:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: Minimum 3 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Mutual Industries; Nondetectable Tape.
   c. Presco; Nondetectable Tape.

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: Minimum 3 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color[a]	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation and slurry lines
[a]As specified in ANSI Z53.1, Safety Color Code.	

2.02 TRENCH STABILIZATION MATERIAL

A. Granular Fill: As specified in Section 31 23 23, Fill and Backfill.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Friable, and no clay balls, roots, or other organic material.

B. Granular Fill: As specified in Section 31 23 23, Fill and Backfill.

2.04 EARTH BACKFILL

A. Earthfill: As specified in Section 31 23 23, Fill and Backfill.

2.05 SOURCE QUALITY CONTROL

A. Contractor's testing laboratory to perform gradation analysis in accordance with ASTM C136.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: As follows:

1. Pipe, 15 Inches and Smaller: 4 inches.
2. Conduit: 4 inches.
3. Direct-Buried Cable: 4 inches.
4. Duct Banks: 4 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.05 BACKFILL PIPE ZONE

A. Upper Limit of Pipe Zone shall Not be Less than Following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls. Compact the material to at least 95 percent of the maximum dry density as determined by ASTM D1557.

F. Do not use power-driven impact compactors to compact pipe zone material.

3.06 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, on top of last lift of pipe zone material. Coordinate with piping installation drawings.

1. Metallic Marking Tape: Install with nonmetallic piping and waterlines.
2. Plastic Marking Tape: Install with metallic piping.

3.07 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 3 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

B. Backfill Areas to be Seeded:

1. Place earth backfill in lifts not exceeding 8-inch thickness.
2. Mechanically compact each lift to a minimum of 90 percent of the maximum dry density as determined by ASTM D1557 prior to placing succeeding lifts.
3. Backfill for Areas Under Facilities and Asphalt or Portland Concrete Paving: Backfill trench above pipe zone with granular fill in lifts not to exceed 6 inches. Compact each lift to a minimum of 98 of the maximum dry density as determined by ASTM D1557 prior to placing succeeding lifts.

C. Replacement of Topsoil:

1. Replace topsoil in top 4 inches of backfilled trench.
2. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.08 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

B. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

C. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified for asphalt concrete pavement.

D. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.09 SITE TESTING

A. Gradation:

1. One sample from each 100 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. Granular Fill and Pipe Zone Fill: One test for every 300 feet of each lift; or one test per lift, whichever requires more tests.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. T11, Standard Method of Test for Materials Finer Than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.
   b. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   c. T89, Standard Specification for Determining the Liquid Limit of Soils.
   d. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.
   e. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   f. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.
   g. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.
   h. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   i. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.
   j. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
2. ASTM International (ASTM):
   a. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   b. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   c. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   d. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.02 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Standard Specifications: When referenced in this section, shall mean Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction, current edition.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 ROAD BASE COURSE

A. As specified in Section 200, Rock Base, and Section 230, Limerock Stabilized Base, of the Standard Specifications.

2.02 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

A. In accordance with Section 200 and 300 of the Standard Specifications.

B. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

A. In accordance with Section 200 and 230 of the Standard Specifications.

3.04 CONSTRUCTION OF COURSES

A. Construction of Courses: In accordance with Section 200, Rock Base, and Section 230, Limerock Stabilized Base, of the Standard Specifications .

3.05 ROLLING AND COMPACTION

A. In accordance with Section 200 and 230 of the Standard Specifications.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Limerock Base Course: Within plus or minus 0.05 foot of grade shown at any individual point.

3.07 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   d. M140, Standard Specification for Emulsified Asphalt.
   e. M208, Standard Specification for Cationic Emulsified Asphalt.
   f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
   g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
   i. T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
   j. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus.
   k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
   l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
   m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).
2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.

3. ASTM International (ASTM):
    a. D2041, Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
    b. D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
    c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
    d. D5821, Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
    e. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. RAP: Reclaimed asphalt pavement.

C. Standard Specifications: Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

1.03 DESIGN REQUIREMENTS

A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of this Specification.

1.04 SUBMITTALS

A. Informational Submittals:

1. Asphalt Concrete Mix Formula:
    a. Submit minimum of 15 days prior to start of production.
    b. Submittal to include the following information: Properties as stated in Section 334 of Standard Specifications.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers’ Field Services, for the following materials:
    a. Aggregate: Gradation, source test results as defined in Section 334 of the Standard Specifications.
    b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
    c. Prime Coat: Type and grade of asphalt.
    d. Tack Coat: Type and grade of asphalt.
    e. Additives.
    f. Mix: Conforms to job-mix formula.

3. Statement of qualification for independent testing laboratory.
4. Test Results:
    a. Mix design.
    b. Asphalt concrete core.
    c. Gradation and asphalt content of uncompacted mix.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat: Cut-back asphalt, conform to Section 300 of the Standard Specifications.

B. Tack Coat: Emulsified asphalt, conform to Section 300 of the Standard Specifications.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Engineer.
2. Source Changes:
    a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
    b. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Asphalt Concrete: As specified in Section 334 of the Standard Specifications.

C. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

D. Aggregate:

1. General: As specified in Section 334, Superpave Asphalt Concrete, of the Standard Specifications.

E. Mineral Filler: In accordance with Section 334 of the Standard Specifications.

F. Asphalt Cement: Paving Grade as shown on Drawings in accordance with Section 334 of the Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control: Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

A. In accordance with Section 334 of the Standard Specifications.

3.04 PREPARATION

A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.

2. Remove existing material to a minimum depth of 25 millimeters (1 inch).
3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with Section 32 11 23, Aggregate Base Course.

B. Prime Coat:

1. Heat cut-back asphalt as specified in Section 300 of the Standard Specifications, prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply when moisture content of upper 75 millimeters (3 inches) of base exceeds optimum moisture content of base, or if free moisture is present.
4. Remove or redistribute excess material.
5. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.

C. Tack Coat:

1. Prepare material, as specified in Section 300 of the Standard Specifications, prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply more tack coat than necessary for the day’s paving operation.
4. Touch up missed or lightly coated surfaces and remove excess material.

D. Pavement Mix:

1. Prior to Paving:
   a. Sweep primed surface free of dirt, dust, or other foreign matter.
   b. Patch holes in primed surface with asphalt concrete pavement mix.
   c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix as specified on Drawings.
3. Total Compacted Thickness: As shown on Drawings.
4. Apply such that meet lines are straight and edges are vertical.

5. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
6. Joints:
   a. Offset edge of each layer a minimum of 150 millimeters (6 inches) so joints are not directly over those in underlying layer.
   b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
   c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
7. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
8. After placement of pavement, seal meet line by painting a minimum of 150 millimeters (6 inches) on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.

E. Compaction: In accordance with Section 300 and Section 330 of Standard Specifications.

F. Tolerances: In accordance with Section 330 of Standard Specifications.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 75 millimeters (3 inches) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 6 millimeters (1/4 inch) or minus 0 millimeter when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T230 and AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 400 mg (500 tons) of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 900 mg (1,000 tons) or once every 8 hours, whichever is greater.
2. Density Tests: Once every 450 mg (500 tons) of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO).
   a. M6, Standard Specification for Fine Aggregate for Portland Cement Concrete.
   b. M80, Standard Specification for Coarse Aggregate for Portland Cement Concrete.
   c. M153, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   d. M157, Standard Specification for Ready-Mixed Concrete.
   e. M213, Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   f. M227/M227M, Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
2. American Concrete Institute (ACI):
   a. 305R, Hot Weather Concreting.
   b. 306R, Cold Weather Concreting.
   c. 308, Standard Practice for Curing Concrete.
   d. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
   e. 325.9R, Guide for Construction of Concrete Pavements and Concrete Bases.
3. ASTM International (ASTM):
   a. A615/A615M, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   b. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   c. C33, Specification for Concrete Aggregates.
   d. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. C78, Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).

g. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
h. C94/C94M, Standard Specification for Ready-Mixed Concrete.
i. C143/C143M, Standard Test Method for Slump of Hydraulic Cement Concrete.
j. C150, Specification for Portland Cement.
k. C172, Standard Practice for Sampling Freshly Mixed Concrete.
l. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
m. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
n. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
o. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
p. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
q. C803/C803M, Test Method for Penetration Resistance of Hardened Concrete.
r. C1330, Specification for Cylindrical Seal Backing for Use With Cold Liquid Applied Sealants.
s. C805, Test Method for Rebound Number of Hardened Concrete.
t. D920, Standard Specification for Elastomeric Joint Seals.
u. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
v. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
w. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
x. D2628, Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete.
y. D2828, Specification for Non-Bituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type.
z. D3406, Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
aa. D3569, Specification for Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant Type for Portland Cement Concrete Pavements.
bb. D3581, Specification for Joint Sealant, Hot-Applied, Jet-Fuel-Resistant-Type, for Portland Cement and Tar-Concrete Pavements.

cc. D5249, Specification for Backer Material for Use With Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
dd. D5893, Specification for Cold-Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
ee. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

4. National Ready Mixed Concrete Association (NRMCA).

1.02 DEFINITIONS

A. Standard Specification: Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

1.03 SUBMITTALS

A. Provide as required in Section 03 30 00, Cast-in-Place Concrete.

B. Action Submittals:

1. Product Data: Admixtures.
2. Design Data:
   a. Concrete mix design signed by concrete mix designer.
   b. Minimum Information:
      1) Name of ready-mix plant.
      2) Project.
      3) Engineer.
      4) Contractor.
      5) Mix design number.
      6) Specified concrete strength.
      7) Water-cement-fly ash ratio.
      8) Maximum aggregate size.
      9) Cement content.
      10) Fly ash content.
      11) Water content.
      12) Type, name, and amount of admixtures.
      13) Unit weight.
      14) Slump.
      15) Ingredient proportions corrected for average moisture content for particular times of year.

C. Informational Submittals:

1. Manufacturers' Certificate of Compliance:
   a. Portland cement.
   b. Admixtures.
   c. Fly ash.
   d. Aggregates.
2. Statements of Qualifications:
   a. Mix designer.
   b. Batch plant.
   c. Testing laboratory.
3. Test Reports:
   a. Admixtures: Chemical ingredients and percentage of chloride in each admixture and fly ash.
   b. Fly Ash: Source test analysis and amount used in accordance with ASTM C94/C94M, Section 16.
   c. Mix Design: For each trial, signed by qualified mix designer.
   d. Laboratory Mixes: Cylinder test results.
4. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.
   b. Minimum Delivery Ticket Information:
      1) Name of ready-mix plant.
      2) Serial number of ticket.
      3) Date and truck number.
      4) Name of Contractor.
      5) Job name and location.
      6) Mix design number.
      7) Amount of concrete (cubic yards).
      8) Type and amount of admixtures.
      9) Amount of water added at batch plant.
      10) Time of loading, arriving at Site, and unloading.
      11) Volume of water added by receiver of concrete and their initials.
   c. Record of drum revolution counter, type, and brand.

1.04 QUALITY ASSURANCE

A. Provide as required in Section 03 30 00, Cast-in-Place Concrete.

B. Qualifications:

1. Mix Designer: Licensed professional engineer registered in the state of Project or a certified concrete mix designer approved by local Department of Transportation.

2. Testing or Inspection Agency: In conformance with ASTM E329.
3. Batch Plant: Currently certified by the National Ready Mixed Concrete Association.

C. Hot Weather Concreting: Conform to ACI 305R.

D. Cold Weather Concreting: Conform to ACI 306R.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Transporting of ready-mix concrete shall be in accordance with ASTM C94/C94M.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement:

1. Furnish cement for Project from one source.
2. Portland cement shall be in Type I in accordance with Section 346, Portland Cement Concrete, and Section 350, Cement Concrete Pavement of the Standard Specifications.

B. Aggregates:

1. General:
   a. Concrete and cement aggregates shall be in accordance with Section 346, Portland Cement Concrete.
   b. Material: Natural aggregates, free from deleterious coatings.
   c. Aggregates shall not be potentially reactive as defined in ASTM C33.
   d. Aggregates not in compliance with soundness and durability requirements of ASTM C33 may be used with prior approval of Engineer; provided it can be shown by special testing or record of past performance that these aggregates produce concrete of adequate strength and durability. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C33 and ASTM C88.

2.02 CONCRETE MIX DESIGN

A. As specified for Class I cement in Sections 346, 347 and 350 of the Standards Specifications.

B. Concrete target strengths shall be in accordance with ACI 318/318R and the FDOT Standard Specifications. Minimum compressive strength shall be 3,000 PSI, have a target slump of 3 inches and an air content range from 1 percent to 6 percent.

PART 3 EXECUTION

3.01 WEATHER LIMITATIONS

A. Concrete shall not be placed:

1. Until the air temperature in the shade is 35 degrees F and rising and is forecast to remain above 35 degrees F.
2. On frozen ground.
3. During periods of rain.

B. Concrete placement shall not continue when air temperature drops below 40 degrees F.

C. Protect concrete pavement from inclement weather for 7 days after it has been placed, when rain is imminent, and when air temperature drops or is forecast to drop below 35 degrees F.

3.02 PREPARATION

A. Prepare base as specified in Section 31 23 13, Subgrade Preparation.

B. Dampen base thoroughly prior to concrete placement; standing water will not be permitted.

C. Formwork shall be complete prior to placement of concrete. Area in which concrete is to be placed, shall be smooth and free of ruts, projections, debris, spilled concrete, mud, sloughed soil, standing water, organic and other objectionable materials.

D. Construction Joints: Inspect prior to placement of concrete.

E. Prior to placing paving equipment in position, full width and length of the area on which the tracks of the paving equipment is to operate shall be brought to density and surface tolerances required.

F. Protect existing exposed surfaces such as grates, catch basins, air valves, manholes, and cleanout lids from splattered and spilled concrete during concrete placement by use of durable waterproof paper.

G. Furnish operable backup vibrator on Site prior to concrete placement.

H. While placing portland cement concrete, provision shall be made for constructing joints, placing dowels, tie bars, and other devices as called for by Drawings and as provided in Article Joints.

I. Portland cement concrete shall be rejected if it:

1. Is not in place within 1 hour after being mixed.
2. Has begun to take an initial set prior to placement.
3. Has been retempered with water.

J. If necessary, supplemental hand spreading and distributing shall be with shovels. Rakes will not be permitted.

K. Portland cement concrete shall not be fouled with foreign matter.

L. Use vibrators to consolidate portland cement concrete pavement at least 6 feet each side of construction joints and expansion joints.

3.03 JOINTS

A. General:

1. Referred to as contraction or construction, either of which may be transverse or longitudinal, as called for by Drawings or as approved by Engineer.
2. Joints, backer material, joint filler and joint sealants shall extend to pavement edges or to each other, as the case may be, and shall be constructed perpendicular to surface of pavement.
3. Joints shall not vary from specified or indicated line by more than 1/4 inch.
4. Contractor shall submit jointing plan and details to Engineer for approval. Take into consideration placement of joints in curb and gutter, at catch basins, and position of manholes and other large structures, as well as other limitations herein mentioned.
5. Place manhole or similar large structure in line of joint, or if impractical, isolate structure from pavement with premolded joint filler, 1/2-inch wide, conforming to AASHTO M213 and ASTM D1751.

3.04 SURFACE FINISHING

A. In accordance with Section 350 Standard Specifications.

3.05 CURING OF PORTLAND CEMENT CONCRETE

A. Immediately after the final floating, surface finishing, and edging has been completed, and while portland cement concrete surface is still moist, cover and cure entire exposed surface for at least 72 hours in accordance with one of the following provisions:

1. Liquid Membrane-Forming Compounds: Apply compound uniformly to portland cement concrete by pressure spray methods at a rate which will form an impervious membrane, but at least at a rate of 1 gallon per 150 square feet.
2. Other Membranes:
    a. Apply to damp portland cement concrete as soon as it can be placed without marring surface.
    b. Place in contact with surface, extend beyond sides or edges of slabs or forms, and fasten down to hold it in position as a waterproof and moistureproof covering.
    c. Laps shall be sufficient to maintain tightness equivalent to sheeting.
    d. Transverse laps for waterproof paper shall be at least 18 inches, and longitudinal seams shall be cemented.
    e. Cotton or jute mats shall be saturated with water prior to placing and kept fully wetted during curing period.

B. Concrete shall be cured by use of curing compound, for minimum of 7 days after concrete placement, in accordance with ACI 308. Curing compounds shall be applied in accordance with manufacturer’s written instructions.

C. Exposed surfaces shall be sprayed with curing compound immediately after free surface water has disappeared from finished surface.

D. Concrete temperature shall be maintained in accordance with ACI 306R.

E. Curing compounds shall not come in contact with hardened concrete that is to be concreted against.

3.06 FIELD QUALITY CONTROL

A. Retain independent testing or inspection agency to perform inspection, sampling, and testing.

B. Concrete Sampling: In accordance with ASTM C172. Take sample not less than every 5,000 square feet or fraction thereof of concrete placed each day.

C. Perform following tests on each sampling:

1. Slump: ASTM C143/C143M.
2. Air Content: ASTM C231.
3. Compressive Strength: ASTM C39/C39M.
4. Flexural Strength: ASTM C78.

D. Strength Tests:

1. Make and cure cylinders and beams in accordance with ASTM C31/C31M.
2. Cylinders: Make four, standard 6-inch diameter by 12 inches high. Cure one in field and three in laboratory.
3. Beams: Make three, standard 6 inches by 6 inches by 21 inches. Cure in field.
4. Compressive: Test one field-cured cylinder at 7 days and two laboratory-cured cylinders at 28 days. Test last cylinder at 56 days if 28-day cylinder is below specified strength.
5. Flexural: Test one beam at 7 days and two beams at 28 days.

E. Acceptance of concrete shall be in accordance with ACI 318/318R.

F. Concrete with compressive strength less than specified, as evidenced by cylinder tested at 56 days, shall be additionally tested as follows:

1. Less Than 500 psi Low in Compression or Less than 75 psi Low in Flexure:
   a. Penetration Resistance Test: ASTM C803.
   b. Rebound Hammer Test: ASTM C805.
   c. Perform tests within 24 hours of noncomplying strength tests.
2. More Than 500 psi Low in Compression or More Than 75 psi Low in Flexure:
   a. Concrete Coring: Take three standard cores from concrete representing original specimens.
   b. Take and prepare cores in accordance with ASTM C42/C42M.
   c. Test cores in accordance with ASTM C39/C39M.
   d. Take cores within 24 hours of noncomplying strength test.

3.07 CLEANING

A. Clean concrete splatter from exposed surfaces.

B. Thoroughly broom and wash concrete surfaces before opening to traffic.

3.08 PROTECTION OF CONCRETE

A. Do not operate construction equipment or allow traffic on newly placed portland cement concrete until the following requirements are met:

1. Joints have been filled as per Article Joints.
2. Concrete has attained a compressive strength of at least 4,000 pounds per square inch.

B. Protect new concrete from construction operations, mechanical disturbances, water flow, and soiling until open for traffic.

C. Erect and maintain suitable barriers to protect concrete from traffic or other detrimental trespass until pavement is opened to traffic.

D. Maintain watchmen after normal working hours for at least a 24-hour period to ensure barriers are not removed or destroyed, and that trespass and vandalism upon pavement does not occur.

E. Wherever it is necessary that traffic, including Contractor's vehicles and equipment, be carried from one side of pavement to the other, construct suitable bridges over pavement, and maintain them in good condition as long as they may be required. Leaving gaps in pavement to facilitate movement of traffic will not be allowed, unless prior written permission is obtained from Engineer.

F. Protect new concrete from dirt, asphalt, and other deleterious substances that may be tracked onto new pavement from construction activities.

G. Pavement damaged by traffic or damaged from any other cause, prior to its official acceptance, shall be repaired or replaced to the satisfaction of Engineer.

END OF SECTION

SECTION 32 16 00
CURBS AND GUTTERS AND SIDEWALKS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 inch) Drop.
2. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
3. ASTM International (ASTM):
   a. C94, Standard Specification for Ready-Mixed Concrete.
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
4. Standard Specification: Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

1.02 SUBMITTALS

A. Action Submittals:

1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Conform to the State of Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

PART 2 PRODUCTS

2.01 MATERIALS

A. Conform to the requirements of the referenced Section 520, Concrete: Gutter, Curb Elements and Traffic Separator, and 522, Concrete Sidewalk, of the Standard Specifications.

2.02 EXPANSION JOINT FILLER

A. As specified in Sections 520 and 522 of the Standard Specifications and Drawings.

2.03 CONCRETE

A. Class I concrete as specified in Section 347, Portland Cement Concrete, Section 520, Concrete: Gutter, Curb Elements and Traffic Separator, and 522, Concrete Sidewalk, of the Standard Specifications.

B. Concrete target strengths shall be in accordance with ACI 318/318R and the FDOT Standard Specifications. Minimum compressive strength shall be 3,000 PSI, have a target slump of 3 inches and an air content range from 1 percent to 6 percent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Perform Work in accordance with the referenced Standard Specification.

3.02 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.03 CURB CONSTRUCTION

A. Expansion Joints: Place at maximum 500-foot intervals and at the beginning and end of curved portions of curb, and at connections to existing curbs. Install expansion joint filler at each joint.

B. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.

C. Contraction Joints:

1. Maximum 15-foot intervals in curb.
2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.
3. Insert steel sheet to full depth of curb.
4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
5. Finish top of curb with steel trowel and finish edges with steel edging tool.

D. Front Face:

1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
3. Remove and replace defective concrete.
4. Apply curing compound to exposed surfaces of curb upon completion of finishing.
5. Continue curing for minimum of 5 days.

E. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.

1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
2. Compact backfill firmly.

3.04 SIDEWALK CONSTRUCTION

A. Thickness: As indicated on Drawings.

B. Connection to Existing Sidewalk:

1. Remove old concrete back to an existing contraction joint.
2. Clean the surface.
3. Apply a neat cement paste immediately prior to placing new sidewalk.

C. Expansion Joints: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

D. Contraction Joints:

1. Installed every 5 feet maximum.
2. Provide transversely to walks at locations opposite contraction joints in curb.
3. Dimensions: 3/16-inch by 1-inch weakened plane joints.
4. Construct straight and at right angles to surface of walk.

E. Finish:

1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
3. Apply curing compound to exposed surfaces upon completion of finishing.
4. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
   b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
   c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
   e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
   h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   k. C150, Standard Specification for Portland Cement.
   l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. F552, Standard Terminology Relating to Chain Link Fencing.
   n. F567, Standard Practice for Installation of Chain-Link Fence.
   o. F626, Standard Specification for Fence Fittings.
   p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   q. F900, Standard Specification for Industrial and Commercial Swing Gates.
   r. F934, Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
   s. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.

t. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
u. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
v. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.
w. F1379, Standard Terminology Relating to Barbed Tape.
x. F1911, Standard Practice for Installation of Barbed Tape.
y. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.02 DEFINITIONS

A. Terms as defined in ASTM F552.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
      1) Fence, gate posts, rails, and fittings.
      2) Chain link fabric.
      3) Gates and hardware.
      4) Accessories: Barbed wire.

B. Informational Submittals:

1. Manufacturer’s recommended installation instructions.
2. Evidence of Supplier and installer qualifications.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.05 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence and gates.

B. Interruption of Existing Utility Service: Notify owner of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Deflection of fence fabric beyond limits.

PART 2 PRODUCTS

2.01 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.02 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392, Type II, Class 1, 1.2 ounces per square foot galvanized after weaving.

B. Height: 96 inches, unless otherwise shown.

C. Core Wire Gauge: No. 9.

D. Pattern: 2-inch diamond-mesh.

E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.

F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.

G. Wires of Twisted Selvages:

1. Twisted in a closed helix three full turns.
2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.

2.03 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F1043, light industrial fence, except as modified in this section.
2. Round Steel Pipe, Schedule 40: ASTM F1083.
3. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.
4. Protective Coatings:
   a. Zinc Coating: ASTM F1043, Type A external and internal coating.

B. Line Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.375 inches.
   b. Weight: 2.96 pounds per foot.

C. End, Corner, Angle, and Pull Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.875 inches.
   b. Weight: 5 4.69 pounds per foot.

D. Posts for Horizontal Sliding Gates:

1. ASTM F1184, Type II, Class 2.
2. Round Steel Pipe:
   a. Outside Diameter: 4 inches.
   b. Weight: 6.56 pounds per foot.

2.04 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:

1. ASTM F1083.
2. Outside Diameter: 1.66 inches.
3. Weight: 2.27 pounds per foot.

B. Protective Coatings: As specified for posts.

C. Strength and Stiffness Requirements: ASTM F1043, top rail, light industrial fence.

2.05 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:

1. One-piece.
2. Length not less than 2 inches shorter than full height of chain link fabric.
3. Provide one bar for each gate and end post, and two for each corner and pull post.

E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

F. Tie Wires, Clips, and Fasteners: According to ASTM F626.

G. Barbed Wire Supporting Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire integral with post cap for each post, with single vertical arms for supporting three strands of barbed wire. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.

2.06 TENSION WIRE

A. Zinc-coated steel marcelled tension wire conforming to ASTM A824 Type I.

2.07 BARBED WIRE

A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade.

2.08 GATES

A. General:

1. Gate Operation: Opened and closed easily by one person.
2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
4. Gate leaves more than 8-feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.
5. Gate Fabric Height: Same as for adjacent fence height.
6. Welded Steel Joints: Paint with zinc-based paint.
7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
8. Gate Posts and Frame Members: Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
9. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Cantilever Horizontal Sliding Gates:

1. Comply with ASTM F1184 for single slide gate types II, Class 2 with internal roller assemblies.
2. Cantilever Gate Support Posts: Spaced on maximum 10-foot centers.
3. Overhead Track Assembly: Manufacturer’s standard track, with overhead framing supports, bracing, and accessories, designed to support size, weight, width, operation, and design of gate and roller assemblies.
4. Roller Guards: As required per ASTM F1184 for Type II, Class 2 gate.
5. Hangers, roller assemblies, and stops fabricated from galvanized malleable iron.

2.09 CONCRETE

A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

2.10 FENCE GROUNDING

A. Coordinate all ground requirements with the Electrical Drawings. The Electrical Drawings and Specifications supersede the requirements herein.

B. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

C. Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel.

PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:

1. Minimum 3 feet below finished grade.
2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 BARBED WIRE SUPPORTING ARMS

A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.07 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.08 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 days.

B. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

C. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.

D. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.

E. 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 on center.

F. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

3.09 BARBED WIRE

A. Install barbed wire uniformly in configurations of three strands of barbed wire on supporting arms. Pull wire taut and install securely to supporting arms and secure to end terminal post or terminal arms.

3.10 GATES

A. Install gates according to manufacturer's written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

3.11 ELECTRICAL GROUNDING

A. Coordinate all ground requirements with the Electrical Drawings. The Electrical Drawings and Specifications supersede the requirements herein.

B. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.12 FIELD QUALITY CONTROL

A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

B. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.13 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, to train Owner's personnel to adjust, operate, and maintain gates.

3.14 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

A. Standard Specification: Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

B. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 8 weeks after all planting is completed.

1.02 SUBMITTALS

A. Action Submittals: Product labels/data sheets.

B. Informational Submittals:

1. Seed: Certification of seed analysis, germination rate, and inoculation:
   a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
      1) Name and address of laboratory.
      2) Date of test.
      3) Lot number for each seed specified.
      4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
   b. Mixtures: Proportions of each kind of seed.
2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.
3. Certification of sod; include source and harvest date of sod, and sod seed mix.
4. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Sod:

1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.
2. Harvest and deliver sod only after laying bed is prepared for sodding.
3. Roll or stack to prevent yellowing.
4. Deliver and lay within 24 hours of harvesting.
5. Keep moist and covered to protect from drying from time of harvesting until laid.

C. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 MAINTENANCE SERVICE

A. Contractor: Perform maintenance operations during maintenance period to include:

1. Watering: Keep surface moist.
2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
3. Mulch: Replace wherever and whenever washed or blown away.
4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
5. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.

PART 2 PRODUCTS

2.01 FERTILIZER

A. In accordance with Section 982, Commercial Fertilizer, of the Standard Specifications.

B. Application Rates: Determined by soil analysis results.

2.02 SEED

A. In accordance with Section 981 of the Standard Specifications.

B. All permanent grass seed shall be Bahiagrass seed and have a minimum pure seed content of 95 percent with a minimum germination of 80 percent.

C. All temporary grass seeding for erosion control shall be annual type ryegrass seed with a minimum pure seed content of 95 percent with a minimum germination of 95 percent.

2.03 SOD

A. All sod shall be Bahiagrass in accordance with Section 981 of the Standard Specification. Sod shall be a minimum of 1-1/4-inch thick including a 3/4-inch thick layer of roots and topsoil. Strongly rooted pads, capable of supporting own weight and retaining size and shape when suspended vertically from a firm grasp on upper 10 percent of pad.

1. Age: Not less than 10 months or more than 30 months.
2. Condition: Healthy, green, moist; free of diseases, nematodes and insects, and of undesirable grassy and broadleaf weeds. Yellow sod, or broken pads, or torn or uneven ends will not be accepted.

2.04 HYDROSEEDING MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

3.03 SEEDING

A. Start within 2 days of preparation completion.

B. Hydroseeding:

1. Application Rate: Per manufacture's recommendation.
2. Apply on moist soil, only after free surface water has drained away.
3. Prevent drift and displacement of mixture into other areas.
4. Upon application, allow absorption and percolation of moisture into ground.
5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

C. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 SODDING

A. Do not plant dormant sod, or when ground is frozen.

B. Lay sod to form solid mass with tightly fitted joints; butt ends and sides, do not overlap.

1. Stagger strips to offset joints in adjacent courses.
2. Work from boards to avoid damage to subgrade or sod.
3. Tamp or roll lightly to ensure contact with subgrade; work sifted soil into minor cracks between pieces of sod, remove excess to avoid smothering adjacent grass.
4. Complete sod surface true to finished grade, even, and firm.

C. Fasten sod on slopes to prevent slippage with wooden pins 6 inches long driven through sod into subgrade, until flush with top of sod. Install at sufficiently close intervals to securely hold sod.

D. Water sod with fine spray immediately after planting. During first week, water daily or more frequently to maintain moist soil to depth of 4 inches.

E. Apply top dress fertilizer at rate of 1 pound per 1,000 square feet.

3.05 FIELD QUALITY CONTROL

A. Eight weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

END OF SECTION

SECTION 33 16 13.15
PRESTRESSED CONCRETE STORAGE TANK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This section specifies the design and construction of an ANSI/AWWA D110 wire-wound prestressed concrete storage tank with a Type II or Type III core wall and galvanized steel diaphragm including all reinforcing, concrete work, accessories, disinfection and testing directly related to the tank.

B. The tank contractor is responsible for furnishing all labor, materials, tools and equipment necessary to design and construct the prestressed concrete storage tank, as indicated on the Drawings and as described in this Specification.

1.02 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 350/350R, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   b. 350.3, Seismic Design of Liquid-Containing Concrete Structures and Commentary.
   c. 372R, Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.
   d. 506R, Guide to Shotcrete.
   e. 506.2, Specification for Materials, Proportioning, and Application of Shotcrete.
2. American National Standards Institute (ANSI):
   a. C652, Disinfection of Water Storage Facilities.
   b. D110, Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
3. American Society of Civil Engineers (ASCE): Standard 7 – Minimum Design Loads for Buildings and Other Structures.
4. ASTM International (ASTM):
   a. A416/A416M, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   c. A653/653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by Hot Dip Process.

d. A821/A821M, Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.
e. A882/A882M, Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Strand.
f. A884/A884M, Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.
g. A1064/A1064M, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
h. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
i. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
j. D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
k. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

5. "Earthquake Induced Sloshing in Tanks with Insufficient Freeboard" by P.K. Malhotra, Structural Engineering International, IASBSE, 3/2006 pp 222-225.
6. OSHA 29 CFR 1910 – OSHA General Industry Regulations.

B. Design Criteria noted on General Structural Notes Drawings.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Design Data:
      1) Proposed details and concepts for prestressed tank walls.
      2) Details of vertical post-tensioning system.
      3) Details for sealing vertical joints of steel diaphragm shell.
      4) Details of prestressed tank accessories.
   b. Description of construction method and materials.
2. Samples: Vertical joint of steel diaphragm shell together with integral pumped epoxy material or other approved method to show evidence of satisfactory seal.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance:
   a. Shotcrete sand.

b. Concrete and shotcrete admixtures do not contain chlorides or other corrosive chemicals.
c. Vertical Post-Tensioning System: Manufacturer's load strain curves certifying physical properties of steel and standard test data that components of anchorage units conform to specified requirements.

2. Manufacturer's Certificate of Proper Installation.
3. Certificates of Inspection: Vertical post-tensioning units have been inspected prior to shipment and contain no apparent defects.
4. Statements of Qualification:
   a. Registered professional engineer.
   b. Prestressed tank installer.
5. Written Test Reports of Each Test and Inspection:
   a. Shotcrete.
   b. Mill test data of chemical composition for vertical post-tensioning system.
   c. Test reports for prestressing steel components.
   d. Mill test data for circumferential prestressing material regardless of manufacture. Include chemical composition, physical properties, and dimensions of steel prior to galvanizing. Mill test data for at least three samples of final prestressing material taken from material delivered to Site. Identify each roll that Samples were taken from. Identify packages or rolls of prestressing material with mill and heat number.
6. Design Data:
   a. Calculations for design of tank and accessories.
   b. For design loads and foundation criteria, show calculations and details based on the seismic forces.
   c. Calculations shall be stamped by professional engineer.
   d. Shop Drawings shall be stamped by a professional engineer.

C. Warranty Document: Submit warranty document in Owner's name in accordance with Article Warranty of this Specification.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Qualified Design Engineer: Registered in the state of Project.
2. Prestressed Tank Installer: Company specializing in design and construction of prestressed tanks. Minimum 5 years' experience on tanks of similar size and type required for Project. Company has designed and built no less than five comparable prestressed (wire or strand wrapped) tanks now in use and are giving

satisfactory service. Tanks shall have been constructed within the last 5 years. Include name and address of Owners.

3. The following are preapproved as acceptable tank construction companies:
   a. The Crom Corporation, Gainesville, Florida.
   b. Precon Corporation, Newberry, Florida.
   c. PRELOAD LLC, Louisville, KY.

1.05 WARRANTY

A. The tank construction company shall provide a warranty for workmanship and materials on the complete structural portion of the tank for a five-year period from the date of acceptance of the work. The warranty shall not apply to any accessory, equipment or product that is not a structural part of the tank and is manufactured by a company other than the tank construction company.

B. If any leakage or other defects appear within the five-year period, the tank construction company shall promptly repair the tank at its own expense upon written notice by the Owner that such defects have been found. Leakage is defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from the inside of the tank. The tank construction company shall not be responsible for, nor liable for, any subsurface condition.

1.06 DESIGN CRITERIA

A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures, ANSI/AWWA D110 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks with Type II or Type III core walls, and currently accepted engineering principles and practices for the design of such structures.

B. The following loadings shall be utilized in the design:

1. Capacity: 0.25 million gallons.
2. Dimensions:
   a. 60-feet - 0-inch Inside Diameter.
   b. 13-feet - 9-inch Side Water Depth.
3. Fluid Loads: Shall be the weight of all liquid when the EQ tank is filled to capacity. The unit weight of the liquid material shall be 62.4 lbs/ft^3.
4. Dead Loads: Consideration shall be given to all permanent imposed loads including concrete and steel.
5. Seismic Loads: Seismic forces and moments resulting from water sloshing and seismic accelerations of the tank dome, wall, and water loads shall be calculated in accordance with ACI 350.3 or ANSI/AWWA D110.

6. Soil Pressure: Earth loads shall be determined by rational methods of soil mechanics. Soil pressure shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.
7. Differential Backfill Loads: Forces from differential backfill loads shall be considered in the design and shall be based on the at-rest coefficient. Passive resistance shall not be used to resist differential backfill loads.
8. Wind Loads: Wind loads shall be considered in the design in accordance with ASCE 7.

C. Subbase: A granular base material shall be used beneath the structural slab when the subgrade materials do not allow free drainage.

1. The base material should consist of a clean, well-compacted, angular or sub-angular material with a minimum thickness of 6 inches.
2. The gradation of the base material should be selected to permit free drainage without the loss of fines or intermixing with the subgrade material.
3. The maximum particle size of the base material should be limited to provide a relatively level working surface without potential intrusion of the base materials into the membrane floor slab concrete.
4. Base material should be compacted to 95 percent of the maximum laboratory density determined by ASTM D1557.

D. Floor: The design of the floor for the prestressed concrete tank shall conform to the following:

1. Concrete structural base mat minimum orthogonal and radial reinforcing steel shall be as noted on Drawings.
2. Pile Supported Structural Floor: Concrete structural floors shall be designed to resist bending moments and shears induced by gravity and environmental loads. Moments and shears shall be calculated based on rational analysis utilizing an influence area derived from the pile spacing plus 2 times the pile spacing tolerance specified below. In no case shall the dimensions and reinforcing steel for the concrete structural floor be less than the minimum shown on Drawings:
3. Pile Supported/Rock Anchor Structural Floor: Circumferential steel shall be added to the outside edge of the structural floor as required to resist calculated bending moments in spans between perimeter piles. Circumferential steel required for bending moments shall be calculated by any rational one-way analysis with a minimum required amount of 0.50 percent placed in a minimum width of 2 feet 6 inches, but not to extend inside of the thickened edge of the floor nor 1/4 of a typical interior pile spacing. Minimum circumferential steel shall be distributed

with 2/3 of the total area required in the top face and 1/3 in the bottom face.

4. Pile Supported/Rock Anchor Structural Floor: Radial steel shall be added to the top and bottom mats of reinforcing steel at the edge of the structural floor to account for edge effects in the circular plate. Edge effects shall include moments at the mid-span of the outer most span and the outside face of the first interior support of a two-way slab and shall be calculated by any rational analysis which considers these effects but in no case shall be less than as shown on Drawings.
5. Pile Supported Structural Floor: Minimum pile embedment shall be into the concrete structural floor shall be 3 inches for concrete piles and 6 inches for steel piles, see Drawings.
6. Pile Supported Structural Floor: Minimum spacing tolerance shall be 6 inches for all driven piles and 3 inches for all auger cast piles and drilled piers or as defined by the geotechnical design professional.

E. Core wall:

1. The wire-wound, prestressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, galvanized steel shell diaphragm.
2. The design of the core wall shall account for appropriate edge restraint. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following minimum reinforcing steel shall be incorporated into the design:
    a. The top 2 feet of core wall shall have not less than 1 percent circumferential reinforcing.
    b. The bottom 3 feet of core wall shall have not less than 1 percent circumferential reinforcing.
    c. Inside Face:
        1) The inside face of the core wall shall utilize the diaphragm as effective reinforcing.
        2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
    d. Outside Face:
        1) Vertical reinforcing steel in the outside face of the core wall shall be: minimum of #4 bars at 12 inch center to center.
        2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
3. The minimum core wall thickness shall be 3-1/2 inch.
4. Reinforcing steel used in the core wall shall be designed using a maximum allowable design tensile stress, f_s, of 18,000 psi.

5. Allowable compressive stress in the core wall due to initial prestressing force, f_{gi}, shall be:
   a. 1250 psi + 75t psi/in. with 0.5 f'_{gi} maximum or less (where f'_{gi} is defined as compressive strength at time initial prestressing force is applied and *t* is the thickness of the core wall in inches).
   b. Maximum of 2250 psi.
6. Allowable compressive stress in the core wall due to final prestressing force, f_g, shall be:
   a. 1250 psi + 75t psi/in. with 0.45 f'_g maximum (where f'_g is defined as compressive strength required for final prestressing force and *t* is the thickness of the core wall in inches).
   b. Maximum of 2025 psi.

F. Prestressing:

1. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire placed under high tension.
2. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.
3. The prestressing design shall conform to the following minimum requirements:
   a. Working stress for the tank wall, fs, shall be a maximum of 115,000 psi.
   b. The allowable design tensile stress in the prestressing wire before losses, fsi shall be 145,600 psi or no greater than 0.63 fu, where fu is defined as the ultimate strength of the wire.
   c. Areas to be prestressed will contain no fewer than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge.
   d. A maximum of 24 wires per layer per foot for 8 gauge and 20 wires per layer per foot for 6 gauge will be allowed.

G. Wall Openings:

1. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall provide no less than 18 inch of prestressing above at the bottom of the wall. The prestressing wires required at the pipe elevation shall be distributed into circumferential bands immediately above and below the opening to maintain the required prestressing force while leaving an unbanded strip around the entire tank.

2. Unbanded strips shall have a vertical dimension of no more than 36 inches unless an axi-symmetric shell analysis is performed to account for compressive forces plus shear and moments caused by displacement of the prestressing wires into adjacent bands.

PART 2 PRODUCTS

2.01 PERFORMANCE

A. Performance of the materials used in the tank construction shall conform to the minimum requirements of this Specification.

B. Substitutions to the materials in this specification may only be made if submitted in writing and approved by the Engineer.

2.02 CONCRETE

A. In accordance with Section 03 30 00, Cast-in-Place Concrete.

2.03 SHOTCRETE

A. Shotcrete shall conform to the requirements of ACI 506.2 except as modified herein.

B. All shotcrete mixes shall utilize Type I/II cement.

C. A maximum of 25 percent of cementitious material may be fly ash.

D. All shotcrete in contact with diaphragm or prestressing wire shall be proportioned to consist of not more than three parts sand to one part Portland cement by weight. All other shotcrete shall be proportioned to consist of not more than four parts sand to one part Portland cement by weight.

E. Admixtures will not contain more than trace amounts of chlorides, fluorides, sulfides or nitrates.

F. Fine aggregate shall meet the requirements of ASTM C33/C33M.

G. Shotcrete mixes used in the tank construction shall conform to the following:

Mix	Compressive Strength (psi)	Maximum W/C Ratio	Slump (in)	Fiber Reinforcement (lbs/cyd)
Core Wall	4000	0.42	5"+/-1"	-
Covercoat	4000	0.42	5"+/-1"	-

2.04 MOISTURE BARRIER

A. The moisture barrier shall be polyethylene, Class A, conforming to ASTM D4397 with a minimum thickness of 6-mils.

2.05 PRESTRESSED REINFORCEMENT

A. The prestressing wire shall conform to the requirements of ASTM A821/A821M, Type B.

B. The prestressing wire size shall be 0.162 inch (8 gauge), 0.192 inch (6 gauge) or larger, but no larger than 0.250 inch.

C. The ultimate tensile strength, fu shall be, 231,000 psi or greater for 8 gauge wire, 222,000 psi or greater for 6 gauge.

D. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the prestressing reinforcement and shall develop the full strength of the wire.

2.06 NON-PRESTRESSED REINFORCEMENT

A. Non-prestressed mild reinforcing steel shall be new billet steel meeting the requirements of ASTM A615/A615M with a minimum yield strength, f_y, of 60,000 psi.

B. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A1064/A1064M with a minimum yield strength, f_y, of 65,000 psi.

2.07 GALVANIZED STEEL DIAPHRAGM

A. The galvanized steel diaphragm used in the construction of the core wall shall be 26 gauge with a minimum thickness of 0.017 inch conforming to the requirements of ASTM A653/A653M. Weight of zinc coating shall be not less than G90 of Table 1 of ASTM A653/A653M.

B. The diaphragm shall be formed with re-entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm.

C. The diaphragm shall be continuous to within 3 inch of the top and bottom of the wall. Horizontal joints or splices will not be permitted.

D. All vertical joints in the diaphragm shall be rolled seamed, crimped and sealed watertight using epoxy injection.

E. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to the waterstop.

2.08 PVC WATERSTOPS, BEARING PADS AND SPONGE FILLER

A. Plastic waterstops shall be extruded from an elastomeric plastic material of which the base resin is virgin polyvinylchloride (PVC). PVC waterstops shall conform to the requirements of CRD-C-572-74.

B. The profile and size of the waterstop shall be suitable for the hydrostatic pressure and movements to which it is exposed.

C. Bearing pads used in floor/wall joints shall consist of neoprene, natural rubber or polyvinyl chloride.

D. Sponge filler at the floor/wall joint shall be closed-cell neoprene.

2.09 EPOXY

A. Epoxy Sealants:

1. Epoxy shall conform to the requirements of ASTM C881/C881M.
2. Epoxy used for sealing the diaphragm shall be Type III, Grade 1, and shall be 100 percent solids, moisture insensitive, low modulus epoxy.
3. Epoxy used for placing the waterstop shall be Type II, Grade 2, and shall be 100 percent solids, moisture insensitive, low exotherm epoxy.
4. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77 degrees F.
5. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC and steel.

B. Bonding Epoxy:

1. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to the requirements of ASTM C881/C881M.

2. Epoxy resins shall be a two-component, 100 percent solids, moisture-insensitive epoxy and shall be Type II, Grade 2.

2.10 SEISMIC RESTRAINT CABLES

A. When required by design, seismic restraint cables shall be seven-wire strand conforming to ASTM A416/A416M.

B. The strand shall be protected with a fusion-bonded, grit-impregnated epoxy coating conforming to ASTM A882/A882M or galvanized.

C. The minimum yield strength of the seven-wire strand shall be 270,000 psi.

2.11 TANK ACCESSORIES

A. Aluminum Accessories:

1. Aluminum accessories shall be shop fabricated and fully welded. All welding shall be in accordance with American Welding Society (AWS) D1.2 to fuse materials without distortion of the material. Mechanical splices shall only be used at field splice locations.
2. Aluminum accessories shall have a "mill" finish.
3. Aluminum surfaces in contact with concrete shall be protected with a coat of bituminous paint.

B. Interior ladder shall be fabricated from aluminum shall conform to all applicable OSHA standards.

C. Through-wall pipe sleeves shall be Type 316 stainless steel sleeves with neoprene modular seal units. Waterstop rings on wall-pipes shall be Type 316 stainless steel.

D. Accessory hardware, unless otherwise noted, shall be Type 316 stainless steel conforming to ASTM F593.

PART 3 EXECUTION

3.01 EXAMINATION

A. All subgrade elevations shall be verified prior to starting tank construction.

3.02 INSTALLATION

A. Floor:

1. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.

2. A 6-mil polyethylene vapor-barrier shall be placed after subgrade preparation has been completed.
3. Form and screed boards shall be of proper thickness and sufficiently braced to ensure that the floor is constructed within proper thickness tolerances.
4. Plate bolsters shall be used to support reinforcing steel supported directly on the subgrade to ensure positive control of placement of reinforcing steel.
5. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.
6. The floor shall be water cured for a minimum of 7 days after casting.
7. The floor shall receive a light broom finish.

B. Core Wall:

1. The wall shall be constructed utilizing diaphragm and shotcrete with each conforming to the following:
   a. Diaphragm Erection: The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the diaphragm for erection except in the top 3 inches. Holes shall not be made in the diaphragm except for inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an epoxy sealant which complies with Article: Epoxy.
   b. Shotcrete:
      1) All shotcrete shall be applied by or under direct supervision of experienced nozzlemen certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.
      2) Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.
      3) No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.
      4) No less than 1/8-inch thick shotcrete shall separate reinforcing steel and prestressing wire.
      5) The diaphragm shall be encased and protected with no less than 1 inch of shotcrete in all locations.
      6) The interior shotcrete shall receive a light broom finish.
   c. Curing: Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is completed.

C. Epoxy Injection:

1. Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure.
2. Epoxy injection shall proceed only after the diaphragm has been fully encased, inside and outside, with shotcrete.

D. Prestressing:

1. The initial tension in each wire shall be read and recorded to verify that the total aggregate force is no less than that required by the design. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.
2. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive force equal to that shown on the design Drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire or when removing a defective section of wire.
3. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.
4. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the design and as shown on approved Drawings.
5. The tank construction company shall supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. The stress measuring equipment shall include: electronic direct reading stressometer accurate to within 2 percent, calibrated dynamometers and a test stand to verify the accuracy of the equipment.
6. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.
7. When multiple layers of wire are required, shotcrete cover between layers shall be no less than 1/8-inch thick.

E. Covercoat:

1. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1 inch shall be placed over the prestressing wires.
2. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.
3. The covercoat shall receive a sliced trowel finish.

F. Wall Openings: All wall pipes, sleeves and manholes passing through the wall shall be sealed to the diaphragm by epoxy injection.

3.03 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Concrete and Shotcrete Testing:
   a. Shall be as specified in Section 03 30 00, Cast-In-Place Concrete.
   b. Slump testing not required for shotcrete.
2. Hydrostatic Testing: Shall be as specified in Section 03 30 00, Cast-in-Place Concrete.

3.04 CLEANING

A. The interior of the tank shall be cleaned to remove debris, construction items, and equipment prior to testing and disinfection.

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. International Building Code (IBC).
6. Florida Building Code 7th Edition (2020).
7. International Mechanical Code (IMC).
8. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.
9. Design Criteria noted on Structural General Notes on Drawings.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, lateral brace, hanger, guide, component, and anchor for piping 6 inches and larger 4 inches and smaller**.** Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

2. Calculations for each type of pipe support, attachment and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Maintenance information on piping support system.
3. Piping support calculations shall be signed and sealed by a Registered Professional Engineer in the State of Florida.
4. Shop drawings shall be signed and sealed by a Registered Professional Engineer in the State of Florida.

1.04 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
3. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
    a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
    b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.
4. Electrical Conduit Support: Include in design of framing support system.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

A. Clevis: MSS SP 58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

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

B. Saddle Supports, Pedestal Type:

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

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

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).

2.06 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, and as specified in Section 05 50 00, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer and Products:
   a. B-Line; B1999 Vibra Cushion.
   b. B-Line; Iso Pipe, Isolation Tape.

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
   a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
   b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
   a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, startup or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and "J" hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
   a. Saddle Supports:
      1) Pedestal Type, elbow and flange.
      2) Provide minimum 1-1/2-inch grout beneath baseplate.
   b. Floor Mounted Channel Supports:
      1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
      2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
      3) Attach pipe to channel with clips or pipe clamps.
   c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.
4. Insulated Pipe:
   a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
   b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
   c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
   a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
   b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
    a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
    b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
    a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
    b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Table 1: Nonchemical Areas.
2. Table 2: Chemical Areas.

END OF SECTION

Table 1
Nonchemical Areas

Exposure Conditions	Support Material
Process Areas: High Humidity or Hydrogen sulfide in Belt Filter Press building, intermediate sludge pump station, and biosolids feed pump station	Stainless steel or FRP
Process Areas: Wetted or Submerged	Stainless steel or FRP
Pipes conveying chemicals listed in Table 2	Provide with corresponding support per Table 2

Notes:

1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

Table 2
Chemical Areas

Exposure Conditions	Support for Direct Exposure	Support for Remote Exposure
Polymer	FRP	Precoated steel

Notes:

1. Direct exposure includes entire area within containment area; area within 20 feet horizontal and 10 feet vertical of chemical pumps or chemical mixing stations; or as specified.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.
5. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   f. B16.9, Factory-Made Wrought Buttwelding Fittings.
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
   i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
   l. B16.25, Buttwelding Ends.
   m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   n. B31.1, Power Piping.
   o. B31.3, Process Piping.
   p. B31.9, Building Services Piping.
   q. B36.10M, Welded and Seamless Wrought Steel Pipe.
5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.

6. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
   g. C153/A21.53, Ductile-Iron Compact Fittings.
   h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
   i. C606, Grooved and Shouldered Joints.
7. American Welding Society (AWS):
   a. Brazing Handbook.
   b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   c. D1.1/D1.1M, Structural Welding Code - Steel.
   d. QC1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
   a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
   g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
   h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.

l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
n. A197/A197M, Standard Specification for Cupola Malleable Iron.
o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
r. A276, Standard Specification for Stainless Steel Bars and Shapes.
s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
aa. A536, Standard Specification for Ductile Iron Castings.
bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
hh. B32, Standard Specification for Solder Metal.
ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
jj. B61, Standard Specification for Steam or Valve Bronze Castings.
kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
ll. B75/B75M, Standard Specification for Seamless Copper Tube.
mm. B88, Standard Specification for Seamless Copper Water Tube.
nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
ww. D1330, Standard Specification for Rubber Sheet Gaskets.
xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.

aaa. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
bbb. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ccc. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
ddd. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
eee. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
ggg. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
hhh. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
iii. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
jjj. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
kkk. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
lll. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
mmm. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
nnn. F436, Standard Specification for Hardened Steel Washers.
ooo. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
ppp. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
qqq. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
rrr. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
sss. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ttt. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

9. FM Global (FM).
10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
11. NSF International (NSF):
    a. ANSI 61: Drinking Water System Components - Health Effects.
    b. ANSI 372: Drinking Water System Components - Lead Content.
12. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
13. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
    a. Top face of channel walls and cover slabs.
    b. Roof of digester, including structure pipe penetrations.
    c. Liquid surface or within 2 feet above top of liquid surface.
    d. Top of tank wall or under tank cover.

1.03 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
    a. Sanitary Building Drainage and Vent Systems: local plumbing code.
3. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
4. Thrust Restraints:
    a. Design for test pressure shown in Piping Schedule.
    b. Allowable Soil Pressure: 1,000 pounds per square foot.

1.04 SUBMITTALS

A. Action Submittals:

1. Submit catalogue cut sheets for all pipe and fittings furnished with sizes and options called out.

2. Shop Fabricated Piping:
   a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
   b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
3. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
4. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
5. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
6. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
7. Pipe Corrosion Protection: Product data.
8. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements:
   a. Pipe and fittings.
   b. Factory applied resins and coatings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fittings: Manufacturer’s product data sheets for gaskets including torqueing requirements and bolt tightening procedures.
4. Qualifications:
   a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
5. Nondestructive inspection and testing procedures.
6. Test logs.
7. Pipe coating applicator certification.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
   b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
   e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
4. Contractor's CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.

B. Quality Assurance: Provide services of independent inspection and testing agency for welding operations.

1. Note, the presence of Owner's Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.03 JOINTS

A. Grooved End System:

1. Rigid type.
2. Use of flexible grooved joints allowed where shown on Drawings or with prior approval by Engineer.
3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

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

D. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than:
   a. 3 degrees for sizes through 12 inches.
   b. 2 degrees for sizes 14 inches through 16 inches.
   c. 1.5 degrees for sizes 18 inches through 24 inches.
   d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.
5. Manufacturers and Products:
   a. EBAA Iron Inc. Megalug.
      1) DI Fittings: Model 1100.
      2) BI Bells: Model 1700.
      3) PVC to DI Fittings: Model 2000PV.
      4) PVC Bells: Model 2800.
   b. Ford Meter Box Co.
      1) DI Fittings: Model 1400.
      2) DI Bells: Model 1450.
      3) PVC to DI Fittings: Model 1500.
      4) PVC Bells: Model 1350.

E. Flexible Mechanical Compression Joint Coupling:

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

F. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer’s standard. Retorque nuts after 4 hours.
4. Gaskets as specified on Data Sheet.

2.04 GASKET LUBRICANT

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

2.05 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

B. Zinc Coating: Zinc coating where required shall include an exterior layer of zinc applied to conform to ISO 8179 standard. The mass of zinc applied shall be 200 g/m2 of pipe surface area.

C. Polyethylene Encasement (Bagging):

1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 1 inch wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.

2.06 VENT AND DRAIN VALVES

A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.07 FABRICATION

A. Mark each pipe length on outside with the following:

1. Size or diameter and class.
2. Manufacturer's identification and pipe serial number.
3. Location number on laying drawing.
4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.08 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet and Piping Schedule.

B. Galvanizing:

1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
2. Electroplated zinc or cadmium plating is unacceptable.
3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer’s instructions.

3.03 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Keep paper record of which welder welded each joint.

C. Pipe End Preparation:

1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ASME B16.25.

D. Surfaces:

1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.

F. Climatic Conditions:

1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Quality: Meet requirements of governing welding codes.

3.04 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
10. Manufacturer: Same as pipe manufacturer.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.

3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

F. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

G. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

H. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

I. PVDF-Lined Steel Pipe Installation:

1. Cut, make up, and install pipe in accordance with pipe manufacturer’s written instructions.
2. Weld vent extension half-couplings in-place prior to lining pipe.
3. Do not weld on pipe after lining is installed.
4. Prevent plugging of vent extensions with insulation or paint.

J. Fiberglass Reinforced Piping:

1. Cut, fabricate, and install in accordance with manufacturer’s written instructions.
2. Provide manufacturer’s representative for instructing workers on proper installation and jointing methods.
3. Installation shall be made by workers experienced in FRP pipe lay-up techniques.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.06 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes:
   a. Provide flexible mechanical compression joints for pressure pipe.
   b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.
2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    a. Shorter pipe lengths.
    b. Special mitered joints.
    c. Standard or special fabricated bends.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC, or HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.

3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
2. Buried: Coat with zinc and bituminous exterior coating. Wrap with polyethylene bagging.
3. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.

B. Carbon Steel Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.
2. Buried:
   a. Pipe: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating.
   b. Joints: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating, or heat shrink wrap as specified herein.
3. Submerged or Embedded: Shop coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.

C. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

D. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
   b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
2. Buried:
   a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
   b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
   c. Flexible Couplings and Similar Items: Wrap with heat shrink wrap.
   d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
   e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe**.**

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

F. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

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

H. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Where required for electrically insulated connection.
2. Pipe Installation:
   a. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.
   b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
   c. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.09 THRUST RESTRAINT

A. Location:

1. Buried Piping: At all joints in piping.
   a. Thrust blocks are not permissible.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Steel Pipe: Attach with joint harness specified in Section 40 27 01, Process Piping Specialties**.**
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

3.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

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

3.11 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

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

3.12 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines as shown.

3.13 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.14 PIPE IDENTIFICATION

A. As specified in Section 09 90 00, Painting and Coating.

3.15 FIELD QUALITY CONTROL

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

3.16 CLEANING

A. Following assembly and testing, and prior to final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

C. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

D. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.17 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:

1. Piping Schedule Legend.
2. Piping Schedule

Number	Title
40 27 00.01	Cement-Mortar Lined Ductile Iron Pipe and Fittings
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings

END OF SECTION

PIPING SCHEDULE LEGEND

SERVICE

DR	Drain, Process
DS	Digested Sludge
POLY	Neat Polymer
POS	Polymer Solution
RD	Roof Drain
V	Vents
WAS	Waste Activated Sludge
W1	Water-Potable
W2	Water-Backflow Prevented
W3	Water – Plant Reuse

EXPOSURE

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

CLDI	Cement-Lined Ductile Iron
CELDI	Ceramic Epoxy-Lined Ductile Iron
DI	Ductile Iron
NYL	Nylon
PVC	Polyvinyl Chloride
SST	Stainless Steel

JOINT TYPE

FL	Flanged
GR	Grooved
HU	Hub and spigot
PRJ	Proprietary Restrained
RM	Restrained Mechanical
S	Screwed
W	Welded (including solvent and fusion)

PRESSURE TEST

G	Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
H	Hydrostatic
I	In Service
P	Pneumatic
PC	Test per Uniform Plumbing Code
NA	Not Applicable

Piping Schedule										
Service	**Legend**	**Size(s) (In.)[1]**	**Exposure**	**Piping Material**	**Specification Section**	**Joint Type**	**Lining/ Coating[2]**	**Test Pressure and Type (psig-x), x = Type indicated in Legend**	**Pipe Color and Label**	**Remarks**
Water-Potable	W1	<4"	EXP/ENC	SST	40 27 00.08	S		150H	See Note 4	
			BUR	PVC	40 27 00.10	W		100H	See Note 4	Piping buried underneath concrete slabs is to be SST.
		>=4"	ALL	CLDI	40 27 00.01	RM/PRJ/ FL	EXP No. 4 BUR–Zinc coated	150H	See Note 4	
Water-Potable Backflow Prevented	W2	<4"	EXP/ENC	SST	40 27 00.08	S		150H	See Note 4	
			BUR	PVC	40 27 00.10	W		100H	See Note 4	Piping buried underneath concrete slabs is to be SST.
		>=4"	ALL	CLDI	40 27 00.01	RM/PRJ/ FL	EXP No. 4 BUR–Zinc coated	150H	See Note 4	

Piping Schedule										
Service	**Legend**	**Size(s) (In.)[1]**	**Exposure**	**Piping Material**	**Specification Section**	**Joint Type**	**Lining/ Coating[2]**	**Test Pressure and Type (psig-x), x = Type indicated in Legend**	**Pipe Color and Label**	**Remarks**
Water-Plant Reuse	W3	<4"	EXP/ENC	PVC	40 27 00.10	W		150H	See Note 4	
			BUR	PVC	40 27 00.10	W		150H	See Note 4	
		>=4"	ALL	CLDI	40 27 00.01	RM/PRJ/ FL	EXP No. 4 BUR–Zinc coated	150H	See Note 4	
Process Drain	DR	<4"	BUR; ENC/EXP	PVC	40 27 00.10	W	EXP-No. 25	G	See Note 4	
		>=4"	BUR; ENC/EXP	CELDI	40 27 00.01	RM/PRJ/ FL	EXP-No. 2	G	See Note 4	
Waste Activated Sludge	WAS	All	BUR; ENC	CELDI	40 27 00.01	RM/PRJ	Zinc Coated	150 H	See Note 4	
			EXP	CELDI	40 27 00.01	FL	EXP-No. 4	150 H	See Note 4	
Digested Sludge	DS	All	BUR; ENC	CELDI	40 27 00.01	RM/PRJ	Zinc Coated	150 H	See Note 4	
			EXP	CELDI	40 27 00.01	FL	EXP-No. 4	150 H	See Note 4	

Piping Schedule

Service	Legend	Size(s) (In.)[1]	Exposure	Piping Material	Specification Section	Joint Type	Lining/ Coating[2]	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color and Label	Remarks
Neat Polymer	POLY	All	EXP	PVC	40 27 00.10	W	EXP-No. 25	150 H	See Note 4	
Polymer Solution	POS	All	EXP	PVC	40 27 00.10	W	EXP-No. 25	150 H	See Note 4	
Vent	V	All	All	PVC	40 27 00.10	W	EXP-No. 25	Test per Uniform Plumbing Code	See Note 4	

[1]">" Greater Than
"<" Less Than
"<=" Less Than or Equal To
">=" Greater Than or Equal To
"All" All Sizes

[2]Coating system number as specified in Section 09 90 00, Painting and Coating, and as specified in Article Pipe Corrosion Protection.

[3]Pipe identification labels required for all piping per Section 10 14 00, Signage.

[4]Per existing color coding at the Crestview WWTP.

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).
Pipe	Buried Liquid Service Using Push-on, Mechanical, or Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. Buried Air Service Using Mechanical, or Proprietary Restrained Joints: AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	Cement-mortar: AWWA C104/A21.4. Ceramic Epoxy: Pipe and fittings to be ceramic-epoxy lined shall not have been previously lined. Surface preparation shall be made to surfaces free of grease, oil, or other substance with abrasive blasting using clean sand or grit abrasive. Lining shall be done within 8 hours of surface preparation and surfaces shall be reblasted if rusting appears before lining. Line with a total dry film thickness of 40 mils of ceramic epoxy. Ceramic epoxy shall be amine-cured Novolac epoxy with 20 percent minimum volume ceramic quartz pigment, Perma-Shield PL Series 431 by TNEMEC and Permox CTF, “or-equal”, for sewer service. Lining shall be applied above 40 degrees F ambient temperature and shall not be applied to flange faces. Lining thickness shall be tested using a magnetic film thickness gauge. Lining integrity shall be tested on surfaces with a nondestructive, 2,500-volt dielectric resistance test.

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Fittings	Lined and coated same as pipe. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure; Victaulic. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.
Joints	Mechanical: 250 psi minimum working pressure. Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic. Flange: Dimensions per AWWA C110/A21.10 flat face, or ASME B16.1 Class 250 raised face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Couplings	Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. Flanged: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.
Gaskets	General: Gaskets in contact with potable water shall be NSF ANSI 61 certified. Mechanical, and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Flanged, Water, Sewage and Hot Air Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000. Full face for flat-faced flanges, flat-ring type for raised-face flanges. Blind flanges shall be epoxy-lined in accordance with the system specified above. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2-1/2" & smaller	Schedule 40S: ASTM A312/A312M, Type 316 seamless, pickled and passivated.
	3" thru 6"	Schedule 10S: ASTM A312/A312M Type 316L, pickled and passivated.
	8" & larger	Schedule 5S: ASTM A312/A312M, Type 316L, pickled and passivated.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F316 or cast Class 150, ASTM A351/A351M, Grade CF8M/316.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" & larger	Butt-Welded: ASTM A403/A403M, Type 316L pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside. Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240/A240M Type D: 316L "as-welded grade", conforming to MSS SP 43, wall thickness same as pipe. Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Bolting	All	Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Van Stone Flanges and anywhere mating flange on equipment is cast iron and gasket is flat ring: Carbon steel ASTM A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All Flanges	Flanged, Water, Hot Air, Fuel Gas and Sewage Services: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Blind Flanges: Gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape.

END OF SECTION

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gaskets used in the neat polymer and polymer solution piping is to be compatible with and intended for use with emulsion polymer systems.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water. Solvent cement used in the neat polymer and polymer solution piping is to be compatible with and intended for use with emulsion polymer systems.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

B. Informational Submittals:

1. Coupling Harness:
   a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
   b. Weld procedure qualifications.
   c. Load proof-testing report of prototype restraint for any size coupling.

C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

2.02 CONNECTORS

A. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Bronze.
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 500 psig at 70 degrees F.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
   a. U.S. Hose Corp.; Series 300.
   b. Anamet Industrial, Inc.
   c. Unisource Manufacturing, Inc.
   d. Proco Products, Inc.

B. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.

3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.
5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
   a. OPW; Kamlock.
   b. Ryan Herco; 1300 Series.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with liquid epoxy in accordance with AWWA C210.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:

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

C. Transition Coupling for Steel Pipe:

1. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 162.
   b. Smith-Blair, Inc.; Style 413.

D. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.

2. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 913.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 912.

E. Restrained Dismantling Joints:

1. Pressure Rating:
   a. Minimum working pressure rating shall not be less than rating of the connecting flange.
   b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
2. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 131.
   b. Smith Blair, Inc.; Model 975.

F. Exposed Metallic Piping Plain End Couplings:

1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, or equal.

2.04 EXPANSION JOINTS

A. Flexible Metal Hose:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
   a. 3 Inches and Larger: Shop fabricated flanged ends to match mating flanges.
   b. 2-1/2 Inches and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 600 psig at 70 degrees F for 12 inches and smaller.
5. Length: Provide hose live-length equal to lengths shown on Drawings.

6. Manufacturer:
   a. U.S. Hose Corp.; Series 401M.
   b. Anamet Industrial, Inc.; BWC21-1.

2.05 FLEXIBLE EXPANSION JOINTS

A. Design:

1. Ball and socket type for earth settlement compensation.
2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
3. Assembly shall accommodate up to 4 inches of expansion in length.
4. Ductile iron conforming to AWWA C153/A21.53.
5. Rated for 350 psi.
6. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets.
7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
8. Joint connecting to mechanical joint shall be thrust restrained.
9. Bonding:
   a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
   b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
   c. Bond wires shall be 2 AWG with two 12-inch long THHN insulated 12 AWG wire pigtails.

B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend.

2.06 SEAL WATER HOSE

A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.

2.07 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.

4. Materials:
    a. Body: Malleable or ductile iron.
    b. Straps: Galvanized steel.
    c. Hex Nuts and Washers: Steel.
    d. Seal: Rubber.
5. Manufacturers and Products:
    a. Smith-Blair; Series 313 or 366.
    b. Dresser; Style 91.

2.08 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: Mechanical joint outlet.

C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16 inch.
2. Seep Ring:
    a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
    b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
    c. Continuously fillet weld on each side all around.
3. Factory Finish:
    a. Galvanizing:
        1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
        2) Electroplated zinc or cadmium plating is unacceptable.
    b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
   a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
   b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable Pipe Data Sheet.
4. Thrust Collars:
   a. Rated for thrust load developed at 250 psi.
   b. Safety Factor: 2, minimum.
   c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
   a. American Cast Iron Pipe Co.
   b. U.S. Pipe and Foundry Co.

B. Steel or Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar:
   a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
   b. Continuously fillet welded on each side all around.

2.11 MISCELLANEOUS SPECIALTIES

A. Water Hose:

1. Furnish two 50-foot lengths of 1-1/2-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
   a. Goodyear.
   b. Boston.

B. Hose Nozzles:

1. Furnish two 1-1/2-inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.
2. Manufacturers:
   a. Croker.
   b. Elkhart.

C. SSH-2, Safety Shower/Eyewash Combination (Freeze-proof):

1. Manufactures:
   a. Haws.
   b. Western.
   c. Guardian.
2. Shower: ABS plastic deluge.
3. Eyewash: Stainless steel bowl with aerated eye/face wash.
4. Valve: Stay open.
5. Support: Freestanding, 1-1/4-inch galvanized pipe standard, stanchion, and floor flange, cable heated and insulated.

PART 3 EXECUTION

3.01 GENERAL

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

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.

2. Install flexible couplings to facilitate piping installation, in accordance with approved Shop Drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from face of structures; joint may be flush with face.
2. Install a second flexible joint, whether or not shown.
   a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of first joint.

D. Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes. Wrap complete joint assembly in a double layer of polyethylene encasement, as specified in Section 40 27 00, Process Piping—General.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer’s instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
   a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
   b. Clean pipe surface before placing closure collars.

c. Wet nonmetallic pipe thoroughly prior to pouring collars.
d. Prevent concrete from entering pipe.
e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
f. Make entire collar in one placement.
g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.04 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.
3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

C. Anchors: Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES

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

B. Plastic Piping: Nylon-coated iron.

3.06 OUTLET/TAPPING SADDLE

A. Install in accordance with manufacturer’s written instructions.

3.07 COUPLINGS

A. General:

1. Install in accordance with manufacturer’s written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Do not remove pipe coating. If damaged, repair before joint is made.

4. Application:
    a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
    b. Concrete Encased Couplings: Flexible coupling.

3.08 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon bellows connector.
2. Copper Piping: Flexible metal hose connector.
3. Compressor and Blower Discharge: Metal bellows connector.
4. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 PIPE SLEEVES

A. Application:

1. As specified in Section 40 27 00, Process Piping—General.
2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.

B. Installation:

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:
    a. Wall pipes with thrust collars.
    b. Provide taps for stud bolts in flanges to be set flush with wall face.

2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
3. Existing Walls: Rotary drilled holes.
4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.11 MISCELLANEOUS SPECIALTIES

A. Safety shower:

1. Each eyewash station shall have a red safety signoff tag. After completing requirements listed below, Contractor and Owner shall sign red safety signoff tag. Requirements area as follows:
   a. Visually check eyewash piping for leaks.
   b. Verify that upon operation, stay-open valves remain open.
   c. Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws Drinking Faucet Co., Model 9015.
   d. Minimum flow rate for eyewash station shall be 3 gpm.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
3. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
   d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
   e. C509, Resilient-Seated Gate Valves for Water Supply Service.
   f. C510, Double Check Valve Backflow Prevention Assembly.
   g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   k. C542, Electric Motor Actuators for Valves and Slide Gates.
   l. C550, Protective Interior Coatings for Valves and Hydrants.
   m. C606, Grooved and Shouldered Joints.
   n. C800, Underground Service Line Valves and Fittings.

6. ASTM International (ASTM):
    a. A276, Standard Specification for Stainless Steel Bars and Shapes.
    b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
    c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
    d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
    e. B61, Standard Specification for Steam or Valve Bronze Castings.
    f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
    g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
    h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
    i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
    j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
    k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
    l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
    m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
    n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
9. FM Global (FM).
10. Food and Drug Administration (FDA).
11. International Association of Plumbing and Mechanical Officials (IAPMO).
12. Manufacturers Standardization Society (MSS):
    a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
    b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
    c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
    d. SP-88, Diaphragm Valves.
    e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
14. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. Underwriters Laboratories (UL).
16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
    b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
    c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
    d. Power and control wiring diagrams, including terminals and numbers.
    e. For each power actuator provided, manufacturer’s standard data sheet, with application specific features and options clearly identified.
    f. Sizing calculations for open-close/throttle and modulating valves.
    g. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
    a. Electric actuators; full compliance with AWWA C542.
    b. Butterfly valves; full compliance with AWWA C504.
3. Tests and inspection data.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
5. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

PART 2 PRODUCTS

2.01 GENERAL

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

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

   1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SCHEDULE

A. Additional requirements relative to this section are shown on Self-Regulated Valve Schedule located at the end of this section.

2.03 MATERIALS

A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

B. Valve materials in contact with or intended for drinking water service to meet the following requirements:

1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.
3. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

2.04 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF/ANSI 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
      6) Supply AWWA gate valves with stainless steel bolting.
      7) AWWA C509 and AWWA C515 valves may be substituted for each other.
2. Type V100 Gate Valve 3 Inches and Smaller:
   a. All-bronze, screwed bonnet, packed gland, single solid wedge gate, nonrising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 1.
   b. Manufacturers and Products:
      1) Crane; Figure 438, NPT threaded ends.
      2) Stockham; Figure B103, NPT threaded ends.
      3) Crane; Figure 1324, soldered ends.
      4) Stockham; Figure B104, soldered ends.
   c. All-bronze, screwed bonnet, packed gland, single solid wedge gate, rising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 2.
   d. Manufacturers and Products:
      1) Crane; Figure 428, NPT threaded ends.
      2) Stockham; Figure B-100, NPT threaded ends.
      3) Crane; Figure 1334, soldered ends.
      4) Stockham; Figure B-108, soldered ends.
3. Type V120 Gate Valve 3 Inches to 48 Inches for Water Service:
   a. AWWA C500, iron body, bronze mounted, flanged ends, double-disc gate, nonrising bronze stem, working water pressure 200 psi for 3 inches through 12 inches and 150 psi for 14 inches through 48 inches.
   b. Manufacturers and Products:
      1) M&H Valve Company; Style 67.
      2) Clow Valve Company; AWWA C500.

4. Type V122 Gate Valve 3 Inches to 48 Inches for Buried Water Service:
   a. AWWA C500, iron body, bronze mounted, mechanical joint ends, double-disc gate, nonrising bronze stem, 2-inch operating nut, and O-ring sealed stuffing box, working water pressure of 200 psi for 3 inches through 12 inches and 150 psi for 14 inches through 48 inches.
   b. Manufacturers and Products:
      1) M&H Valve Company; Style 67.
      2) Clow Valve Company; AWWA C500.

B. Globe Valves:

1. Type V236 Globe Style Hose Valve 1 Inch to 3 Inches:
   a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, complies with MSS SP-80, rated 300 WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T.
      2) Crane Co.; Cat. No. 7TF.
      3) Nibco; Figure T-235-Y.
2. Type V237 Angle Pattern Hose Valve 1 Inch to 2 Inches:
   a. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, cast brass male NPT by male NHT adapter with hexagonal center wrench nut, complies with MSS SP-80, rated 300 WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-222T.
      2) Crane Co.; Cat. No. 17TF.
      3) Nibco; Figure T-335-Y.

C. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
   a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded:
         a) Conbraco Apollo; 70-100.
         b) Nibco; T-580-70.

2) Soldered:
a) Conbraco Apollo; 70-200.
b) Nibco; S-580-70.

2. Type V308 Stainless Steel ball valve 2 Inches and Smaller.
a. Two piece, standard port, NPT threaded ends, ASTM A351/A351M GR CF8M stainless steel body and end pieces, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout proof stem, rated 1,500 psig WOG minimum, 150 psi SWP, complies with MSS SP-110.
b. Manufactures and Products:
1) Conbraco Apolla; 76-110.
2) Nibco; T-580-S6-R-66-LL.
3) Milwaukee; 20SSOR-02.

3. Type V330 PVC Ball Valve 2 Inches and Smaller:
a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.
b. Manufacturers and Products:
1) Nibco; Chemtrol Tru-Bloc.
2) ASAHI/America; Type 21.
3) Spears; True Union.

4. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1. Provide pressure relief hole drilled on low pressure side of ball.
b. Manufacturers and Products:
1) Nibco; Chemtrol Tru-Bloc.
2) ASAHI/America; Type 21.

D. Plug Valves:

1. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.

b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
c. For buried service, provide external epoxy coating.
d. Operators:
   1) 3-Inch to 4-Inch Valves: Wrench lever manual.
   2) 6-Inch to 12-Inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
e. Manufacturers and Products:
   1) Pratt; Ballcentric.
   2) DeZurik; Style PEC.
   3) Milliken; Millcentric Series 600.

2. Type V420 Nonlubricated Plug Valve 2 Inches and Smaller:
   a. Ductile iron or carbon steel body, Type 316 stainless steel plug with straight-way rectangular ports, Teflon sleeves, screwed ends, wrench operator.
   b. Class: 150.
   c. Rating: 275 psi WOG.
   d. Manufacturers and Products:
      1) Duriron Co.; Figure No. G432.
      2) Tufline; Figure 066.
3. Type V462 Gauge Cock 1/8 Inch to 1/4 Inch:
   a. 1/4-inch bronze body, hexagon end pattern, tee head, male ends, rated 125-pound SWP.
   b. Manufacturer and Product: United Brass Works; Figure 973.
4. Type V464 Corporation Stop 1/2 Inch to 2 Inches:
   a. AWWA C800 type, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads, outlet compression connection or IPS threads to suit connecting pipe, stops 1 inch and smaller rated 100 psi, larger stops rated 80 psi.
   b. Manufacturers and Products:
      1) Ford Meter Box Co.
      2) Mueller Co.

E. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
      4) No travel stops for disc on interior of body.
      5) Self-adjusting V-type or O-ring shaft seals.
      6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
      8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
      9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
      10) Valves to be in full compliance with NSF/ANSI 61.
   b. Non-AWWA butterfly valves to meet the following actuator requirements:
      1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.
2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna N rubber seat and stainless steel seating surface.
   d. Manufacturers and Products:
      1) Pratt; Model 2FII or Triton XR 70.
      2) DeZurik; AWWA Valve.

F. Check and Flap Valves:

1. Type V608 Swing Check Valve 2 Inches to 24 Inches:
   a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with rubber facing, stainless steel hinge shaft.
   b. Valves, 2 inches through 12 inches rated 175-pound WWP. Valves to be fitted with adjustable outside lever and spring. Increasing-pattern body valve may be used where increased outlet piping size is shown.
   c. Manufacturers and Products:
      1) M&H Valve; Style 59, 159, or 259.
      2) Mueller Co.; No. A-2600 Series.
2. Type V640 Double Check Valve Backflow Prevention Assembly 3/4 Inch to 10 Inches:
   a. Two resilient seated check valves, two nonrising stem outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C510, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
   b. Manufacturers and Products:
      1) FEBCO; Model 850.
      2) Danfoss Flomatic; Model DCVE/DCV.
      3) Watts; Series 007/709.

G. Self-Regulated Automatic Valves:

1. Type V754 Sewage Combination Air Valve 2 Inches to 6 Inches:
   a. Suitable for sewage service; combines operating functions of air and vacuum valve and an air release valve. Air and vacuum portion shall automatically exhaust air during filling of a system and allow air to re-enter during draining or when a vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system. Single body unit with air and vacuum valve and an air release valve in a single housing.
   b. Rated working pressure of 150 psi; built and tested to AWWA C512.
   c. Materials: Cast-iron or ductile iron body and covers, NTP threaded inlet and outlet, with concave or skirted stainless steel float and trim.
   d. Sewage air release valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.

e. Manufacturers and Products:
   1) APCO Valve and Primer Corp.; Series 440 SCAV.
   2) Val-Matic Valve; Series 800.

H. Miscellaneous Valves:

1. Type V910 Telescoping Valve, 4 to 36 Inches:
   a. Consists of valve tube that travels inside a rigor pipe.
   b. Tube:
      1) Of sufficient length to facilitate valve travel and maintain appropriate insert depth.
      2) Minimum of 3 mm thick.
      3) Travel: 5 feet, unless otherwise shown.
      4) Top: Plain style, unless otherwise noted or shown.
   c. Lifting Rail: Attaches tube to connecting stem. Same material as tube. Rigidly welded to tube.
   d. Lift and Stem:
      1) Rising, unless otherwise shown.
      2) Handwheel type, with stub acme to provide automatic self-locking, infinite valve positioning.
   e. Materials:
      1) Frame, Rails, Cover, Slides, Yokes: Type 316 stainless steel, unless otherwise noted.
      2) Fasteners: Type 316 stainless steel, unless otherwise noted.
      3) Stem: Type 316 stainless steel, unless otherwise noted.
      4) Gasket: Neoprene rubber.
      5) Mill finish on all stainless steel surfaces. Epoxy paint on all cast iron or steel surfaces.
   f. Manufacturers and Products:
      1) Waterman Telescoping Valve, Model TS-2.
      2) RW Gate Telescoping Valve, Series RW7000S.
2. Type 959 Pressure Reducing/Back Pressure Sustaining Valve 3 inches and Larger:
   a. Standard swing type check valve with adjustable spring to provide adequate and adjustable back pressure.
   b. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with rubber facing, stainless steel hinge shaft.
   c. Valves, 2 inches through 12 inches rated 175-pound WWP. Valves to be fitted with adjustable outside lever and spring.
   d. Manufacturers and Products:
      1) Penn Valley Pump Co., Inc, Model PVP759.
      2) Approved Equal.

3. HV-2 Sanitary Yard Hydrant (Freeze-proof):
    a. Freestanding freeze-proof sanitary yard hydrant with automatic draining, integral ASSE 1050 double check backflow preventer, diverter spout, and drainage reservoir below frost line, 3/4-inch hose connection, 1-inch inlet connection.
    b. The entire working portion of the hydrant shall be removable without excavation.
    c. Bury Depth: Minimum 3 feet.
    d. Manufacturer and Product: Woodford Mfg. Co.; Model S4H.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
    a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
    b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
    c. Operator self-locking type or equipped with self-locking device.
    d. Position indicator on quarter-turn valves.
    e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator’s threaded steel reach rod with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
    a. Galvanized and painted handwheel.
    b. Cranks on gear type operator.
    c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
    d. Valve handles to take a padlock, and wheels a chain and padlock.
3. Buried Operator:
    a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
    b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
    c. Buried valves shall have extension stems, bonnets, and valve boxes.

B. Electric Operators, 120 Volts:

1. General:
   a. Unit shall be low profile to reduce amount of required space and weigh 15 pounds or less.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of the valve.
   c. Provide operator mounting bracket to mount operator to valve providing minimal torque to piping system when operating.
2. Operator Operation, General:
   a. Suitable for full 90-degree rotation of quarter-turn valves.
   b. Manually override handwheel.
   c. Mechanical valve position indication.
3. Electronic Control:
   a. Torque Limiting Switches: Two single pole, double throw mechanical switches. Switches operate at any point in valve travel.
   b. Jammed-valve detection and protection.
   c. Motor over-temperature detection and protection.
   d. Travel limit switches, single pole double throw.
4. Open-Close (O/C) Service:
   a. Duty cycle for intermittent ON-OFF operation shall be 25 percent.
   b. Operator shall power to OPEN and power to CLOSE.
   c. Local Indication and Control:
      1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
      2) Integral OPENED and CLOSED indication lights.
      3) Integral LOCAL-OFF-REMOTE (L-O-R).
      4) Integral OPEN maintained switch which causes the valve to stroke full OPENED, even if OPEN switch is released, while L-O-R switch is in LOCAL.
      5) Integral CLOSE maintained switch which causes valve to stroke full CLOSED, even if CLOSED switch is released, while L-O-R switch is in LOCAL.
   d. Remote Indication and Control:
   e. Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
   f. Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
   g. Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.

C. Manufacturer and Product: Rotork; or approved equal.

2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing valve tag number shown on Self-Regulated Valve Schedule or Drawings.

B. Limit Switch:

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

C. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

1. Manufacturers and Products:
   a. Pratt.
   b. DeZurik.

D. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum depth 3 inches, nonlocking type, marked WATER, SEWER, or GAS as applicable.
3. Extensions: Cast iron, ABS, or PVC pipe.
4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
6. Manufacturers and Products:
   a. East Jordan Iron Works; Cast-Iron Valve Boxes.
   b. Bingham & Taylor; Cast-Iron Valve Boxes.

E. Concrete Valve Box: Designed for traffic loads, sliding type, with minimum of 10-inch ID shaft.

1. Box: High-density, reinforced concrete, minimum depth 12 inches, cast-iron ring seat.
2. Lid: Cast iron, minimum depth 3 inches, nonlocking type, marked WATER, SEWER, or GAS as applicable**.**
3. Extensions: ABS, PVC, or cast-iron pipe.
4. Manufacturers and Products:
   a. Christy Concrete Products; G Series.
   b. BES Concrete Products; G Series.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

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

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

D. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.
   c. Install valves per manufacturer's recommendations.
2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
3. Eccentric Plug Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve as follows:
      1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
      2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
      3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).

4. Butterfly Valves:
    a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
    b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
    c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
    d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
    e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
5. Check Valves:
    a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
    b. Install valve in vertical flow (up) piping only for gas services.
    c. Install swing check valve with shaft in horizontal position.
    d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
6. Solenoid Valves: Install in accordance with manufacturer's instructions.

E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

G. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

H. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

I. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate "L" type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.

E. Set, verify, and record set pressures for relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 MANUFACTURER'S SERVICES

A. Valve(s) as listed below require manufacturer's field services: V910.

B. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for performance testing and completion of Manufacturer's Certificate of Proper Installation.

C. See Section 01 43 33, Manufacturer's Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is part of this Specification.

1. Self-Regulated Valve Schedule.
2. Electric Actuated Valve Schedule

END OF SECTION

Self-Regulated Valve Schedule							
Tag No.*	**Valve Type No.**	**Size (inches)**	**Inlet** Pressure**	**Outlet* Pressure**	**Maximum psig**	**Flow (gpm)**	**Fluid**
40-ARV-22-1	V754	2		5 psi	100	200	DS

* 40-ARV-22-1 to be supplied by BFP manufacturer.

**Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.

Electric Actuated Valve Schedule									
Tag Number	**Valve Type**	**Actuator Power Supply**	**Valve Size (inches)**	**Process Fluid**	**Maximum Operating Flow (gpm)**	**Maximum ΔP (psi)**	**Service**	**Travel Time (Seconds)**	**Control Feature Modifications/ Supplements**
40FV 20-1	V300	120-volt	1 1/2"	W3	120	50	O/C	Manuf. Recommended	B

Service: O/C = Open-Close, T = Throttling, M = Modulating

Control Feature Modifications/Supplements:

A = Actuator shall open valve upon loss of signal.

B = Actuator shall close valve upon loss of signal.

C = Actuator shall remain in last position upon loss of signal.

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
   a. Submit prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
   b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
5. Test Pressure: As indicated on Piping Schedule, or as specified by equipment manufacturer.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

where:

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

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

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2 gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace test and seal individual joints, and retest as specified.

3.04 FIELD QUALITY CONTROL

A. Test Report Documentation:

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

END OF SECTION

SECTION 40 90 00
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Section 40 91 00, Instrumentation and Control Components.
2. Section 40 95 80, Fiber Optic Communication System.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Process instrumentation including primary elements, transmitters, control devices, and control panel modifications.
2. Programmable controller modifications.
3. A complete and operational fiber optic data communication subsystem as shown on the Drawings.
4. At existing Panel CP-B in the existing electrical building, modify the existing Allen-Bradley CompactLogix Programmable Logic Controller (PLC) to meet the functionality shown on the Drawings or indicated in the Loop Specifications.
5. All standard and applications software required at the Plant including but not limited to PLC applications software and all human machine interface (HMI) software standard software.
   a. Include developing new HMI computer graphics for the new I/O at existing PLC-B. Graphics shall include monitoring of all new I/O. Provide HMI graphics that allow the operator to select such parameters as manual/auto, lead pump and manual speed adjust.
   b. The I/O count of new I/O at PLC-B is approximately 28, consisting of 18 discrete inputs, 6 discrete outputs, 2 analog inputs and 2 analog outputs.
6. Standard and Applications Software:
   a. No software is required to be procured and delivered by PIC System Integrator. The PIC System Integrator will be required to use their own development software for programming, configuration, and startup of the system.

b. HMI: Modifications provided by the PIC System Integrator.
c. Reports: Modifications provided by the PIC System Integrator.
d. All Other Standard and Applications Software Including Network Communications Programming: Modifications provided by PIC System Integrator.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section and other PIC subsections:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   d. B32, Standard Specification for Solder Metal.
   e. B88, Standard Specification for Seamless Copper Water Tube.
3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. The International Society of Automation (ISA):
   a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Instrinsic Safety.
   b. S5.1, Instrumentation Symbols and Identification.
   c. S5.4, Instrument Loop Diagrams.
   d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
6. International Conference on Energy Conversion and Application (ICECA).
7. National Electrical Code (NEC).
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, Industrial Control and Systems General Requirements.

9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. FDT: Factory Demonstration Test.
2. HMI: Human-Machine Interface.
3. HVAC: Heating, Ventilating, and Air Conditioning.
4. I&C: Instrumentation and Control.
5. I/O: Input and Output.
6. O&M: Operation and Maintenance.
7. P&ID: Process and Instrument Diagram.
8. PC: Personal Computer.
9. PIC: Process Instrumentation and Control.
10. PLC: Programmable Logic Controller.
11. RTU: Remote Terminal Unit.
12. SCADA: Supervisory Control and Data Acquisition.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and field bus devices.

E. Application Software: The customized software that is configured and programmed to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:

1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
2. Programming in any programming or scripting language.

F. Rising/Falling: Define action of discrete devices about their set point.

1. Rising: Contacts close when an increasing process variable rises through set point.
2. Falling: Contacts close when a decreasing process variable falls through set point.

G. Signal Types:

1. Analog Signal, Current Type:
   a. 4 to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Analog Signal, Voltage Type: 1 to 5 volts dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of PIC Components and PIC Drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.

3. PIC design as shown and specified includes:
    a. Functional requirements, performance requirements, and component specifications.
    b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

B. The PIC System Integrator shall perform the following work:

1. For PIC Equipment and Ancillaries:
    a. Completing detail design.
    b. Submittals.
    c. Equipment, enclosures, and ancillaries.
    d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
    e. Verify readiness for operation.
    f. Verify correctness of final power and signal connections (lugging and connecting).
    g. Adjusting and calibrating.
    h. Starting up.
    i. Testing and coordination of testing.
    j. Training.
2. Verify following Work not by PIC System Integrator is provided:
    a. Correct type, size, and number of signal wires with their raceways.
    b. Correct electrical power circuits and raceways.
    c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
    d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. Non-PIC Equipment Directly Connected to PIC Equipment:
    a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
    b. Coordinate with Contractor to allow required interface and operation with PIC.
    c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
    d. Test to demonstrate required interface and operation with PIC.
    e. Examples of items in this category, but not limited to the following:
        1) Valve operators, position switches, and controls.
        2) Chemical feed pump and feeder speed/stroke controls.
        3) Automatic samplers.

4) Motor control centers.
5) Adjustable speed and adjustable frequency drive systems.

f. Examples of items not in this category:
1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Partial Submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format:
   a. Hard Copy: Required for all submittals.
   b. Electronic Copies: Required, unless otherwise noted for specific items.
      1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
      2) Documents created specifically for Project:
         a) Text and Graphics: Microsoft Word.
         b) Lists: Microsoft Excel, unless otherwise noted for specific items.
         c) Drawings: AutoCAD.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
   a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
   b. Use identical abbreviations in PIC subsections.
   c. Submit updated versions as they occur.
6. Activity Completion:
   a. Action Submittals: Completed when reviewed and approved.
   b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) PIC Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.
      3) Manufacturer, complete model number and all options not defined by model number.
      4) Quantity supplied.
      5) Component identification code where applicable.
      6) For panels, include panel reference number and name plate inscription.
   c. Formats: Hard copy and Microsoft Excel.
2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
   a. Catalog information, marked to identify proposed items and options.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content: Specific features and configuration data for each component, including but not limited to:
      1) Tag Number.
      2) Component type identification code and description.
      3) Location or service.
      4) Service conditions.
      5) Manufacturer and complete model number.
      6) Size and scale range.
      7) Set points.
      8) Materials of construction.
      9) Options included.

10) Power requirements.
11) Signal interfaces.
12) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

c. Electronic Copies: Microsoft Excel.

4. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for Flow Elements:
         a) Minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
   c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
5. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and location of front of panel devices.
   b. Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunicator inscriptions.
   c. Submit electronic copies of Drawings.
6. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
   b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunicator inscriptions.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
   e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
   f. Submit electronic copies of Drawings.
7. Panel Wiring Diagrams:
   a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
   b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.

c. Diagram Type:
   1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
   2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.

d. Item Identification: Identify each item with attributes listed.
   1) Wires: Wire number and color. Cable number if part of multiconductor cable.
   2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
   3) Components:
      a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
      b) Switching action (open or close on rising or falling process variable), set point value and units, and process variable description (for example, Sump Level High).
   4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
   5) Relay Coils:
      a) Tag number and its function.
      b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
   6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
   7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.

e. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.

f. Ground wires, surge protectors, and connections.

g. Wire and Cable Names: Show names and wire color corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.

8. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
   a. Conform to the minimum requirements of ISA S5.4.
   b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
   c. Show loop components within a panel and identify each component, component terminals, and panel terminals.

d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
    1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
    2) Identify the component by tag and description.
    3) Identify panel and component terminal numbers.
e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.
g. One Drawing Per Loop: Show each loop individually. No "typical" loop diagrams will be allowed.
h. Show:
    1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
    2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
    3) Tabular summary on each analog loop diagram:
        a) Transmitting Instruments: Output capability.
        b) Receiving Instruments: Input impedance.
        c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
        d) Total loop impedance.
        e) Reserve output capacity.
    4) Circuit and raceway schedule names.

9. Communications and Digital Networks Diagrams:
    a. Scope: Includes connections to telephone system, Ethernet network, remote I/O, and field bus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
    b. Format: Network schematic diagrams for each different type of network.
    c. Show:
        1) Interconnected devices, both passive and active.
        2) Device names and numbers.
        3) Terminal numbers.
        4) Communication Media: Type of cable.
        5) Connection Type: Type of connector.
        6) Node and device address numbers.
        7) Wire and cable numbers and colors.

10. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
    a. Required voltages, currents, and phases(s). Include calculations and list assumptions.
    b. Maximum heat dissipations Btu per hour. Include calculations and list assumptions.
    c. Maximum permissible internal temperature based on operating range of internal components.
    d. Computed maximum internal temperature. Include calculations and list assumptions. Include the impacts of internal heat generation, solar radiation and shielding.
    e. Use the ambient parameters listed in this section for the applicable service condition.
11. Intrinsic Safety Data: Provide calculations, tables and other data that document entity method application to each circuit using intrinsic safety as a means of dealing with classified area requirements. Include intrinsic safety parameters for devices (maximum voltage allowed, maximum current allowed, internal capacitance, internal inductance, etcetera) and barriers (open circuit voltage, short circuit current, allowed capacitance, and allowed inductance) for all devices in all circuits.
12. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for:
    a. Pipes and Tubes: Thickness, pressure rating, and materials.
    b. Components: Valves, regulators, and filters.
    c. Connections to panel-mounted devices.
    d. Panel interface connections.
    e. Submit electronic copies of Drawings.
13. Installation Details: Include modifications or further details required and define installation of I&C components.
14. HMI Application Software Preliminary Design:
    a. Application Software Standards: Standards and procedures to be used by persons developing, programming, configuring, and testing application software.
        1) Standard graphic display pre-built symbol library.
        2) Alarming and alarm management standard display and operations routine.
        3) Standard color table for process equipment, equipment status, and process piping.
        4) Graphic display hierarchy organization and mapping of displays for operations migration.
        5) Standard trending routine for real and historical trends.
    b. Preliminary layout of Process Graphic Displays.
    c. Preliminary functional graphic objects for:
        1) Analog Display.
        2) Tank or Wet Well Level Display.

3) Constant speed motor display and control.
4) Variable speed motor display and control.
5) Equipment Order Control.
6) Isolation Valve (or Gate) Control.
7) Modulating Valve (or Gate) Control.
8) Solenoid Valve Control.
9) Proportional Integral Derivative Controller.
10) Cascade Controller.
11) Feed Forward Flow Pacing Controller.

d. HMI tag database listing, including tag description, tag type, analog tag ranges, discrete tag zero and one states, and PLC memory location.
e. Preliminary Layout of monthly reports.
f. Provide one copy of the application files saved on compact disk (CD). Engineer may review using the standard software.

15. Spares, expendables, and test equipment.
16. Shop Drawings for Changes Impacting PLC Programming:
    a. Submit details of changes required to PLC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.
    b. Submit changes at 30-day intervals.
17. Color schedule for control panels.
18. Ethernet Network Switch Configuration Document. Complete list of settings, parameters, and configuration details.

C. Informational Submittals:

1. Statements of Qualification:
    a. PIC System Integrator's site representative.
    b. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).
2. PICS Portion of Schedule of Values:
    a. Upon acceptance by Engineer, incorporate in Contractor's Schedule of Values specified in Section 01 29 00, Payment Procedures.
    b. Incorporate proposed Submittal breakdown.
3. PICS Portion of Progress Schedule:
    a. Upon acceptance by Engineer, incorporate in Contractor's Detailed Progress Schedule specified in Section 01 32 00, Construction Progress Documentation.
    b. Incorporate proposed submittal breakdown.

4. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
    a. General:
        1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
        2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
    b. Final versions of Legend and Abbreviation Lists.
    c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
    d. Provide the following items as defined under heading Action Submittals:
        1) Bill of materials.
        2) Catalog cuts.
        3) Instrument list.
        4) Component data sheets.
        5) Detailed Wiring Diagrams: As-built drawings.
            a) Panel wiring diagrams.
            b) Loop diagrams.
            c) Interconnecting wiring diagrams.
        6) Panel plumbing diagrams.
        7) Applications software documentation.
    e. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
        1) Content for Each O&M Manual:
            a) Table of Contents.
            b) Operations procedures.
            c) Installation requirements and procedures.
            d) Maintenance requirements and procedures.
            e) Troubleshooting procedures.
            f) Calibration procedures.
            g) Internal schematic and wiring diagrams.
            h) Component and I/O Module Calibration Sheets from field quality control calibrations.
        2) Provide PDF file will linked index to all manuals.
    f. List of spares, expendables, test equipment and tools provided.
    g. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.
5. Provide Manufacturer's Certificate of Proper Installation where specified.

6. Testing Related Submittals:
    a. Factory Demonstration Test:
        1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
        2) Final Test Procedures:
            a) Proposed test procedures, forms, and checklists.
            b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
        3) Test Documentation: Copy of signed off test results.
    b. Functional Test:
        1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
        2) Final Test Procedures: Proposed test procedures, forms, and checklists.
        3) Test Documentation:
            a) Copy of signed-off test results.
            b) Completed component calibration sheets.
    c. Performance Test:
        1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
        2) Final Test Procedures: Proposed test procedures, forms, and checklists.
        3) Test Documentation: Copy of signed-off test results.
7. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.
8. Maintenance Service Agreement: Prior to Substantial Completion, submit proposed service agreements for work required under Article Maintenance Service.

1.06 QUALITY ASSURANCE

A. Qualifications: PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. General: Refer to Section 01 31 19, Project Meetings, for PIC coordination meetings.
2. PIC Schedule Coordination Meeting:
    a. Timing: Following Engineer review of PIC Schedule.
    b. Purpose: Discuss Engineer's comments and resolve scheduling issues.

3. HMI Application Software Design Meeting:
    a. Timing: Following Engineer review of HMI Application Software Preliminary Design submittal.
        1) Specifically discuss Biosolids Feed Pump control as it relates to the Belt Filter Press. Do not begin developing applications software for this control strategy until this control strategy is discussed.
    b. Purpose: Resolve required changes to proposed HMI Application Software Preliminary Design.
4. Report, Trending and Information Retrieval Design Meeting:
    a. Timing: Following Engineer review of Report and Trend Preliminary Design submittal.
    b. Purpose: Resolve required changes to proposed reports and trend outputs. Discuss printing and scheduling of reports and trend outputs. Discuss retrieval of information from the historian.
5. Training Coordination Meeting:
    a. Timing: Following Engineer review of preliminary training plan.
    b. Purpose:
        1) Resolve required changes to proposed training plan.
        2) Identify specific Owner personnel to attend training.

C. Coordination with Package System Suppliers:

1. Work with suppliers to coordinate the interface to the process control system including, but not limited to, requirements for network connections, installation switches, patch panels, converters, and network cables.
2. Obtain from suppliers a list of proposed or available I/O.
3. Work with suppliers to:
    a. Tailor the list to satisfy project requirements.
    b. Agree on variable engineering units, tag numbering network traffic, and response times.
    c. Coordinate applications software development.

D. Develop and implement a field integration, startup, and testing plan in compliance with PICS and package systems requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements.

B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

A. Refer to Section 01 31 13, Project Coordination, for Contractor's scheduling requirements for applications software testing.

B. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawing Reviews by Engineer:
   a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
   b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
2. HMI Application Software Design Meeting: Engineer review of HMI Application Software Preliminary Design submittal
3. HMI Application Software Completion: HMI Application Software Design Meeting.
4. Report and Trending Software Completion: Report, Trending, and Information Retrieval Design Meeting.
5. Test Prerequisite: Associated test procedures Submittals completed.
6. Training Prerequisite: Associated training plan Submittal completed.
7. PLC and HMI Shipment to Site:
   a. General Prerequisites:
      1) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
      2) FDT completed.
8. PLC and HMI Installation Prerequisite: Equipment received at Site.
9. Functional Test: PLC and HMI installation complete.
10. Performance Test: Functional test completed and facility started up.

1.09 MAINTENANCE

A. Maintenance Service Agreement for PIC system is not included as part of this Contract. Submit to Owner a proposed Maintenance Service Agreement including pricing. Include, as a minimum, the following in the proposed Maintenance Service Agreement:

1. Duration of 1 year unless otherwise noted in PIC subsections.
2. Performed by factory-trained service engineers with experience on PIC systems to be maintained.
3. PIC Systems Covered: PIC components, PLC, and HMI.

4. Materials and labor for preventive maintenance and quarterly Site visits.
5. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m., Monday through Friday.
6. Response Time: Service engineer shall be onsite within 24 hours of request by Owner.
7. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.
8. Repair or replace components or software found to be faulty.
9. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.
10. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone Support: As specified in PIC subsections.

C. Software Subscription: As specified in PIC subsections.

1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Chemical for analyzers.
2. Calibration/test gas for combustible gas detection.
3. Corrosion-inhibiting vapor capsules.
4. pH sensor overhaul kits: Two.
5. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software, whether indicated or not, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals".
2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.

C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Reference PLC Components in Section 40 91 00, Instrumentation and Control Components.

2.04 PLC I/O

A. Physical I/O points are shown on P&IDs and are included in the PLC Input/Output List referenced in Article Supplements. This list is not all-inclusive. Provide any additional I/O, functions or operations required to provide a completely operational system. Note that this list does not show the PLCs diagnostic fault detection points which are required. In cases of conflict between P&IDs and the PLC I/O lists, P&IDs take precedence.

B. Spare I/O:

1. Provide each PLC with installed spare I/O points.
   a. For the specific case of PLC-B, install one DI and one DO card. Existing AI and AO spares will be used for new analog signals.
2. Wire all spare I/O to terminal blocks and, where required, surge suppressors so that it is ready for field termination.

C. Spare Slots:

1. Provide at least four spare slots at a given location, i.e. PLC or remote I/O rack.
2. If the above constraint exceeds the PLC vendor's maximum number of slots available for a given rack model, provide sufficient subpanel space to install a future rack.
3. Size panel to include space for future I/O. Panel to include space for future terminal blocks, surge suppressors, and interposing relays for each of the I/O for each of the spare slots.
   a. Unless otherwise noted, size panel assuming one of each type module for each of the four spare slots.
   b. For CP-95, size panel assuming two of each type module for eight spare slots.
   c. Provide DIN rail to allow future connection of I/O modules.

D. Separate I/O Modules for Parallel Controlled Modules: For controlled critical equipment, to improve reliability, provide separate discrete and analog output modules for parallel controlled equipment. For instance, if there are a total of three pumps in a pump station, provide two sets of output modules. Wire two pumps to one module and the third to a second module.

E. Cables: Provide all cables for interconnecting PLC components both inside individual panels and between panels or remote devices.

F. Interposing Relays:

1. Provide an interposing relay in the circuit for each Discrete Output (DO).
2. Installed Spare Interposing Relays: Provide 30 percent installed spare interposing relays for the DO circuits.

2.05 CABLING, NETWORK AND HMI COMPONENTS

A. Reference PIC subsections.

B. Metallic Ethernet Cabling:

1. CAT6: Meets or exceeds ANSI/TIA/EIA-568-C.2 CAT6.
2. Plenum Rated:
   a. Includes flame-retardant PVC jacket and FEP insulation.
   b. CMP, FT6 Compliant.

2.06 SERVICE CONDITIONS

A. Standard Service Conditions: The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:

1. Computer Room, Air Conditioned:
   a. Temperature: 60 degrees F to 80 degrees F.
   b. Relative Humidity: 40 percent to 60 percent.
   c. NEC Classification: Nonhazardous.
2. Inside, Air Conditioned:
   a. Temperature:
      1) Normal: 60 degrees F to 80 degrees F.
      2) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
   b. Relative Humidity:
      1) Normal: 10 percent (winter) to 70 percent (summer).
      2) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
   c. NEC Classification: Nonhazardous.
3. Inside:
   a. Temperature: 15 degrees F to 100 degrees F.
   b. Relative Humidity: 0 percent to 100 percent.
   c. NEC Classification: Nonhazardous.
4. Inside, Corrosive:
   a. Temperature: 15 degrees F to 100 degrees F.
   b. Relative Humidity: 0 percent to 100 percent.
   c. Corrosive Environment: Hydrogen sulfide gas.
   d. NEC Classification: Nonhazardous.
5. Inside, Hazardous:
   a. Temperature: 15 degrees F to 100 degrees F.
   b. Relative Humidity: 0 percent to 100 percent.
   c. NEC Classification: As shown on Electrical Drawings.
6. Outside:
   a. Temperature: 15 degrees F to 100 degrees F.
   b. Relative Humidity: 0 percent to 100 percent, rain.
   c. NEC Classification: Nonhazardous.

7. Outside, Corrosive:
   a. Temperature: 15 degrees F to 100 degrees F.
   b. Relative Humidity: 0 percent to 100 percent, rain.
   c. Corrosive Environment: Hydrogen sulfide gas.
   d. NEC Classification: Nonhazardous.
8. Outside, Hazardous:
   a. Temperature 15 degrees F to 100 degrees F.
   b. Relative Humidity: 0 to 100 percent, rain.
   c. NEC Classification: As shown on Electrical Drawings.

B. Standard Service Conditions for Panels and Consoles: Unless otherwise noted, in Instrument List and Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:

1. Freestanding Panel and Consoles:
   a. Inside, Air Conditioned: NEMA 1.
   b. Inside: NEMA 12.
2. Smaller Panels and Assemblies (that are not freestanding):
   a. Inside, Air Conditioned: NEMA 12.
   b. All Other Locations: NEMA 4X.
3. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.07 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Materials: Laminated plastic attached to panel with stainless steel screws.
2. Letters: 1/2-inch high, black on white background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, black on white background, unless otherwise noted.

C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.

2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, black on white background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
   c. Refer to P&IDs on Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch high, imposed.
4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.08 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.09 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs or panel control diagrams.

C. Supplemented by standard functional requirements in PIC subsections.

2.10 LOOP SPECIFICATIONS

A. See Article Supplements located at End of Section.

B. Organization: By unit process and loop number.

C. Loop Subheadings:

1. Hardwired Special Functions: Clarifies functional performance of loop, including abstract of complex interlocks for hard wired logic, for example in MCCs and control panels.
2. PLC Special Functions: Specifies nonstandard PLC functions. When required for clarification, additional definition is shown by logic diagrams or sequence diagrams on Drawings.
3. HMI Special Functions: Specifies nonstandard HMI functions.

2.11 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

B. Wiring External to PIC Equipment:

1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

D. Wires within Enclosures:

1. AC Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits:
   a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
   b. Panels with Circuits Less than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
   c. Size: No. 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than No. 18 AWG.
4. Special Signal Circuits: Use manufacturer’s standard cables.

5. Wire Identification: Numbered and tagged at each termination.
    a. Wire Tags: Machine printed, heat shrink.
    b. Manufacturers:
        1) Brady Perma Sleev.
        2) Tyco Electronics.

E. Terminate and identify wires entering or leaving enclosures as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals terminated using manufacturer's standard connectors.
3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.

F. Terminal Blocks for Enclosures:

1. Quantity:
    a. Accommodate present and spare indicated needs.
    b. Wire spare PLC I/O points to terminal blocks.
    c. One wire per terminal for field wires entering enclosures.
    d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
    e. Spare Terminals: 20 percent of connected terminals, but not less than 5 per terminal block, unless otherwise shown on Drawings.
2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
    a. Locate signal ground at dc power supply for loop.
    b. Use to ground wire shields for loop.
    c. Group and ground wire shields in following locations:
        1) Locate signal ground at dc power supply for loop.
        2) Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
   a. Is separated from nonintrinsically safe circuits as specified by NEC.
   b. Is colored light blue and has message “Intrinsically Safe Circuits Only” on raceway cover every 6 inches.

J. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer’s standard connectors for the device to which the signals terminate.

K. Electrical Transient Protection:

1. General:
   a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   b. Show suppressors on Shop Drawings.
   c. Furnish, install, coordinate, and inspect grounding of surge suppressors:
      1) For both analog and ac power signals, as shown on the P&IDs, where “SS-X” means “Surge Suppressor, Type X.”
2. Products: Surge suppressors shall conform to the requirements of the Surge Suppressor Products Table, which is a Supplement to this section.
3. Installation and Grounding of Suppressors:
   a. As shown. See Surge Suppressor Installation Details.
   b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.
   c. The PIC System Integrator shall coordinate with the Electrical Subcontractor to ensure that the suppressors have been installed and grounded properly.

2.12 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: Refer to Control Panel Schedule in Article Supplements for maximum external dimensions allowed for individual control panels.

2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
3. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
4. UL Listing Mark for Enclosures:
    a. Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
    b. Mark shall include the unique serial number for the listed panel.
5. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Inner Swing-Out Panel(s):

1. Unless otherwise noted, furnish an inner swing-out panel for each control panel. Provide either a full length swing-out panel or two half swing-out panels.
2. Install all circuit breaker(s) on the swing-out panel(s) to completely de-energize the panel. The operator shall be able to completely de-energize the panel by placing these circuit breaker(s) in the Off position.
3. Install other components; for example, relays, PLCs, power supplies on the back panel behind the inner swing-out panel.

C. Data Ports:

1. Provide a dataport on the front of the following control panels:
    a. CP-B.
    b. CP-95.
    c. CP-10-2.
2. Purpose of the dataport is to allow programming the PLC or accessing its registers without opening the front door. Dataport location will be reviewed during the submittal process.
3. Ports:
    a. One NEMA 5-15R non-GFCI duplex receptacle, minimum.
    b. One RJ-45 Ethernet port, minimum.
    c. One USB port, minimum.
4. Construction:
    a. NEMA Type 4/12 rating.
    b. Powder coated steel.
    c. Quarter turn latch with lock.
5. Features:
    a. 5-amp circuit breaker.
    b. Door Gasket.
6. Manufacturer and Product: Hoffman, Intersafe Data Interface Ports.

D. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. Ventilated Panels:
      1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
      2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
      3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
      4) Louver Construction: Stamped sheet metal.
      5) Ventilation Fans:
         a) Furnish where required to provide adequate cooling.
         b) Create positive internal pressure within panel.
         c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
      6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
   c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
3. Space Heaters:
   a. Thermostatically controlled to maintain internal panel temperatures above dew point.
   b. Refer to Control Panel Schedule in Article Supplements.

E. Freestanding Panel Construction:

1. Materials:
   a. Sheet steel, unless otherwise noted in Control Panel Schedule in Article Supplements.
   b. Minimum Thickness: 10-gauge, unless otherwise noted.
2. Panel Front:
   a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
   b. No seams or bolt heads visible when viewed from front.
   c. Panel Cutouts: Smoothly finished with rounded edges.
   d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.

3. Internal Framework:
    a. Structural steel for instrument support and panel bracing.
    b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Door:
    a. Full height, fully gasketed access door where shown on Drawings.
    b. Latch: Three-point, Southco Type 44.
    c. Handle: “D” ring, foldable type.
    d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
    e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
    f. Front and Side Access Doors: As shown on Drawings.

F. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
    a. Panels listed as inside, air conditioned:
        1) Enclosure Type: NEMA 12.
        2) Materials: Steel.
    b. Other Panels:
        1) Enclosure Type: NEMA 4X.
        2) Materials: Type 316 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
    a. Rubber-gasketed with continuous hinge.
    b. Three-point latching mechanisms.
        1) For NEMA 4X panels, latch shall be NEMA 4X rated.
4. Manufacturers:
    a. Hoffman Engineering Co.
    b. H. F. Cox.

G. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels:

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

H. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
      2) Make provisions for feeder circuit conduit entry.
      3) Furnish terminal block for termination of wires.
   b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
      1) Locate to provide clear view of and access to breakers when door is open.
      2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
         a) Branch Circuit Breakers: 15 amps at 250V ac.
      3) Breaker Manufacturers and Products: Refer to Division 26, Electrical.
   c. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
      1) Devices on Single Circuit: 20, maximum.
      2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
      3) Branch Circuit Loading: 12 amperes continuous, maximum.
      4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
      5) Provide 120V ac plugmold for panel components with line cords.
2. Signal Distribution:
   a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
   b. Within Panels: 4 to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 to 20 mA dc only.
   d. Signal Wiring: Twisted shielded pairs.
   e. RTD and Thermocouple Extension Cable:
      1) Continuous field to panel with no intermediate junction boxes or terminations.
      2) RTDs in motor windings are considered a 600-volt circuit.
      3) Terminate thermocouple extension wire directly to loop instrument.
3. Signal Switching:
   a. Use dry circuit type relays or switches.
   b. No interruption of 4 to 20 mA loops during switching.

c. Switching Transients in Associated Signal Circuit:
   1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
   2) 1V dc to 5V dc Signals: 0.05V, maximum.

4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
   a. Type: Switched 100-watt incandescent back-of-panel lights.
   b. Quantity: One light for every 4 feet of panel width.
   c. Mounting: Inside and in the top of back-of-panel area.
   d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
   b. Quantity:
      1) Panels 4 Feet Wide and Smaller: One.
      2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
   c. Mounting: Evenly spaced along back-of-panel area.
8. Internal Panel Lights and Service Outlets for Smaller Panels:
   a. Internal Panel Light: Switched 100-watt incandescent light.
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle:
   c. Required for panels. Refer to Control Panel Schedule in Article Supplements.
9. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

10. Standard Light Colors and Inscriptions:
    a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green

Tag Function	Inscription(s)	Color
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber

I. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
   a. Locking-fork-tongue or ring-tongue lugs.
   b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
   c. Wires terminated in a crimp lug, maximum of one.
   d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
   a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
   b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.

12. Conductors Carrying Foreign Voltages within a Panel:
    a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
    b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
    a. 120V ac: No. 14 AWG, MTW.
    b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
14. Panelwork:
    a. No exposed connections.
    b. Allow adjustments to equipment to be made without exposing these terminals.
    c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
15. Plastic Wire Ducts Color:
    a. 120V ac: White.
    b. 24V dc: Gray.
    c. Communications Cables and Fiber Optic Jumpers: Orange.
16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

J. Control Relay Arrangement:
    1. Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels.
    2. Spares:
        a. Unless otherwise noted, provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.
        b. For CP-95, provide 100 percent space for future relays.

K. Factory Finishing:

    1. Furnish materials and equipment with manufacturer’s standard finish system in accordance with Section 09 90 00, Painting and Coating.

2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
3. Stainless Steel and Aluminum: Not painted.
4. Nonmetallic Panels: Not painted.
5. Steel Panels:
    a. Sand panel and remove mill scale, rust, grease, and oil.
    b. Fill imperfections and sand smooth.
    c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
    d. Sand surfaces lightly between coats.
    e. Dry Film Thickness: 3 mils, minimum.
    f. Color: Manufacturer's standard.

2.13 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
    a. Northern Instruments; Model Zerust VC.
    b. Hoffmann Engineering; Model A-HCI.

2.14 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer's decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
    a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
    b. Describe each test item to be performed.
    c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
    a. Provide special testing materials and equipment.
    b. Wherever possible, perform tests using actual process variables, equipment, and data.

c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
d. Define simulation techniques in test procedures.
e. Test Format: Cause and effect.
1) Person conducting test initiates an input (cause).
2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
a. Interconnect and test PIC, except for primary elements and smaller panels.
b. Exercise and test functions.
c. Provide stand-alone testing of smaller panels.
d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
b. Perform FDT on all panels listed in Control Panel Schedule in Article Supplements.
3. Location: PIC System Integrator's facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
a. Simulate each discrete signal at terminal strip.
b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications: All required and shown functions.
7. Nonloop-Specific Functions:
a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
b. Timing: Include tests for timing requirements.

c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
d. Trends and reports.
e. Communication Watchdog function.
f. Ethernet Network Management.
g. Fiber optic ring self-healing.
h. Application Security.
i. Power outage recovery.
j. HMI Server Redundancy.

8. Correct deficiencies found and complete prior to shipment to Site.
9. Failed Tests:
   a. Repeat and witnessed by Engineer.
   b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
10. Make following documentation available to Engineer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.
    d. Approved hardware Shop Drawings for equipment being tested.
    e. Approved preliminary software documentation Submittal.
11. Daily Schedule for FDT:
    a. Begin each day with meeting to review day's test schedule.
    b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.
4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

D. Mechanical Systems:

1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
4. Tubing and Conduit Bends:
    a. Tool-formed without flattening, and of same radius.
    b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
    c. Slope instrument connection tubing in accordance with installation details.
    d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
    e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
    f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
    g. Blow debris from inside of tubing.
    h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
    i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
    j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
    k. Provide separate support for components in tubing runs.

l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
m. Keep tubing and conduit runs at least 12 inches from hot pipes.
n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
o. Securely attach tubing raceways to building structural members.

5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During preparation for testing, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.
2. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation.
    a. Loop/Component Inspections and Tests:
        1) These inspections and tests will be spot checked by Engineer.
        2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
        3) Provide space on forms for signoff by PIC System Integrator.
        4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
            a) Project name.
            b) Loop number.
            c) Tag number for each component.
            d) Checkoffs/Signoffs for Each Component:
                (1) Tag/identification.
                (2) Installation.
                (3) Termination wiring.
                (4) Termination tubing.
                (5) Calibration/adjustment.
            e) Checkoffs/Signoffs for the Loop:
                (1) Panel interface terminations.
                (2) I/O interface terminations with PLCs.
            f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
            g) Total loop operational.
            h) Space for comments.
        5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs, I/O module and include the following:
            a) Project name.
            b) Loop number.
            c) Component tag number or I/O module number.
            d) Component code number for I&C elements.
            e) Manufacturer for I&C elements.
            f) Model number/serial number for I&C elements.

g) Summary of Functional Requirements; For Example:
(1) Indicators and recorders, scale and chart ranges.
(2) Transmitters/converters, input and output ranges.
(3) Computing elements' function.
(4) Controllers, action (direct/reverse) and control modes (P, I, D).
(5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
(6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
(1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
(2) Discrete Devices: Actual trip points and reset points.
(3) Controllers: Mode settings (P&ID).
(4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
(5) Space for comments.

b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.

c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.

d. FDT-Repeat:
1) Repeat FDT onsite with installed PIC equipment and software.
2) As listed in PIC subsections, certain portions of FDT may not require retesting.
3) Use FDT test procedures as basis for this test.
4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.

e. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.

3. Functional Test:
a. Scope: Confirm PIC, including applications software, is ready for operation.
b. Refer to PIC subsections for additional requirements.
c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

F. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Demonstrate report generation. Confirm reports include the required information in the required format.
6. Demonstrate trending. Print out sample trends specifically requested by operations staff. Confirm trends are in the proper format, correctly labeled and time stamped.
7. Demonstrate that information can be successfully retrieved from the historian. Retrieve information specifically requested by the operations staff.
8. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
9. Make O&M data available to Engineer at Site both before and during testing.
10. Follow daily schedule required for FDT.
11. Determination of Ready for Operation: When Functional Test has been completed.
12. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: As required by each PIC subsection.

B. Specialty Equipment: For certain components or systems provided under this section, but not manufactured by PIC System Integrator, provide services of qualified manufacturer's representative during installation, startup, demonstration testing, and training. Provide original equipment manufacturer's services for:

1. F4, Flow Element and Transmitter, Electromagnetic, 1-day minimum.

3.05 TRAINING

A. General:

1. Provide an integrated training program for Owner's personnel.
2. Perform training to meet specific needs of Owner's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
5. Owner reserves the right to reuse videotapes of training sessions.

B. Operations and Maintenance Training:

1. General:
   a. Refer to specific requirements specified in PIC Subsections.
   b. Include review of O&M data and survey of spares, expendables, and test equipment.
   c. Use equipment similar to that provided.
   d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Owner's operations personnel on operation of I&C components.
   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: Two.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.

e. Content: Conduct training on loop-by-loop basis.
   1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
   2) Loop Operation: For example, adjusting process variable set points, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunicator acknowledgement and resetting.
   3) Interfaces with PIC subsystems.

3. Maintenance Training:
   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: One.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed for routine maintenance of PIC.
   e. Content: Provide training for each type of component and function provided.
      1) Loop Functions: Understanding details of each loop and how they function.
      2) Component calibration.
      3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
      4) Troubleshooting and diagnosis for equipment and software.
      5) Replacing lamps, chart paper, and fuses.
      6) I&C components removal and replacement.
      7) Periodic preventive maintenance.

3.06 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.08 SUPPLEMENTS

A. Supplements listed below, follows “End of Section,” are part of this Specification.

1. Supplement 1, Control Strategy Narratives.
2. Supplement 2, Instrument Component and Panel Lists.
3. Supplement 3, PLC Input/Output List.
4. Supplement 4, Surge Suppressor Products Table.

END OF SECTION

Control Strategy Narratives

Crestview WWTP Solids Handling Project

City of Crestview, Florida

Contents

Table(s)

No table of contents entries found.

Acronyms and Abbreviations

gph	gallon(s) per hour
gpm	gallon(s) per minute
HMI	human-machine interface
lb/gal	pound(s) per gallon
LSHH	high, high level switch
LSH	high level switch
LSL	low level switch
LSLL	low, low level switch
mA	milliampere(s)
mg/L	milligrams per liter
OIU	operator interface unit
PID	proportional integral derivative
PLC	programmable logic controller
PV	process value
SCADA	supervisory control and data acquisition

Definitions

Adjustable	Viewable and adjustable from the human-machine interface (HMI).
Local (Hand)	Control is performed local to the device.
Remote	This is a manual hand switch position that is wired as an input to the PLC. When this position is selected, the final control element or device is controlled by the main plant PLC system.
Manual	This is a software-provided hand switch position. This software switch is only active when the hardware hand switch has already been placed in the REMOTE position. When the hardware switch is in REMOTE and the software switch is in MANUAL, the output will be manually controlled by the operator to either the ON output state or the OFF output state.
Auto	This is a software-provided hand switch position. This software switch is only active when the hardware hand switch has already been selected to the REMOTE position. When the hardware switch is in REMOTE and the software switch is in AUTO, the main plant PLC will automatically control the output functions.
Off	This is a software-provided hand switch position. This software switch is only active when the field switch is in REMOTE and the software switch is in MANUAL. When the OFF switch is selected, the output from the PLC to the device will be de-energized.
On	This is a software-provided hand switch position. This software switch is only active when the Field switch is in REMOTE and the software switch is in MANUAL. When the ON switch is selected, the output from the PLC to the device will be energized.
Interlock	A condition that causes the control system to force a device or devices to a pre-determined state. This state is off or closed unless otherwise noted.
Out of Service	A device can be flagged as In Service or Out of Service from the HMI. The purpose of the flag would be to notify other personnel who may be viewing the graphics that the particular device is not available for operation. This is not a replacement for proper lock out/tag out procedures. Alarms for a device will be masked when it is Out of Service. Run commands to a device will be disabled when it is Out of Service.
Permissive	A condition that must be met for a device or sequence to be activated. For example, sufficient available volume in a backwash waste tank is occasionally used as a permissive to start a backwash sequence.
Operator Adjustable	Adjustable from the HMI

1. Global Functions

1.1 Device Controls

The control narrative shall specify some functions for all motor-driven devices. If done globally, any exceptions for a specific device shall be identified specifically in that devices section of the control narrative. These functions include:

- A device in Remote/Auto shall have its run command removed and placed Off on the following (device will remain in Remote/Auto and can resume automatic function once device is once again available for operation):
  - Placement into out of service at the human-machine interface (HMI)
  - Field mode selector switch taken out of Remote (that is, in LOCAL mode)
  - Software-generated device failure
  - Field input failure
  - Power fail
- A device in Remote/Manual shall have its run command removed and be placed in Manual and Off on:
  - Placement into out of service at the human-machine interface (HMI)
  - Field mode selector switch taken out of Remote (that is, in LOCAL mode)
  - Software-generated device failure
  - Field input failure
  - Power fail
- HMI selection of In Service or Out of Service
- Runtimes and starts shall continue to be collected and displayed while a device is in LOCAL.
- **Fail Reset:** When the equipment fails because of an alarm condition, the fail reset must be used to clear the alarm and re-enable the equipment for use.
- **Fail to Start/Open:** A piece of equipment that is commanded to run/open from the programmable logic controller (PLC), but is not confirmed running/opened within 30 (device-specific) seconds generates a fail to start/open alarm. Unless otherwise noted, running is confirmed by receiving an On status input, and open is confirmed by receiving the Open status input. This alarm requires a fail reset. This alarm will remove the start command from the equipment and place the device in Remote/Auto/Off.
- **Fail to Stop/Close:** A piece of equipment that is commanded to stop/close from the PLC, but is not confirmed off/closed within 30 (device specific) seconds generates a fail to stop/close alarm. Unless otherwise noted, off is confirmed by not receiving an ON status input, and closed is confirmed by receiving the CLOSED status input. This alarm will remove the start command from the equipment and place the deice in Remote/Auto/Off.
- **Elapsed Runtime:** Calculate total time (in tenths of an hour) a device has been in operation (motors only).
- **Cycle Count:** Count the number of cycles a piece of equipment undergoes. One cycle is defined as the transition from Off to On or from Closed to Open.

1.2 Alarms

Logic shall ensure that nuisance alarms are not generated. Technique shall include masking based on process status, and including deadbands and/or timers to provide delays for intermittent signal or process noise. All analog points shall have high high, high, low, and low low alarms available. Those not required shall be masked in the program and on the HMI. The high and low will typically be alarms with automatic reset. The high high and low low will typically be alarms with associated interlocks in the logic and require operator reset. All analog points shall include the ability to force a value, for use when equipment is offline (for example, for calibration). The actual field value will also be displayed during the force active. An alarm for analog signals to indicate that the input signal is out of range (less than 2 milliamperes [mA] or greater than 22 mA) shall be provided.

2. Common Functions

2.1 Duty/Standby Equipment

There are certain processes that require two identical pieces of equipment to serve as duty and standby equipment for redundancy and process reliability.

For duty/standby control to be functional, both the duty and standby pieces of equipment must be available for use. the operator shall be able to select which piece of equipment is the duty piece of equipment, and which is standby, via the supervisory control and data acquisition (SCADA) HMI, provided both pieces of equipment are available for use. Selecting a particular piece of equipment as the duty equipment shall automatically switch the redundant piece of equipment as standby, and vice versa.

Under normal operation in Auto mode, the duty equipment shall be used as the primary piece of equipment, and shall start or stop as requested based on the associated automatic process control logic. If the duty piece of equipment fails, as determined by an alarm condition or device failure, the standby equipment shall be brought online as the new duty piece of equipment, and started or stopped as required by the process. The equipment whose alarm state indicated failure shall be switched to standby mode upon failure.

Once any alarm conditions have cleared and been acknowledged, the equipment shall again be switchable between duty and standby, as described previously, by the operator via the SCADA HMI.

Any equipment that is out of service shall automatically be switched to standby, and the redundant, in-service piece of equipment shall be automatically switched to duty mode, without further operator intervention. The equipment shall not be switchable out of this mode until both pieces of equipment are again available for service.

2.2 Lead/Lag/Standby Equipment

There are certain processes with redundant pieces of equipment for a particular process, sized to handle only a portion of the process capacity. The equipment is brought online in stages, based on the process capacity requirements. Typically the first or lead piece of equipment is started to handle the minimum process capacity. As capacity requirements increase, the lag equipment is started in sequence to handle the capacity increase. There can also be more than one lag position, depending on the number of pieces of equipment used in the process.

The operator shall be able to assign the equipment to a lead, lag, or standby positions. The operator shall be able to choose at the HMI which pieces of equipment are assigned to any of the positions.

Equipment assigned to operate in this fashion shall need to be in Remote Auto mode to be included in the duty table, otherwise that particular equipment shall not be available for starting based on the process requirements. When equipment is in this mode, it shall be available to run as part of the sequencing set up in a duty table for the process.

Regardless of the control mode, the run status of all equipment associated with the particular process shall be considered when determining which equipment should run based on process requirements. For example, if a certain process requires a single pump to run, and a pump is currently running in manual,

the fact that this pump is running shall be considered to determine if the process capacity requirements have been satisfied.

Under normal operation in Auto mode, the equipment shall start or stop as requested based on the associated automatic process control logic. If any piece of equipment fails, as determined by an alarm condition or network failure, the standby piece of equipment in the duty sequence table shall be started as required by the process, and this piece of equipment shall become the new lead. The equipment whose alarm state indicated failure shall be taken out of the duty table until the alarm condition is cleared and acknowledged. Once these conditions are met, the piece of equipment can be returned to the duty table in the standby position. Any equipment that is out of service shall be taken out of the duty table as well.

2.3 Proportional Integral Derivative (PID) Controller

The PID controller shall have the following features:

- Proportional, Integral and Derivative functions.
- Derivative selectable on process value or error.
- Error deadband.
- Output deadband.
- AUTO and MANUAL modes.
- LOCAL and REMOTE setpoint modes.
- Bumpless transfer between AUTO and MANUAL modes.
- Bumpless transfer between REMOTE and LOCAL setpoint modes (where REMOTE setpoint mode is implemented).
- Anti-reset windup.
- Process value signal failure response: Unless otherwise noted, the Analog control shall transfer into Manual when signal failure is detected on the Process variable. Provide an HMI alarm that indicates that the loop was set to MANUAL.
- Hold State: Output is frozen and controller values adjusted to provide bumpless transfer at exit from hold state.
- Deviation alarm: An alarm that is activated when the controller has been in AUTO and the difference between the active set point and process value is greater than a preset amount for greater than a preset period.

2.4 Control Narratives

2.4.1 Aerobic Digester Aerators (08-N-6001)

2.4.1.1 Process Overview

Each digester contains one floating aerator, 20-MIX-30-1 and 20-MIX-40-1. The aerators are used to continuously mix and oxygenate the sludge for aerobic digestion.

The aerators are controlled by MCC C4.

2.4.1.2 Control Narrative

Manual Start/Stop control of each aerator shall be provided via HAND/OFF/REMOTE selector switch on MCC C4 The motors have associated high temperature sensors that shall stop the aerator from running until reset using the pushbutton on the MCC.

The MCC shall include an Aerator Fault alarm. The aerators shall not be allowed to run while the aerator is faulted.

In addition to the functionality previously described, provide the following at MCC C4:

- Digester Aerator Running pilot lights (2)
- Digester Aerator Alarm pilot lights (2)
- Digester Aerator Reset pushbuttons (2)

Provide control of the aerators from SCADA when the equipment is in the Remote mode.

- The operator may utilize the HMI for remote, manual control of the Aerators.
- Provide a cycle timer in the HMI for operating the Aerators with operator-adjustable ON and OFF times that will apply to each Aerator when placed in remote, auto control.

2.4.2 Intermediate Sludge Pumps (08-N-6001)

2.4.2.1 Process Overview

Intermediate Sludge Pumps transfer sludge from the new Digesters 3 and 4 to the inlet piping on the existing Digesters 1 and 2. The intermediate sludge pumps can be turned off and bypassed to convey sludge to the existing Digesters 1 and 2 via gravity, the Sludge Drying Beds, the existing Belt Filter Press, or the new Biosolids Pump Station which services the new Belt Filter Press.

2.4.2.2 Control Narrative

Control logic for the Intermediate Sludge Pumps shall reside in the local control panel 25-LCP-10-1

Manual Start/Stop control of each pump shall be provided via HAND/OFF/REMOTE selector switch on 25-LCP-10-1.

The LCP shall include the following alarms. The pumps shall not be allowed to run while the pump alarms are active.

- Pump Fault alarm
- Pump high discharge pressure alarm
- Digester 1 and Digester 2 high level alarms

In addition to the functionality previously described, provide the following at 25-LCP-10-1:

- Intermediate Sludge Pump Running pilot lights (2)
- Intermediate Sludge Pump Alarm pilot lights (2)
- Intermediate Sludge Pump Reset pushbuttons (2)
- Digester Level displays (4)

Provide control of the pumps from SCADA when the equipment is in the Remote mode.

- The operator may utilize the HMI for remote, manual control of the Intermediate Sludge Pumps.
- Provide a cycle timer in the HMI for operating the pumps with operator-adjustable ON and OFF week-days and times that will apply to each pump when placed in remote, auto control. When both pumps are placed in remote, the pumps are to operate as a duty/standby arrangement. Alternate duty pump selection after each On/Off run cycle.

2.4.3 BFP Biosolids Feed Pumps (08-N-6002)

2.4.3.1 Process Overview

BFP Biosolids feed pumps use AFDs to supply a consistent flow of digested sludge to the Belt Filter Press (BFP). BFP Biosolids feed pumps AFDs are to be in the MCC.

2.4.3.2 Control Narrative

Control logic for the biosolids feed pumps shall reside in the vendor control panel 40-VCP-20-1 for the BFP. The vendor control panel PLC to be provided with a BFP Biosolids Feed Pump selection option to dictate which of the pumps will be run during the dewatering sequence. Include a warning message on the local OIU for the operators to confirm manual valving is correct for the selected pump. Provide an operator-adjustable flow setpoint on the OIU and perform PID control of the pump when the BFP is in auto to maintain the flow setpoint based on the reading from 40-FIT-20-1 sludge feed flow.

CP-B and 40-VCP-20-1 shall exchange data directly between their respective PLCs. Refer to specification section 44 46 16, Belt Filter Press Dewatering Equipment for a list of minimum messaging data.

PLC-B will provide a BFP run permissive, a Biosolids Feed Pump run status, and a Selected Biosolids Feed Pump permissive signal which will be derived from:

- Selected Biosolids Feed Pump: REMOTE.
- Selected Biosolids Feed Pump: FAIL

Additionally, PLC-B will receive a speed command for the selected Biosolids Feed Pump and a signal that indicates which Biosolids Feed Pump has been selected.

SCADA HMI system shall exchange data directly with the PLC in the vendor supplied control panels.

2.4.4 Belt Filter Press (08-N-6003)

2.4.4.1 Process Overview

Belt Filter Press (BFP) will thicken and dewater the digested sludge so that it can be hauled away for disposal. The BFP is controlled by the vendor control panel 40-VCP-20-1.

2.4.4.2 Control Narrative

Control logic for the BFP and associated process equipment shall reside in the vendor control panel for the BFP. Refer to specification section 44 46 16, Belt Press Dewatering Equipment for BFP local control requirements.

SCADA HMI system shall exchange data directly with the PLC in the vendor supplied control panel.

2.4.5 Sludge Cake Conveyor (08-N-6004)

2.4.5.1 Process Overview

The conveyor system consists of one transfer conveyor (40-CONV-30-1) The conveyor system is designed to receive cake that has been dewatered by the Belt Filter Press (BFP) and convey the cake to one drop point in the truck bay. The conveyor is powered in the BFP control panel which shall consist of forward and reversing starters.

The conveyor has a zero speed switch (SSL) and emergency stop pull-cord that surrounds the conveyor. Additionally, because the conveyor discharges cake into the truck bay which is separated from the BFP room, the conveyor also has an emergency stop pushbutton which is stanchion mounted and easily accessible to the operator on the ground floor in the truck bay.

2.4.5.2 Control Narrative

Control logic for the conveyor shall reside in the PLC in 40-VCP-20-1.

Hand/Off/Remote control of the conveyor shall be provided via a field-mounted HOR control station. In Hand, manual start/stop control shall be implemented. The direction of the conveyor is determined by the position of the Forward/Reverse (FR) selector switch, also located in a field mounted control station. These field mounted control stations shall be placed in a location that is easily accessible to the operator on the ground floor.

Provide control of the conveyor from the SCADA when the equipment is in the Remote mode.

- The operator may utilize the HMI for remote, manual control of the conveyor in Forward direction only.
- The operator will monitor the filling of the truck and be responsible for moving the truck as needed to fill the truck evenly.

Activation of any conveyor system E-Stop shall shutdown all associated equipment and related BFP systems.

Return each conveyor to its pre-power-loss AUTO or MANUAL state on return of power. Any run latches interrupted during the power outage must be re-established using normal startup procedures.

The conveyor system sequencing shall be reviewed and adjusted as necessary during the specified Control Strategy workshops.

2.4.6 Polymer Makeup Units (08-N-6005)

2.4.6.1 Process Overview

Polymer Makeup Unit is a packaged skid that will deliver polymer to the new BFP. Polymer makeup unit is controlled by vendor control panel 40-VCP-40-1 using control signals that are hardwired from the BFP control panel 40-VCP-20-1.

2.4.6.2 Control Narrative

Control logic for the polymer makeup unit shall reside in the vendor control panel for the BFP.

SCADA HMI system shall exchange data directly with the PLC in the vendor supplied control panel 40-VCP-20-1. The BFP PLC shall make available the polymer makeup unit run status and alarm to the HMI. Refer to specification section 44 44 63, Polymer Feed System Liquid for local control requirements.

INSTRUMENT, COMPONENT and PANEL LIST

TAG	QTY	COMP CODE	COMPONENT TITLE	OPTIONS	P&ID	Inst. Detail	COMMENTS
40-FIT-20-1	1	F4	FLOW ELEMENT AND TRANSMITTER, ELECTROMAGNETIC	Meter Size: 4-inch Process Range:50-200 gpm Span Range: 0-300 gpm	08-N-6003		Sludge Feed Flow to Belt Filter Press
20-LIT-20-X (X=1 to 4)	4	L007E	LEVEL ELEMENT AND TRANSMITTER, RADAR	Process Range: 0-13.75 ft Zero Reference: Bottom of Digester	08-N-6001	4091-255G	Aerobic Digester Level; Class I, Division 2, Group D
FOPP-B2	1	Y724	Fiber Optic Patch Panel	Refer to Section 40 95 80	08-N-7001	N/A	Add to Existing Panel CP-B
FOPP-B2	2	Y724	Fiber Optic SC Connector Panel	Refer to Section 40 95 80	08-N-7001	N/A	Add to Existing Panel CP-B
PLC-B	1	Y53	ControlLogix Discrete Input Module, 1756-IB16I	Refer to Section 40 91 00	08-N-7001	N/A	Add to Existing Panel CP-B
PLC-B	1	Y53	ControlLogix Discrete Output Module, 1756-OB16I	Refer to Section 40 91 00	08-N-7001	N/A	Add to Existing Panel CP-B
PLC-B	1	Y53	ControlLogix Analog Input Module, 1756-IF6I	Refer to Section 40 91 00	08-N-7001	N/A	Add to Existing Panel CP-B
PLC-B	2	S125	Analog Signal Splitter	Refer to Section 40 91 00	08-N-6001	N/A	Add to Existing Panel CP-B

PLC I/O LIST

PLC	Tag	Tag Suffix/Function	Description	DI	DO	AI	AO
CP-B	20-MIX-30-1	IR REMOTE Status	Digester Aerator 3	1			
CP-B	20-MIX-30-1	YS ON Status	Digester Aerator 3	1			
CP-B	20-MIX-30-1	RK RUN Command	Digester Aerator 3		1		
CP-B	20-MIX-30-2	IR REMOTE Status	Digester Aerator 4	1			
CP-B	20-MIX-30-2	YS ON Status	Digester Aerator 4	1			
CP-B	20-MIX-30-2	RK RUN Command	Digester Aerator 4		1		
CP-B	20-LIT-20-1	LIT Level	Digester Aerator 1			1	
CP-B	20-LIT-20-2	LIT Level	Digester Aerator 2			1	
CP-B	20-LIT-20-3	LIT Level	Digester Aerator 3			1	
CP-B	20-LIT-20-4	LIT Level	Digester Aerator 4			1	
CP-B	25-P-10-1	ALARM Status	Intermediate Sludge Pump 1	1			
CP-B	25-P-10-1	IR REMOTE Status	Intermediate Sludge Pump 1	1			
CP-B	25-P-10-1	YS ON Status	Intermediate Sludge Pump 1	1			
CP-B	25-P-10-1	RK RUN Command	Intermediate Sludge Pump 1		1		
CP-B	25-P-10-2	ALARM Status	Intermediate Sludge Pump 2	1			
CP-B	25-P-10-2	IR REMOTE Status	Intermediate Sludge Pump 2	1			
CP-B	25-P-10-2	YS ON Status	Intermediate Sludge Pump 2	1			
CP-B	25-P-10-2	RK RUN Command	Intermediate Sludge Pump 2		1		
CP-B	30-P-30-1	FAULT Status	Biosolids Feed Pump 1	1			
CP-B	30-P-30-1	IR REMOTE Status	Biosolids Feed Pump 1	1			
CP-B	30-P-30-1	YS ON Status	Biosolids Feed Pump 1	1			
CP-B	30-P-30-1	RK RUN Command	Biosolids Feed Pump 1		1		
CP-B	30-P-30-1	SPEED Status	Biosolids Feed Pump 1			1	
CP-B	30-P-30-1	SPEED Command	Biosolids Feed Pump 1				1
CP-B	30-P-30-2	FAULT Status	Biosolids Feed Pump 2	1			
CP-B	30-P-30-2	IR REMOTE Status	Biosolids Feed Pump 2	1			
CP-B	30-P-30-2	YS ON Status	Biosolids Feed Pump 2	1			
CP-B	30-P-30-2	RK RUN Command	Biosolids Feed Pump 2		1		
CP-B	30-P-30-2	SPEED Status	Biosolids Feed Pump 2			1	
CP-B	30-P-30-2	SPEED Command	Biosolids Feed Pump 2				1
CP-B	40-CONV-30-1	ALARM Status	Sludge Cake Conveyor 1	1			
CP-B	40-CONV-30-1	E-STOP Status	Sludge Cake Conveyor 1	1			
CP-B	40-CONV-30-1	IR REMOTE Status	Sludge Cake Conveyor 1	1			
CP-B	40-CONV-30-1	YS ON FWD Status	Sludge Cake Conveyor 1	1			
CP-B	40-CONV-30-1	YS ON REV Status	Sludge Cake Conveyor 1	1			
CP-B	40-CONV-30-1	RK RUN FWD Command	Sludge Cake Conveyor 1		1		
25-LCP-10-1	25-PSL-10-1	ALARM Pressure	Intermediate Sludge Pump 1	1			
25-LCP-10-1	25-PSH-10-1	ALARM Pressure	Intermediate Sludge Pump 1	1			
25-LCP-10-1	25-P-10-1	ALARM Status	Intermediate Sludge Pump 1		1		
25-LCP-10-1	25-P-10-1	IR REMOTE Status	Intermediate Sludge Pump 1		1		
25-LCP-10-1	25-P-10-1	YS ON Status	Intermediate Sludge Pump 1		1		
25-LCP-10-1	25-P-10-1	RK RUN Command	Intermediate Sludge Pump 1	1			
25-LCP-10-2	25-PSL-10-2	ALARM Pressure	Intermediate Sludge Pump 2	1			
25-LCP-10-2	25-PSH-10-2	ALARM Pressure	Intermediate Sludge Pump 2	1			
25-LCP-10-2	25-P-10-2	ALARM Status	Intermediate Sludge Pump 2		1		
25-LCP-10-2	25-P-10-2	IR REMOTE Status	Intermediate Sludge Pump 2		1		
25-LCP-10-2	25-P-10-2	YS ON Status	Intermediate Sludge Pump 2		1		
25-LCP-10-2	25-P-10-2	RK RUN Command	Intermediate Sludge Pump 2	1			
30-AFD-30-1	30-PSL-30-1	ALARM Pressure	Biosolids Feed Pump 1	1			
30-AFD-30-1	30-PSH-30-1	ALARM Pressure	Biosolids Feed Pump 1	1			
30-AFD-30-1	30-P-30-1	FAULT Status	Biosolids Feed Pump 1		1		
30-AFD-30-1	30-P-30-1	IR REMOTE Status	Biosolids Feed Pump 1		1		

PLC	Tag	Tag Suffix/Function	Description	DI	DO	AI	AO
30-AFD-30-1	30-P-30-1	YS ON Status	Biosolids Feed Pump 1		1		
30-AFD-30-1	30-P-30-1	RK RUN Command	Biosolids Feed Pump 1	1			
30-AFD-30-1	30-P-30-1	SPEED Status	Biosolids Feed Pump 1				1
30-AFD-30-1	30-P-30-1	SPEED Command	Biosolids Feed Pump 1			1	
30-AFD-30-2	30-PSL-30-2	ALARM Pressure	Biosolids Feed Pump 2	1			
30-AFD-30-2	30-PSH-30-2	ALARM Pressure	Biosolids Feed Pump 2	1			
30-AFD-30-2	30-P-30-2	FAULT Status	Biosolids Feed Pump 2		1		
30-AFD-30-2	30-P-30-2	IR REMOTE Status	Biosolids Feed Pump 2		1		
30-AFD-30-2	30-P-30-2	YS ON Status	Biosolids Feed Pump 2		1		
30-AFD-30-2	30-P-30-2	RK RUN Command	Biosolids Feed Pump 2	1			
30-AFD-30-2	30-P-30-2	SPEED Status	Biosolids Feed Pump 2				1
30-AFD-30-2	30-P-30-2	SPEED Command	Biosolids Feed Pump 2			1	
40-LCP-40-1	40-PSH-40-1A	ALARM Pressure	NEAT Polymer Reactor 1	1			
40-LCP-40-1	40-PSL-40-1C	ALARM Pressure	NEAT Polymer Reactor 1	1			
40-LCP-40-1	40-FSL-40-1	ALARM Flow	NEAT Polymer Reactor 1	1			
40-LCP-40-1	40-SV-40-1	IR REMOTE Status	Polymer W2 Booster Valve 1	1			
40-LCP-40-1	40-SV-40-1	FAULT Status	Polymer W2 Booster Valve 1	1			
40-LCP-40-1	40-SV-40-1	OPEN Status	Polymer W2 Booster Valve 1	1			
40-LCP-40-1	40-SV-40-1	CLOSE Status	Polymer W2 Booster Valve 1	1			
40-LCP-40-1	40-SV-40-1	OPEN Command	Polymer W2 Booster Valve 1		1		
40-LCP-40-1	40-SV-40-1	CLOSE Command	Polymer W2 Booster Valve 1		1		
40-LCP-40-1	40-SSH-40-1	YS ON Status	Safety Shower Flow ON	1			
40-LCP-40-1	40-VCP-20-1	ALARM Flow	Polymer System		1		
40-LCP-40-1	40-VCP-20-1	ALARM Pressure	Polymer System		1		
40-LCP-40-1	40-VCP-20-1	YS ON Status	Polymer System		1		
40-LCP-40-1	40-VCP-20-1	RK RUN Command	Polymer System	1			
40-LCP-40-1	40-VCP-20-1	SPEED Status	Polymer System				1
40-LCP-40-1	40-VCP-20-1	SPEED Command	Polymer System			1	
40-VCP-20-1	40-LCP-40-1	ALARM Flow	Polymer System	1			
40-VCP-20-1	40-LCP-40-1	ALARM Pressure	Polymer System	1			
40-VCP-20-1	40-LCP-40-1	YS ON Status	Polymer System	1			
40-VCP-20-1	40-LCP-40-1	RK RUN Command	Polymer System		1		
40-VCP-20-1	40-LCP-40-1	SPEED Status	Polymer System			1	
40-VCP-20-1	40-LCP-40-1	SPEED Command	Polymer System				1
40-VCP-20-1	40-CONV-30-1	ALARM Status	Sludge Cake Conveyor 1	1			
40-VCP-20-1	40-CONV-30-1	E-STOP Status	Sludge Cake Conveyor 1	1			
40-VCP-20-1	40-CONV-30-1	IR REMOTE Status	Sludge Cake Conveyor 1	1			
40-VCP-20-1	40-CONV-30-1	YS ON FWD Status	Sludge Cake Conveyor 1	1			
40-VCP-20-1	40-CONV-30-1	YS ON REV Status	Sludge Cake Conveyor 1	1			
40-VCP-20-1	40-CONV-30-1	RK RUN FWD Command	Sludge Cake Conveyor 1		1		
40-VCP-20-1	40-FIT-20-1	FIT Flow	Sludge Feed Flow 1			1	
40-VCP-20-1	40-HS-20-1A	E-STOP Status	Belt Filter Press 1	1			
40-VCP-20-1	40-PSL-20-1	ALARM Pressure	Washwater Booster Pump 1	1			
40-VCP-20-1	40-PSL-20-1C	ALARM Pressure	Hydraulic Tensioning System 1	1			
40-VCP-20-1	40-M-20-1E	YS ON Status	Belt Drive 1	1			
40-VCP-20-1	40-M-20-1E	RK RUN Command	Belt Drive 1		1		
40-VCP-20-1	40-M-20-1D	YS ON Status	Belt Conveyor 1	1			
40-VCP-20-1	40-M-20-1D	RK RUN Command	Belt Conveyor 1		1		
40-VCP-20-1	40-P-20-1	YS ON Status	Washwater Booster Pump	1			
40-VCP-20-1	40-P-20-1	RK RUN Command	Washwater Booster Pump		1		
40-VCP-20-1	40-P-20-1	SPEED Status	Washwater Booster Pump			1	
40-VCP-20-1	40-P-20-1	SPEED Command	Washwater Booster Pump				1
40-VCP-20-1	40-FV-20-1	OPEN Status	Washwater Valve	1			
40-VCP-20-1	40-FV-20-1	CLOSE Status	Washwater Valve	1			

PLC	Tag	Tag Suffix/Function	Description	DI	DO	AI	AO
40-VCP-20-1	40-FV-20-1	OPEN Command	Washwater Valve		1		
40-VCP-20-1	40-FV-20-1	CLOSE Command	Washwater Valve		1		
40-VCP-20-1	40-M-20-1C	FAULT Status	Main Belt Drive	1			
40-VCP-20-1	40-M-20-1C	YS ON Status	Main Belt Drive	1			
40-VCP-20-1	40-M-20-1C	RK RUN Command	Main Belt Drive		1		
40-VCP-20-1	40-M-20-1C	SPEED Status	Main Belt Drive			1	
40-VCP-20-1	40-M-20-1C	SPEED Command	Main Belt Drive				1
40-VCP-20-1	40-M-20-1A	YS ON Status	Sludge Distributor	1			
40-VCP-20-1	40-M-20-1A	RK RUN Command	Sludge Distributor		1		
40-VCP-20-1	40-M-20-1A	SPEED Status	Sludge Distributor			1	
40-VCP-20-1	40-M-20-1A	SPEED Command	Sludge Distributor				1
40-VCP-20-1	40-M-20-1B	YS ON Status	Gravity Belt	1			
40-VCP-20-1	40-M-20-1B	RK RUN Command	Gravity Belt		1		
40-VCP-20-1	40-M-20-1B	SPEED Status	Gravity Belt			1	
40-VCP-20-1	40-M-20-1B	SPEED Command	Gravity Belt				1
			TOTAL FOR ADDITIONS	62	34	15	10

Surge Suppressor Products Table

SS Type	Application	Enclosure/Mounting	Manufacturer/Model	Principle of Operation/Performance Criteria/Features	COMMENTS
1	Protect 120V ac, single-phase power in control panels	NEMA Rating: None Locate inside panel	ASCO, Model 252	**Principle of Operation:** Two stage: 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device **Performance Criteria:** 1) ARC: Handles 60 kA on 10 by 350 waveform 2) MOV: Handles 40 kA on 8 by 20 waveform 3) GT: Handles 10 kA on 8 by 20 wavefor	Nominal Amp Capacity: 15A rovide as needed
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	ASCO, Model 175	**Principle of Operation:** Two-Stage: 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	Tested and rated for 50 occurrences of 2,000-amp peak test wave form. Provide as needed.
3	Analog signal of 2-wire transmitter	NEMA Rating: NEMA 4X Field installed in stainless steel pipe nipples; adjacent to 2-wire transmitter	ASCO, Model 157	**Principle of Operation:** Two-Stage: 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	
4	Both analog signal and 120V ac power of 4-wire transmitter	NEMA rating: NEMA 4X Field installed; adjacent to 4-wire transmitter	ASCO, Model 265	**Principle of Operation:** Two stage: 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device **Performance Criteria:** 1) With 120V AC outlet and AC circuit breaker in a weatherproof enclosure	Tested and rated for 50 occurrences of 2,000-amp peak test waveform. Provide as needed

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. For air or water service, unless otherwise noted.
2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral differential pressure regulators:
   a. For water service.
   b. For air service for level ranges greater than 10 feet of water.
7. Rotameters for water service.

8. Manufacturers and Products:
    a. Fischer & Porter; Series 10A3130.
    b. Brooks; Series DS-1350.

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Products:
    a. Anderson, Greenwood and Co.; Type M1.
    b. Evans.

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
    a. Ashcroft Utility; Gauge Series 1000.
    b. Marsh; Standard Gauge Series.
    c. Ametek U.S.; Gauge Series P500.
    d. Acculite; Series 2000.

D. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
    a. Whitey; Series 41 through Series 43.
    b. Hoke; Flomite 7100 Series.

E. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
    a. Body: Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
    b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.

4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

F. Test Tap:

1. Manufacturers and Products:
   a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
   b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
   c. Parker; CPI Series precision quick couplings.

G. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. Manufacturers:
   a. Parker-Hannifin.
   b. Swagelok tube fittings.

H. Plastic Tubing and Fittings:

1. Tubing:
   a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
   b. Manufacturers and Products:
      1) Dekoron; Type P.
      2) Imperial Eastman; Poly-Flo black instrument tubing.
2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.

I. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.

J. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.

b. Manufacturers and Products:
   1) Parker Flodar; BA Series.
   2) Swagelok tube fittings.
   3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.

2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.

K. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer's recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
4. Manufacturers:
   a. Globetray.
   b. Cope.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funneled shaped inputs to facilitate wire entry.

f. Mounting:
   1) Standard DIN rail.
   2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
   3) End Stops: Minimum of one at each end of rail.
g. Wire Preparation: Stripping only permitted.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
   1) Terminal number shown on both sides of terminal block.
   2) Allow use of preprinted and field marked tags.
   3) Terminal strip numbers shown on end stops.
   4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
   5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
j. Test Plugs: Soldered connections for 18 AWG wire.
   1) Pin Diameter: 0.079 inch.
   2) Quantity: (10, 20, 40 (need two plugs per test meter).
   3) Manufacturer and Product: Entrelec; Type FC2.

2. Terminal Block, General Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 24 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Test Sockets: One screw test socket 0.079-inch diameter.
   h. Manufacturer and Product: Entrelec; Type M4/6.T.
3. Terminal Block, Ground:
   a. Wire Size: 24 AWG to 10 AWG.
   b. Rated Wire Size: 10 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25 inch, maximum.
   e. Grounding: Electrically grounded to mounting rail.
   f. Manufacturer and Product: Entrelec; Type M4/6.P.
4. Terminal Block, Blade Disconnect Switch:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 10 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body, orange switch.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.SNT.

5. Terminal Block Diode:
    a. Rated Voltage: 24V dc.
    b. Rated Current: 30 ma.
    c. Wire Size: 16 AWG.
    d. Manufacturer and Product: Phoenix Contact ST-IN.
6. Terminal Block, Fused, 24V dc:
    a. Rated Voltage: 600V dc.
    b. Rated Current: 25 amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body.
    f. Fuse: 0.25 inch by 1.25 inches.
    g. Indication: LED diode 24V dc.
    h. Spacing: 0.512 inch, maximum.
    i. Manufacturer and Product: Entrelec; Type ML10/13.SFD.
7. Terminal Block, Fused, 120V ac:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 25 amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Gray body.
    f. Fuse: 0.25 inch by 1.25 inches.
    g. Indication: Neon lamp, 110V ac.
    h. Leakage Current: 1.8 mA, maximum.
    i. Spacing: 0.512 inch, maximum.
    j. Manufacturer and Product: Entrelec; Type ML10/13.SFL.
8. Terminal Block, Fused, 120V ac, High Current:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 35 amps.
    c. Wire Size: 18 AWG to 8 AWG.
    d. Rated Wire Size: 8 AWG.
    e. Color: Gray.
    f. Fuse: 13/32 inch by 1.5 inches.
    g. Spacing: 0.95 inch, maximum.
9. Manufacturer and Product: Entrelec; Type MB10/24.SF.

B. Relays:

1. General:
    a. Relay Mounting: Plug-in type socket.
    b. Relay Enclosure: Furnish dust cover.
    c. Socket Type: Screw terminal interface with wiring.
    d. Socket Mounting: Rail.
    e. Provide holddown clips.

2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.
4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V dc or 277V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.

h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
i. Time Delay Setpoint: As noted or shown.
j. Mode of Operation: As noted or shown.
k. Adjustment Type: Integral potentiometer with knob external to dust cover.
l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
   a. Protect instruments from damage due to power supply failure.
   b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
   a. Type: Indicating.
   b. Mount so fuses can be easily seen and replaced.

D. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

2.04 I&C COMPONENTS

A. F4 Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.

b. Type:
   1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
   2) Full bore meter with magnetic field traversing entire flow-tube cross section.
   3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.

2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
3. Operating Temperature:
   a. Element:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
      2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.
4. Performance:
   a. Flow Range: As noted.
   b. Span Range: As noted.
   c. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
   d. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
6. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.

7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
    a. Meter Tube Material: Type 304.
    b. Liner Material: Hard Rubber.
    c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
    d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
    e. Electrode Material: Hastelloy C.
    f. Grounding Ring:
        1) Required, unless otherwise noted.
        2) Quantity: Two, unless otherwise noted.
        3) Material: Type 316 stainless steel, unless otherwise noted.
    g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    h. Submergence:
        1) Temporary: If noted.
        2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
    i. Direct Buried (3 to 10 feet): If noted.
    j. Hazardous Area Certification:
        1) Class 1, Division 2, Groups A, B, C, D: If noted.
        2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
        3) Class 1, Division 1, Groups C, D, and FM approved: If noted.
9. Transmitter:
    a. Mounting: Surface (wall), unless otherwise noted.
    b. Display: Required, unless otherwise noted.
        1) Digital LCD display, indicating flow rate and total.
        2) Bi-directional Flow Display: Not required.
            a) Forward flow rate.
            b) Forward totalization.
    c. Parameter Adjustments: By keypad or non-intrusive means.
    d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
    e. Empty Pipe Detection:
        1) If noted.
        2) Drives display and outputs to zero when empty pipe detected.
10. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
        2) Supports Superimposed Digital HART protocol: If noted.
    b. Discrete Outputs: If noted.
        1) Two discrete outputs, typical, rated for up to 30 volts, typical.

2) Programmable as noted for the following typical parameters:
a) Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.

c. Discrete Input: If noted.
1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.

d. Other: As noted.

11. Cables:
a. Types: As recommended by manufacturer.
b. Lengths: As required to accommodate device locations.

12. Built-in Diagnostic System:
a. Features:
1) Field programmable electronics.
2) Self-diagnostics with troubleshooting codes.
3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
4) Initial flow tube calibration and subsequent calibration checks.

13. Factory Calibration:
a. Calibrated in an ISO 9001 and NIST certified factory.
b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.

14. Factory Ready for Future In situ Verifications: If noted.
a. Original meter parameter values available from vendor by request.

15. Manufacturers:
a. Krohne [includes IFC 100K/IFC 300K (integral) or IFC 100F/IFC 300F (remote) signal converter].
1) EnviroMag, IFS 2000 Flowmeter series, no equal.

B. L007E Level Element and Transmitter, Radar, Type E:

1. General:
a. Function: Continuous level measurement.
b. Type: Radar, noncontacting.
c. Loop powered.
d. Parts: Element/remote transmitter and accessories as noted.

2. Service:
    a. Application: Aerobic Digester wastewater level.
    b. Operating Temperature Range:
        1) Ambient: Minus 40 degrees F to plus 176 degrees F.
3. Performance:
    a. Process Range: As noted.
    b. Zero Reference: As noted.
    c. Frequency: 80 Ghz.
    d. Accuracy (maximum measurement error):
        1) Up to 10 meters (23 feet), plus or minus 10 mm (0.39 inch).
    e. Resolution: 0.04 inch (1mm.)
    f. Transition Zone (not recommended for measurement): 8 inches from lower end of antenna.
    g. Medium Suitability:
        1) Suitable for most liquids with measuring range decreasing for liquids with smaller dielectric constants.
        2) For conductive liquids, (for example, water) maximum possible measuring range is 72 feet.
4. Element/Integral Transmitter:
    a. Enclosure:
        1) Transmitter: NEMA 4X/IP65 watertight.
        2) Antenna: NEMA 6P/IP68.
    b. Display: Remote mounted, with optional illumination and touch control, 5m cable minimum.
    c. Antenna Type: Integrated, PEEK, 40mm, unless otherwise noted.
        1) Available Antenna Types: Integrated, PEEK or PTFE cladded flush mount.
    d. Antenna Parameters:
        1) Size: 40 mm, unless otherwise noted.
        2) Material: PEEK, unless otherwise noted.
        3) Seal: FKM, Viton, unless otherwise noted.
    e. Process Connection:
        1) Thread: MNPT 1-1/2 inch.
        2) Material: Type 316L stainless steel.
    f. Approvals:
        1) Others: As noted.
5. Signal and Electrical Interface:
    a. Analog:
        1) 4 mA to 20 mA dc HART.
    b. Discrete: Open Collector Output, for High Level Alarm.
    c. Conduit Type: 1/2-inch NPT, unless otherwise noted.
6. Other: Weather protection cover.

7. Accessories:
   a. Remote Field Signal Indicator: If noted.
      1) Signal Interface: 4 mA to 20 mA dc.
      2) Enclosure: NEMA 4, IP65.
      3) Cable: as noted.
      4) Mounting Bracket: 1/2-inch pipe mount.
      5) Certification:
         a) Class I, Div 1, Group A-D
      6) Model: Remote Display FHX50.
   b. Others: As noted.
8. Manufacturer and Product: Endress and Hauser Micropilot FMR62.

C. S125 Analog Signal Splitter:

1. General:
   a. Function: Split and isolate an analog input current signal into two identical isolated analog output current signals.
   b. Type:
      1) Solid state with external power supply.
      2) Four-way isolation of the input signal, output signals, and external power supply.
   c. Parts: Signal splitter.
2. Performance:
   a. Isolation:
      1) Four-way isolation between input, output 1, output 2, and power circuits for common mode voltages up to 250V ac, or 354V dc off ground, on a continuous basis.
      2) Able to withstand 1,500V ac dielectric strength test for 60 seconds without breakdown.
   b. Output Ripple: Less than plus or minus 0.1 percent of maximum output span.
   c. Accuracy: Plus or minus 0.1 percent of output span.
   d. RFI Resistance: 10V/meter at frequencies of 80 to 1,000 MHz AM and 900 MHz keyed carrier, per EN61000-4-3 and ENV50204.
   e. EMI resistance: Less than plus or minus 0.25 percent of output span effect under the influence of electromagnetic fields from switching solenoids or commutator motors and drill motors.
   f. Ambient Temperature, Operating: Minus 13 degrees F to plus 167 degrees F.
3. Features:
   a. Two 15-turn potentiometers, Zero and span, per output channel, accessible from front of unit.
   b. Calibration independent of load.

4. Signal Interface:
   a. Input:
      1) 4 to 20mA dc.
      2) Impedance: 150 ohms at full scale.
   b. Output:
      1) 4 to 20 mA dc each channel.
      2) Drives output load impedance up to 950 ohms.
5. Enclosure:
   a. NEMA 1, unless otherwise noted.
   b. Mounting: DIN Rail, unless otherwise noted.
6. Power: 24V dc, unless otherwise noted.
7. Manufacturer:
   a. Acromag; Model 633T-0100.
   b. Action; I/Q Q404-4.
   c. Phoenix Contact; MCR-FL-C-UI-2UI-DCI.

D. Y53 Programmable Control (Large Size, 120V ac):

1. PLC I/O Subsystem:
   a. Input/Output:
      1) The input/output subsystem shall consist of all of the hardware for the CPU to communicate with the specified types of input and output modules.
      2) Also provide Remote I/O subsystem(s) as shown on the Drawings.
   b. Discrete Input Modules:
      1) Voltage: 24V dc.
      2) Sink/Source.
      3) Points per Module: 16.
      4) The discrete input modules shall be Allen-Bradley Model No. 1756-IB16I with Allen-Bradley No. 1756-TBCH.
   c. Discrete Outputs:
      1) Voltage: 24 V dc.
      2) Points per Module: 16.
      3) Type: Individually Isolated Contact Outputs.
      4) The digital output module shall be Allen-Bradley, No. 1756-OB16I, 16-point modules with Allen-Bradley No. 1756-TBCH wiring arms.
2. Identification:
   a. Nameplates installed above/below each PLC component (CPU, I/O, power supply, etc.).
   b. Identify on I/O modules and terminal blocks the specific I/O points as they have been configured (addressed) in the system.
3. Manufacturer: Allen-Bradley, ControlLogix.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
9. Telecommunications Industry Association (TIA):
   a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
   b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
   c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
   d. 568-C.3, Optical Fiber Cabling Components Standard.
   e. 598, Optical Fiber Cable Color Coding.
   f. 606, Administration Standard for Commercial Telecommunications Infrastructure.

10. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.
    b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
    c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
    d. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
    e. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
    f. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
    g. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
    h. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
    i. 942, Telecommunications Infrastructure Standard for Data Centers.
    j. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.
11. Underwriter Laboratories (UL): 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. dB: Decibel.

C. FIM: Facilities Information Management.

D. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

E. FOCS: Fiber Optic Communication System.

F. FOIRL: Fiber Optic Inter Repeater Link.

G. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

H. Hybrid Cable: Cable containing more than one type of fiber.

I. LAN: Local Area Network.

J. m: Meter.

K. Mbps: Megabits per Second.

L. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

M. Megahertz (MHz): One million cycles per second.

N. MHz: Megahertz.

O. Micron: Micrometer or one millionth meter.

P. mm: Millimeter.

Q. N: Newton.

R. nm: Nanometer.

S. OFL: Over-filled Launch.

T. OFN: Nonconductive Optical Fiber Cable.

U. OFNP: Nonconductive Optical Fiber Plenum Cable.

V. OFNR: Nonconductive Optical Fiber Riser Cable.

W. OLTS: Optical Loss Test Sets.

X. OTDR: Optical Time Domain Reflectometer.

Y. PIC: Process Instrumentation and Control.

Z. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

AA. UPS: Uninterruptible Power Supply.

BB. V ac, VAC: Volts Alternating Current.

CC. WAN: Wide Area Network.

1.03 SYSTEM DESCRIPTION

A. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

B. Provide a complete FOCS based on referenced standards for a wide area Fast Ethernet network.

1. Provide fiber optic network hardware and cabling to connect new fiber communications nodes into the facility's existing fiber optic network.
2. Configure new and upgraded fiber communications nodes with the facility's existing network in a self-healing ring topology between the Existing Electrical Building CP-B PLC panel and Belt Filter Press Building 40-VCP-20-1 PLC panel.

1.04 SUBMITTALS

A. Action Submittals:

1. Cable Schedule Showing:
   a. Cable identification.
   b. Fiber counts for each cable and identification of used fiber pairs.
   c. Cable length and attenuation, with two connector pairs and no splices, based on TIA 568-C.3, Annex H.
2. Component Data:
   a. Manufacturer and model number.
   b. General data and description.
   c. Engineering specifications and data sheet.
   d. Scaled drawings and mounting arrangements.

B. Informational Submittals:

1. Manufacturer's statement that installer is certified to perform installation Work.
   a. Testing and acceptance plan, 30 days prior to beginning of testing.
   b. Fiber test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing:
      1) Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
      2) Attenuation of each fiber upon delivery to Site.
      3) Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
      4) Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.

c. For each maintenance organization, identify location of base of service and how required coverage will be achieved.

2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
3. Manufacturer's suggested installation practice.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.
3. Connector:
   a. ISO 9001 or QF TL 9000 registered.
   b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. Certified by fiber cable manufacturer.

C. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
   a. Manufacturer of fiber optic cable and fiber optic connectors.
   b. Manufacturer of test equipment used for field certification.
   c. Other independent training organizations acceptable to Owner.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

1.07 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of work specified in this specification section found defective during a period of 4 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

1.08 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare equipment and tools.

Item	Quantity
Jumpers of each length needed	One complete set

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 MULTIMODE FIBER OPTIC CABLE

A. 62.5/125-micron, for use in backbone and horizontal distribution subsystems, meets or exceeds the requirements of TIA 568-C.3, including the following specifications:

1. Maximum Mean Fiber Loss:
   a. 3.5 dB per km at 850 nm.
   b. 1.5 dB per km at 1,300 nm.
2. Minimum OFL Bandwidth: OM1-200/500 MHz•km minimum at 850 nm; TIA 492AAAA.
3. Distance Capacity per IEEE 802.3:
   a. 100Mbit Ethernet: OM1 1000m at 850 nm and 2000m at 1310 nm.
   b. 1 Gbit Ethernet: OM1 275m at 850 nm and 550m at 1310 nm.

2.02 FIBER CENTERS (PATCH PANELS)

A. Function: Provides secure place to terminate fiber optic cables.

B. Features:

1. Compartments: Two; one for fiber optic cable, one for jumpers to individual equipment.
2. Coil Former: Former to wind slack cable around, provides controlled long radius bends.
3. Connectors: Minimum 24 SC connectors for entry and exit.
4. Size: Maximum 18 inches by 12 inches by 4 inches.
5. Construction: 1.5-mm steel with corrosion proof finish.
6. Mountings: Suitable for permanent attachment as shown, or provide separate mountings that do not obscure covers and doors.
7. Doors: Separate lockable doors for cable and jumper terminations.

C. Locations: Provided inside panels CP-B and 40-VCP-20-1.

D. Manufacturers:

1. Ortronics Infinium™ 615 series surface mount fiber cabinets manufactured by Legrand Data Communications.
2. Wall-Mountable Connector Housings (WCH) manufactured by Corning Optical Communications LLC (Hickory, N.C.).

2.03 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
2. SC connectors.
3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
    a. Ferrules: Free-floating low loss ceramic.
    b. Polarizing key on duplex connector systems.
5. Attenuation:
    a. In accordance with TIA 568-C.3.
    b. Maximum of 0.75 dB per connector pair.
6. Manufacturer: AMP.

2.04 PATCHCORDS

A. General:

1. In accordance with TIA 568-C.3.
2. Function: Connect fiber centers to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
4. Cable Configuration:
    a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
    b. Protected with kevlar strength members and enclosed in thermoplastic jacket.
5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
6. Connectors:
    a. As required by Article Connectors.
    b. On-axial Pull Strength: 33 N.
    c. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector: Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).

2.05 CONDUIT

A. In accordance with Section 26 05 01, Electrical.

2.06 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
    a. Not dented, nicked, or kinked.
    b. Not subjected to pull stress greater than manufacturer's specification.
    c. Not bent to a radius below manufacturer's minimum bend radius.
    d. Not subjected to treatment that may damage fiber strands during installation.
5. Cables per Conduit or Innerduct: In accordance with NFPA 70 NEC conduit fill limitations.
6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. Splices: Install fiber optic cables in unspliced lengths from fiber centers to switches or hubs.
8. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections shall not be permitted.
9. Identification:
    a. Identify cable on both ends, in access holes, and pull points.
    b. In accordance with TIA 606.
10. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.
11. Access Holes:
    a. Provide supports for cables in access and handholes at minimum 600 mm.
    b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Fiber Center, Fiber Distribution Frame, Housing, Panel, Splice Tray: Install securely in field panels or enclosures as shown on Drawings.

C. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
   a. Sleeve over individual fibers with transparent furcation tubes.
   b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.
3. Break-out Kits:
   a. Terminate cables using manufacturer-supplied break-out kits.
   b. Terminate in accordance with manufacturer's recommendations.
4. Slack:
   a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
   b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
   a. Terminate 100 percent fibers in each cable to specified connector.
   b. Connect into fiber management system.

3.02 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 72 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
3. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
4. Testing performed on incomplete systems shall be redone on completion of the Work.
5. Document Test Results: Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
6. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
   a. LIA Z136.2.
   b. TIA/EIA 455-78.
   c. TIA/EAI 455-133.

d. TIA 526-7.
e. TIA 526-14.
f. TIA 568-C.1.
g. TIA 568-C.3.
h. TIA TSB 140.

2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for single-mode and multimode links and channels.
   b. OTDR traces and event tables for single-mode and multimode links and channels.

C. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Multimode 62.5/125 µm	850	3.5	1300	1.5

   b. OTDR Testing:
      1) Reflective Events: Maximum 0.75 dB.
      2) Nonreflective Events: Maximum 0.3 dB.
   c. Magnified Endface Inspection:
      1) Visually inspect fiber connections for end-face quality.
      2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

D. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

E. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

F. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
      1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
   c. Perform Testing:
      1) On each cabling segment (connector to connector).
      2) On each cabling channel (equipment to equipment).
      3) Using high-quality test cords of same fiber type as cabling under test.
         a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
         b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.
2. Optical Loss Testing (OLTS):
   a. Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
   b. Perform tests in both directions.
3. OTDR Testing:
   a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      1) Multimode: 850 nm and 1,300 nm.

b. Test each fiber link and channel in one direction.
c. Install launch cable between OTDR and first link connection.
d. Install receive cable after last link connection.

4. Length Measurement:
   a. Record length of each fiber.
   b. Measure optical length using OLTS or OTDR.
5. Polarity Testing:
   a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
   b. Verify polarity of paired duplex fibers using OLTS.
6. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
   c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.
   d. Circuit IDs reported by test instrument shall match specified label identification.
   e. Provide in electronic database for each tested optical fiber with the following information:
      1) Identification of Site.
      2) Name of test limit selected to execute stored test results.
      3) Name of personnel performing test.
      4) Date and time test results were saved in memory of tester.
      5) Manufacturer, model, and serial number of field test instrument.
      6) Version of test software and version of test limit database held within test instrument.
      7) Fiber identification number.
      8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.

9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
11) Length for each optical fiber as calculated by the OTDR.
12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

G. Drawings:

1. Record Copy: Provide at end of Project on CD-ROM.
   a. CAD format and include notations reflecting as-built conditions of additions and variations from Drawings provided, such as to cable path and termination point.
   b. CAD drawings are to incorporate test data imported from test instruments.
2. As-built Drawings:
   a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.
   b. Include field changes made up to construction completion:
      1) Field directed changes to pull schedule.
      2) Field directed changes to cross connect and patching schedule.
      3) Horizontal cable routing changes.
      4) Backbone cable routing or location changes.
      5) Associated detail drawings.

3.03 SUPPLEMENTS

A. Supplement listed below, following “End of Section,” is part of this Specification.

1. As-Built Fiber Optic Cable Installation Form.

END OF SECTION

PROJECT:

Contractor:

Signed by:

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Sheet 1 of 1

Cable Identification:
Routing: From: In:
(Identify field panel, control room, etc. in building)

Through: 1
(Identify access hole, building, gallery, etc.)
Through: 2 Through: 5
Through: 3 Through: 6
Through: 4 Through: 7
To: In:
See As-Built Conduit/Innerduct Installation forms for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:
Multimode Fibers

		cable length*	
850 nm:	3.5 dB/km x	km + 1.5 dB =	dB
1300 nm:	1.0 dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		850 nm	1,300 nm	850 nm	1,300 nm

SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. International Society of Automation (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer’s factories.

B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer’s factory.

1.03 SUBMITTALS

A. Action Submittals:

1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.

5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
7. Panel Power Requirements and Heat Dissipation: As defined in Section 40 90 00, Instrumentation and Control for Process Systems.
8. Intrinsic Safety Data: Provide calculations, tables and other data that document entity method application to each circuit using intrinsic safety as a means of dealing with classified area requirements. Include intrinsic safety parameters for devices (maximum voltage allowed, maximum current allowed, internal capacitance, internal inductance, etc.) and barriers (open circuit voltage, short circuit current, allowed capacitance, and allowed inductance) for all devices in all circuits.
9. Programmable Controller Submittals for Network Connected PLCs:
    a. Hardware Documentation:
        1) Provide the following for all elements of the PLC:
            a) Block Diagram: A diagram showing all major system components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically.
            b) Bill-of-Materials: A list of all PLC components. Group components by type and include:
                (1) Component manufacturer, model number, and part number.
            c) Component description.
            d) Quantity supplied.
            e) Reference to component catalog information.
            f) Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements of the PLC system. Clearly mark all options and features proposed for this Project.
            g) Interconnecting Wiring Diagrams: Diagrams shall show all PLC elements, their interconnecting cables and wiring terminations, and all terminations to all interacting elements and subsystems. Terminations shall be numbered. Terminations for circuits extending outside PLC assemblies and/or leaving panels shall be labeled with circuit names corresponding to the Circuit and Raceway Schedule. The external circuit portion of this diagram shall be coordinated with the Electrical Subcontractor and

shall bear his mark showing that this work has been done.

h) Input/Output List: For each I/O point, list point type, tag number of the source or final control element, equipment description, PLC number, PLC terminal identification, rack number, module slot number, and PLC address.

b. Application Software Documentation for Network Connected PLCs:

1) Provide PLC and operator interface documentation in electronic (i.e. viewable in programming package) and hard copy format.
2) Fully documented ladder logic listings.
3) Function listings for function blocks not fully documented by ladder logic listings.
4) Cross-reference listing.
5) Programmable Logic Controller Data Exchange List:
   a) Provide a data exchange list where data is exchanged across a network connection.
   b) Include a hard copy and an electronic file using Microsoft Excel 2007 or later. List and describe each analog and discrete input or output point to the PLC along with all internally calculated variables including discrete variables.
   c) Define all list parameters in enough detail that the plantwide PLC and HMI software developer can completely and accurately configure and program the plantwide PLCs and HMI computers.
   d) Provide documentation for PLC to PLC and HMI data exchange for coordination with the plant process control system applications programmer. Reflect the tag numbering and engineering unit ranges agreed on with the plant process control system applications programmer.
   e) Once accepted, promptly update and deliver to the plantwide software developer any changes made to the data exchange list during any phase of Work.
   f) Package system vendor programs may require tag changes or network update timing changes to optimize data exchange communications.
   g) Include, as a minimum, the following data fields on the list:
      (1) Tag or address as applicable.
      (2) Scaling parameters.

(3) Engineering Units.
(4) Data type.

B. Informational Submittals:

1. Programmable Controller Submittals:
   a. Complete set of user manuals.
   b. Fully documented ladder logic listings.
   c. Function listing for function blocks not fully documented by ladder logic listings.
   d. Cross-reference listing.
2. Manufacturer's list of proposed spares, expendables, and test equipment.
3. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.05 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:

1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
2. Light Bulb: 100 percent, 2 minimum, of each type used.
3. Fuse: 100 percent, 5 minimum, of each type used.
4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Section 40 90 00, Instrumentation and Control for Process Systems.

2.02 SIGNAL CHARACTERISTICS

A. Analog Signals:

1. 4 to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.

1. Power source: Less than 30V dc.

C. Discrete Signals:

1. Two-state logic signals.
2. Utilize 120V ac sources for control and alarm signals.
3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

D. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.

2.04 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14-gauge.

D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.

E. Doors:

1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
2. For doors on NEMA 4X panels, three-point latching mechanism.

F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Location of Operator Controls and Indicators: Unless otherwise noted, install all indicating lights, selector switches and pushbuttons on the panel front.

I. Inner Swing-Out Panel and Its Function:

1. Furnish an inner swing-out panel. Install all circuit breaker(s) on it necessary to completely de-energize the panel. The operator shall be able to completely de-energize the panel by placing these circuit breaker(s) in the Off position.
2. Install other control components; for example, relays, PLCs, power supplies, on the back panel behind the inner swing-out panel.

J. Temperature Control:

1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
2. Furnish cooling fans with air filters if required to dissipate heat.
3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

K. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

L. Lighting: Minimum of one hand switch controlled internal 100-watt incandescent light for panels 12 cubic feet and larger.

M. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

N. Finish:

1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer’s standard gray unless otherwise specified.
2. Internal Surfaces: White enamel.

O. Panel Manufacturers:

1. Hoffman.
2. H.F. Cox.

P. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures:

1. Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.
    a. Mark shall include unique UL serial number for panel.

B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

C. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
    a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
    b. Branch Circuit Breakers: 15 amps at 250V ac.
    c. Breaker Manufacturers and Products:
        1) Heineman Electric Co.; Series AM.
        2) Airpax/North American Philips Controls Corp.; Series 205.

D. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. Interlock main circuit breaker with panel door.
    a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
    b. Mount operator controls and indications on front access door.
2. Circuit Breakers:
    a. In accordance with NEMA AB 1.
    b. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
    c. 42,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
    d. Tripping: Indicate with operator handle position.
3. Magnetic Motor Starters:
    a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
    b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
    c. Manual reset type with reset button mounted on panel door.

4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
    a. Power Control Transformer:
        1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
        2) Limit voltage variation to 15 percent during contact pickup.
        3) Fuse one side of secondary winding and ground the other.
        4) Furnish primary winding fuses in ungrounded conductors.
5. Power Monitoring Relay:
    a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
    b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
    c. Transient Voltage Protection: 10,000 volts.
    d. Manufacturer and Product: Furnas; Class 47.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:

1. ac Circuits:
    a. Type: 600-volt, Type MTW stranded copper.
    b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
    a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
    b. Size: 18 AWG, minimum.
3. Other dc Circuits.
    a. Type: 600-volt, Type MTW stranded copper.
    b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
    a. Wire Tags: Machine printed, heat shrink.
    b. Manufacturers:
        1) Brady PermaSleeve.
        2) Tyco Electronics.

F. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

G. Terminal Blocks:

1. Quantity:
   a. For external connections.
   b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
   c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
   b. Compression Clamp:
      1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
      2) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 to plus 110 degrees C.
      2) Two funnel shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: One at each end of rail, minimum.
   g. Wire Preparation: Stripping only.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown.
3. Terminal Block, 120-Volt Power:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amps.
   c. Wire Size: 22 through 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.

f. Spacing: 0.25 inch, maximum.
g. Manufacturer and Product:
    1) Entrelec; Type M4/6.
    2) Weidmuller.
    3) Allen-Bradley.

4. Terminal Block, Ground:
    a. Wire Size: 22 through 12 AWG.
    b. Rated Wire Size: 12 AWG.
    c. Color: Green and yellow body.
    d. Spacing: 0.25 inch, maximum.
    e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
    f. Manufacturer and Product:
        1) Entrelec; Type M4/6.P.
        2) Weidmuller equivalent.
        3) Allen-Bradley equivalent.
5. Terminal Block, Blade Disconnect Switch:
    a. Use: Provide one for each discrete input and output field interface wire.
    b. Rated Voltage: 600V ac.
    c. Rated Current: 10 amps.
    d. Wire Size: 22 through 12 AWG.
    e. Rated Wire Size: 12 AWG.
    f. Color: Gray body, orange switch.
    g. Spacing: 0.25 inch, maximum.
    h. Manufacturer and Product:
        1) Entrelec; Type M4/6.SN.
        2) Weidmuller equivalent.
        3) Allen-Bradley equivalent.
6. Terminal Block, Fused, 24V dc:
    a. Rated Voltage: 600V dc.
    b. Rated Current: 6.3 amps.
    c. Wire Size: 22 through 12 AWG.
    d. Rated Wire Size: 12 AWG.
    e. Color: Gray body.
    f. Fuse: 5 by 20 GMA fuses.
    g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
    h. Indication: LED diode 24V dc.
    i. Leakage Current: 5.2 mA, maximum.
    j. Spacing: 0.32 inch, maximum.
    k. Manufacturer and Product:
        1) Entrelec; Type M4/6.SFD.
        2) Weidmuller equivalent.
        3) Allen-Bradley equivalent.

7. Terminal Block, Fused, 120V ac:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 6.3 amps.
    c. Wire Size: 22 through 12 AWG
    d. Rated Wire Size: 12 AWG.
    e. Color: Gray body.
    f. Fuse: 5 by 20 GMA fuses.
    g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
    h. Indication: Neon lamp 110V ac.
    i. Leakage Current: 1.8 mA, maximum.
    j. Spacing: 0.32 inch, maximum
    k. Manufacturer and Product:
        1) Entrelec; Type M4/6.SFL.
        2) Weidmuller equivalent.
        3) Allen-Bradley equivalent.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

I. Relays:

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

3. Control Circuit Switching Relay, Latching:
    a. Type: Dual coil mechanical latching relay.
    b. Contact Arrangement: 2 Form C contacts.
    c. Contact Rating: 10A at 28V dc or 120V ac.
    d. Contact Material: Silver cadmium oxide alloy.
    e. Coil Voltage: As noted or shown.
    f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
    g. Expected Mechanical Life: 500,000 operations.
    h. Expected Electrical Life at Rated Load: 50,000 operations.
    i. Manufacturer and Product:
        1) Potter and Brumfield; Series KB/KBP.
        2) Schneider Electric equivalent.
        3) Allen-Bradley equivalent.
4. Control Circuit Switching Relay, Time Delay:
    a. Type: Adjustable time delay relay.
    b. Contact Arrangement: 2 Form C contacts.
    c. Contact Rating: 10A at 240V ac.
    d. Contact Material: Silver cadmium oxide alloy.
    e. Coil Voltage: As specified or shown.
    f. Operating Temperature: Minus 10 to 55 degrees C.
    g. Repeatability: Plus or minus 2 percent.
    h. Delay Time Range: Select range such that time delay setpoint fall between 20 to 80 percent or range.
    i. Time Delay Setpoint: As specified or shown.
    j. Mode of Operation: As specified or shown.
    k. Adjustment Type: Integral potentiometer with knob external to dust cover.
    l. Manufacturer and Products:
        1) Potter and Brumfield.
            a) Series CB for 0.1-second to 100-minute delay time ranges.
            b) Series CK for 0.1- to 120-second delay time ranges.
        2) Schneider Electric equivalent.
        3) Allen-Bradley equivalent.

J. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
    a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
    a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

K. Control Panels with Network Connected PLCs:

1. Provide PLC hardware, PLC programming software, OIU hardware, and OIU configuration software where shown on block diagrams.
2. Unless otherwise noted, provide Allen-Bradley CompactLogix or ControlLogix PLC connected to the plantwide Ethernet network and local area network.
3. Provide additional communication modules, if required, to support data transfer rates.
4. Provide for a programming port on both the PLC and OIU while the OIU remains connected to the PLC and the PLC remains connected to the plant Ethernet network.
5. Provide a minimum of 20 percent spare PLC program memory available upon completion of startup of the equipment.
6. Operator Interface Unit (OIU):
   a. Manufacturer and Model: Allen-Bradley PanelView Plus 7 Touch Display Module, display size 10 inches minimum.
   b. Configuration Software: FactoryTalk Studio ME.

L. Programmable Controllers:

1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
2. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
3. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.
4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
5. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.
6. Manufacturers:
   a. Rockwell Automation - Allen-Bradley.

M. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:

1. Potentiometer Units:
   a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.

b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
c. Include legend plates with service markings.
d. Manufacturers and Products:
    1) Allen-Bradley; Model 800T.
    2) Eaton/Cutler-Hammer; Model 10250T.

2. Indicating Lights:
    a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
    b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
    c. Manufacturers and Products:
        1) Eaton/Cutler-Hammer; Type 10250T.
        2) General Electric; CR2940U.
3. Pushbutton, Momentary:
    a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
    b. Standard size legend plates with black field and white markings for service legend.
    c. Manufacturers and Products:
        1) Square D; Class 9001, Type K.
        2) Eaton/Cutler-Hammer; Type T.
        3) General Electric; Type CR-2940.
4. Selector Switch:
    a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
    b. Standard size, black field, legend plates with white markings, for service legend.
    c. Operators: Black knob type.
    d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
    e. Manufacturers and Products for Units with up to Four Selection Positions:
        1) Eaton/Cutler-Hammer; Type T.
        2) Square D; Type K.
    f. Manufacturers and Products for Units with up to 12 Selection Positions:
        1) Rundel-Idec; Standard Cam Switch.
        2) Electroswitch; 31.

N. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
   a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include engraved legend plates with service markings.
   d. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
   b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
3. Pushbutton, Momentary, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
4. Selector Switch, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
   e. Manufacturer and Products:
      1) Square D; Class 9001, Type SK.
      2) Allen-Bradley; Type 800H.

O. Y499 Control Panel Air-Conditioner Unit:

1. General:
   a. Type: Closed-loop type with heater and programmable thermostat controller, UL listed.
   b. Enclosure: Stainless steel, NEMA 4X.
   c. Mounting Type: Outdoor, side-panel mount.
2. Performance:
   a. Capacity: As required. Provide heat sizing calculations for each control panel installation.
   b. Input Power: As required.
3. Accessories: Provide replacement filters for up to one year.
4. Manufacturer and model:
   a. Hoffman (nVent), Spectracool.
   b. Kooltronics GuardianX.
   c. Or approved equal.

2.06 INSTRUMENT TAG NUMBERS

A. A shorthand tag number notation is used. For example:

AI-1-12(2)(3)[pH]

Notation	**Explanation**
AI	ISA designator for Analysis Indicator
1	Unit process number
12	Loop number
(2)	First unit number; number of same component types in a given loop; -1 and 1-2 in this example
(3)	Second unit number; number of same component types with same first unit number in a given loop; -1, -2, and -3 in this example
[pH]	Same notation shown at 2 o'clock position on ISA circle symbol on Process and Instrument Diagram

B. In this example, AI-1-12(2)(3)[pH] is shorthand for:

AI-1-12-1-1[pH], AI-1-12-1-2[pH], AI-1-12-1-3[pH]

AI-1-12-2-1[pH], AI-1-12-2-2[pH], AI-1-12-2-3[pH]

2.07 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.

1. Panel Mounted: Plastic, mounted to instrument behind panel face.
2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:

1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
2. Color: White with black letters.
3. Letter Height: 3/16 inch.
4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2-inch high.

C. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber

1. Lettering: Black on white and amber lenses; white on red and green lenses.
2. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.

2.08 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.

B. Suppressor Locations:

1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressor Design:

1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2. Response: 5 nanoseconds maximum.
3. Recovery: Automatic.
4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
5. Enclosure Mounted: Encapsulated inflame retardant epoxy.

D. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Power Supplies for Continuous Operation:
   a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
   b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.

2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
   b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. Analog Signals Lines: Emerson Asco Model 175 series.
2. 120V ac Lines: Emerson Asco Model 252.
3. 480-Volt, Three-Phase Power Supplies:
   a. Square D Model SDSA3650.
   b. DITEK Z40-3Y.
4. Field Mounted at Two-Wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Asco Model 157 series.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
   a. Enclosure:
      1) NEMA 4X fiberglass or Type 316 stainless steel with door.
      2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Asco Model 265 series.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26 05 26, Grounding and Bonding for Electrical Systems, and suppressor manufacturer's requirements.
2. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.

3.02 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

END OF SECTION

SECTION 44 42 13
HIGH-SPEED MECHANICAL FLOATING AERATORS

PART 1 GENERAL

1.01 SUMMARY

A. The Manufacturer shall comply with the general requirements listed in Part 2, Particular Specifications as well as with Sections 05 05 23, Welding and 05 50 00, Metal Fabrications.

B. This section covers the design, manufacture, delivery, site storage, installation, testing and placement into operation of two High-Speed Mechanical Floating Aerators to be installed in sludge digestors.

C. The Floating Aerators include but are not limited to pivot arm moorings, electrical service cables and drive motors.

1.02 REFERENCES AND STANDARDS

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

1. American National Standards Institute (ANSI).
2. American Water Works Association (AWWA).
3. ASTM International (ASTM).

1.03 DEFINITIONS

A. Actual Oxygen Transfer Rate (AOTR): The rate of oxygen transfer at actual design conditions.

B. Standard Oxygen Transfer Rate (SOTR): The rate of oxygen transfer to tap water at standard conditions of 20 degrees C, 0.0 mg/L dissolved oxygen concentration, and a barometric pressure of 101.3 kPa (dry air).

1.04 SUBMITTALS

A. Action Submittals:

1. Size, details, and complete list of materials.
2. Details of pivot arm mooring system.
3. Commissioning reports.

B. Informational Submittals:

1. Factory test results, reports, and certification. Include oxygen transfer performance test results.
2. Special shipping, storage and protection, and handling instructions.
3. Routine maintenance requirements prior to plant startup.
4. Manufacturer's Certificate of Compliance and Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturer's Field Services.
5. Operation and maintenance data: as specified in Section 01 78 23, Operation and Maintenance Data.

1.05 SPECIAL GUARANTEE

A. The Floating Aerators shall meet the design requirements specified in this section.

B. The Manufacturer shall provide extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. The special guarantee shall provide for correction, or at option of Owner, removal and replacement complete Floating Aerator or any component found defective during a period of 5 years after startup. Startup is defined as when waste activated sludge is put in the aerobic digestors for the first time. Duties and obligations for correction or removal and replacement of defective work shall be as specified in the Contract.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage of spare parts and special tools recommended by the Manufacturer for 1-year and 5-year operation.

B. Parts shall be protected as for an extended storage period. The box shall be heavily constructed with hinged cover, hasp and lock, and designed as a permanent storage enclosure for the spare parts. The spare parts shall, if possible, be enclosed within an airtight membrane.

C. Spare parts supplied in matched sets shall be wrapped, bound, or labelled to indicate a set.

D. Parts shall be labelled clearly, along with Manufacturer's parts numbers.

E. All spare parts shall be interchangeable with, and of the same materials and workmanship as the corresponding original parts furnished under this section.

F. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Motor starters, breakers, switchgear, external wiring, and conduit for all equipment covered under this Section will be provided by the Contractor as specified within the Contract Documents.

B. The Contractor shall provide concrete pads on the digester bottoms below the Floating Aerators to avoid damage to the basin bottoms and walls. Aerator Manufacturer to coordinate with Contractor and Tank Manufacturer for position and size of the concrete pad.

C. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

D. The Manufacturer shall design the Floating Aerators for continuous full load duty.

E. Safety Devices: the completed Work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other local health and safety regulations.

2.02 SERVICE CONDITIONS

A. All of the system components specified herein shall be designed to operate and endure the environment presented by normal plant operation.

B. Equipment will be located outdoor. Ambient air temperature at the Site is expected to range from approximately 0 degrees C to 38 degrees C.

2.03 MANUFACTURERS

A. Aqua-Aerobics; Aqua-Jet Aerator.

B. Evoqua; Aqua-Lator Aerator.

C. Or approved equal.

2.04 AERATOR MANUFACTURER, CONTRACTOR, AND PRE-STRESSED CONCRETE TANK MANUFACTURER COORDINATION

A. Aerator manufacturer to coordinate the aerator mooring arm and cable(s) mounting locations with the Contractor and Tank manufacturer. The mooring assembly to be positioned around the digester tank to allow the aerator to swing over to the side of the digester and land in front of the elevated access platform and associated swing gate for maintenance access to the aerator from the platform.

B. Aerator manufacturer to coordinate the associated mooring arm and cable loads with the Tank manufacturer.

2.05 DESIGN REQUIREMENTS

A. Floating aerators for Sludge Digestors:

1. The Floating Aerators shall be designed to aerate and stabilize sludge produced in the secondary treatment process.
2. The Aerobic Digestors consist of two aerated pre-stressed concrete tanks. Each tank will be aerated by one Floating Aerator.
3. Refer to Contract Drawings for basin dimensions.
4. Minimum power requirement per aerator shall be 75 hp.
5. Design operating conditions:

Sludge temperature:	15 degrees C
Sludge pH:	6 – 8 S.U.
Tank retention time	20 days
VSS in feed sludge	3,500 lb/day
VSS reduction	38%
Basin side wall depth:	13′ 9" ft
Maximum water side wall depth: (design high water level)	12 ft
Minimum water side wall depth: (low water level)	5 ft

6. Design air requirements:

Minimum residual dissolved oxygen concentration	2 mg/L
Theta	1.024
Specific AOTR	1.5 lbs O2/BHP-hr
Specific SOTR	to be calculated by Manufacturer - O2/BHP-hr

2.06 AERATOR DRIVE MOTORS

A. The motors shall be 1,200 rpm and 75 hp. It shall be wired for 460 volts, 60 cycle, three-phase service.

B. The motors shall be EXP and rated severe chemical duty.

C. A minimum service factor of 1.15 shall be furnished.

D. The motors shall be of vertical design suitable for operation in Class I, Division 1, Group D area. Submerged motors are not acceptable.

E. The motors shall in all cases equal or exceed standard NEMA Specifications.

F. The motor winding insulation shall in all cases equal or exceed NEMA Class F design and shall be non-hygroscopic.

G. A condensate drain shall be located at the lowest point in the lower end-bell housing.

H. All motor end bells shall be deep registered and Permatex sealed.

I. All through bolts, nuts and screws shall be of Type 18-8 stainless steel.

J. Each motor will have a rain cap constructed of cast iron or non-corrosive Type 304 stainless steel. Painted or plated carbon steel rain caps will not be acceptable.

K. A stainless steel nameplate shall be provided with each motor, and shall be securely fastened thereto. The voltage, speed, phase, insulation class, amperage, service factor, wiring diagram, motor serial number, and manufacturer's name and address shall be stamped thereon or otherwise permanently marked.

2.07 AERATOR MOTOR BEARINGS

A. Motor bearings shall be re-greasable. Sealed bearings are not acceptable. Top bearing shall be shielded on the bottom side only. Bottom bearing shall be open.

B. The top and bottom motor bearings shall be of the combined radial and axial thrust type and shall be packed at the factory with “high performance” grease.

C. The lower motor bearing inner race shall be locked to the motor shaft via a special washer and locking nut arrangement. The shaft shall be threaded just below the lower bearing and shall have a keyway cut into the motor shaft. This key shall accept a tab from the I.D. of the locking washer, and the

locking nut shall have recesses to accept a tab from the OD of the locking washer to prevent the nut from backing off. Snap ring type bearing retainers will not be acceptable.

2.08 MOTOR SHAFTS

A. Each Floating Aerator motor shall have a one piece motor shaft continuous from the top motor bearing, through the lower bearing and down to and through the impeller.

B. The Aerator motor shaft shall be manufactured from 17-4 precipitation hardened (PH) stainless steel or comparable stainless steel having a minimum yield strength of $6.89 \text{ X } 10^5$ kPa on units of 2 KW and higher.

C. The Aerator motor shaft shall operate freely without contacting any bearings or bushings other than the motor bearings.

2.09 DIFFUSION HEADS

A. Materials of Construction: diffusion head shall be a Type 304 stainless steel one-piece casting.

B. The design of the diffusion head shall be such that the liquid spray will discharge at angle of 90 degrees to the motor shaft, and over a 360 degrees pattern in the horizontal plane, and shall be a stainless steel monolithic casting.

C. The diffusion head casting shall act as a base for the aerator motor, and alignment of the motor to this base shall be controlled by machined index fittings that engage the P-base of the motor. Diffusion head/motor arrangements that are dependent upon bolt holes only for alignment will not be acceptable. All diffusion head hardware will be Type 304 stainless steel and safety wired.

D. The diffusion head casting shall act as a thrust block to deflect the high velocity, pumped volume of the aerator from the vertical to the horizontal direction. The bottom side of this casting shall have a 90-degree radius transition to effect the hydraulic change in direction with a minimum of head loss.

E. The diffusion head shall absorb all normal and shock loads encountered by the propeller and transmitted to the diffusion head via the motor shaft and lower motor end-bell. The diffusion head shall distribute these forces into the float via webs that terminate in a flange or ring that is an integral part of the diffusion head. This flange shall mate with a similar flange that is an integral part of the float/volute to spread the stresses generated by the propeller

uniformly around the float so that no point loading of the float is allowed. These flanges shall be machined flat to provide proper bearing surfaces. The alignment of the diffusion head flange to the float/volute shall be by use of a 360-degree index pilot.

F. Specifically, diffusion head designs that employ studs and spacers, shoulder bolts or fiberglass are not allowed. Load bearing, machined flat, flange-to-flange connections will be mandatory.

G. The diffusion head shall contain an anti-deflection journal insert to limit the radial deflection of the motor shaft.

H. This anti-deflection journal insert shall be located in the lower extremity of the diffusion head, approximately one-half the distance between the motor base and the lower end of the shaft.

I. The journal insert shall be machined from Delrin or molded from moly-filled urethane and shall be a minimum of 0.060-inch larger through the bore than the diameter of the motor shaft.

J. Units featuring a one-piece unsupported shaft will not be acceptable.

K. There shall be a fluid deflector located on the motor shaft immediately below the anti-deflection journal, which shall cover completely the anti-deflection journal insert and the lower portion of the diffusion head.

L. The fluid deflector shall be molded from black neoprene and shall be press fit onto the motor shaft.

2.10 LOW TRAJECTORY DIFFUSER FOR SLUDGE DIGESTOR AERATORS

A. Each Floating Aerator provided for the aerobic digesters shall be furnished with a low trajectory diffuser made of stainless steel. This assembly shall be attached to the top of the diffusion head and shall be used to lower the aerator spray pattern and reduce windblown spray.

2.11 FLOATS

A. Each aerator shall have reserve buoyancy to ensure stability and to provide support flotation required during aerator servicing. Floats shall be one-piece; i.e.; segmented floats are not acceptable.

B. Flotation stability will be mandatory. Under no circumstances will unstable flotation designs requiring counterbalancing, ballast of liquid, solid mass or submerged major fabricated assemblies to stabilize the operation of the aerator be allowed. Only aerators demonstrating stable operational characteristics, without rocking or oscillating will be acceptable.

C. The float shall be fabricated of a minimum of 14 gauge, Type 304 stainless steel or fiber reinforced polyester skin (FRP).

D. All floats shall be constructed so that the internal void can be filled full of closed cell polyurethane foam having a minimum 2.0 lbs/ft^3 density and shall be completely sealed watertight.

E. All floats shall have a single mooring arm and two mooring cables spaced around the outer tank circumference as recommended by aerator manufacturer. No mooring connections will be allowed to attach to the upper or lower float covers. Only tension type connections perpendicular to the outer sidewall will be approved. All mooring connections shall be stainless steel.

F. The float construction shall be such that the volute will distribute the load of the entire motor, drive, diffusion head and volute static load, plus the entire dynamic load from the propeller thrust and radial forces by spreading these forces uniformly around the full 360-degree circumference of the float's central core. Point connected joints or point stressed connections will not be accepted.

2.12 PROPELLERS

A. The propeller shall be a two-blade, left-handed, marine type precision casting of Type 316 stainless steel. It shall be a self-cleaning type that will not accumulate fibers, rags, stringy materials, etc.

B. Units using inclined screw impellers will not be acceptable. The propeller shall be securely attached to the motor shaft in such a manner so that reversal operation for liquid back flushing will not loosen its connection; therefore, propellers requiring the threading of the shaft for attachment will not be allowed.

C. The propeller shall be “pitch balanced” to insure equalization of load under full flow operation. Each blade's pitch and rake shall not vary more than 2 percent from the other. The propeller must be attached to the motor shaft with a hardened stainless steel pin and set screw. No tapered, threaded shafts with nut fasteners will be acceptable.

D. No liquid spray or other liquid leakage upward onto the surface of the motor support surface or flotation chassis will be allowed at any time.

2.13 VOLUTE ASSEMBLIES

A. The propeller shall operate in a volute made of Type 304 stainless steel plate. It shall be round and true so that propeller blade tip clearance is uniform within the volute as it rotates. A minimum of four full-length stainless steel

gussets shall be welded on a 90-degree spacing around the circumference of the volute between the top and bottom flanges.

B. The volute shall have a large machined flange at its top extremity that completely encircles the volute, and this flange shall match a similar flange on the bottom of the diffusion head to provide for a bolted, machined flange-to-flange fit to provide uniform distribution of the dynamic loads generated by the propeller and the static weight of the motor and drive. A 360-degree machined index in the upper flange shall provide concentric alignment of the propeller in the volute by engaging the inside diameter of the mating flange on the diffusion head. Bolt holes alone will not be acceptable to locate the important alignment of the propeller.

C. No plastic, fiberglass, carbon steel or cast iron materials shall be acceptable.

2.14 INTAKE CONES

A. The intake cone shall be fabricated from Type 304 stainless steel having a gradually expanding opening outward to the intake end. The length and inlet diameter shall be sufficient to provide uniform inlet hydraulics so that no increase in vibration is caused due to its shape or size.

B. The material used to fabricate the intake cone shall be structurally sufficient to support the weight of the entire aerator assembly when the aerator is freestanding on dry ground.

C. For maximum in-depth mixing efficiency, the intake cone shall be designed so that the suction lift from the aerator propeller is vertical from the liquid depth below the aerator. Unless specifically required for anti-erosion requirements, side or angle entry suction inlets will not be approved. Fiberglass intake cones are not allowed.

D. All aerators of 15 KW and larger must provide anti-vortex crosses welded inside the cones. Anti-erosion devices, if required, must be welded to the crosses.

2.15 MOORING

A. Pivotal Mooring – Aerobic Digestor Aerators:

1. Pivotal mooring shall be utilized to allow for great water level variation.
2. A Pivotal mooring arm and mooring cables shall be fastened to the aerator float and shall consist of a Type 304 stainless steel mooring arm and stand-off bracket and Type 316 stainless steel mooring cables, hardware, thimbles, and clips. Mooring arms attached to side skins of the float are not acceptable.

3. The mooring arm shall connect to the sludge digestor wall. The mooring arrangement shall permit the unit to rise and fall with the varying water level.
4. J bolt made of Type 316 stainless steel shall be utilized to connect the mooring devises the floatation unit. A minimum of three connections are required.
5. Furnish the mooring arm and all necessary cables and appurtenances required for installation.
6. Mooring cable and Pulley System:
    a. Route the two mooring cables around the digester wall back to the elevated platform for ease of maintenance access without needing to access any other point in the basin via a heavy-duty pulley system designed and supplied by the aerator manufacturer.
    b. The pulley system to be of Type 304 stainless steel and Type 316 stainless steel wall anchors.
    c. Pulley system to be aligned to allow an operator to pull on the cables to retrieve the floating aerator in a smooth and non-binding motion.
    d. The mooring cable attached to the aerator opposite of the platform is to be supplied with a maintenance loop of sufficient length to allow the aerator to be retrieved all the wall to the platform without detaching from the wall via the mooring wall anchor.
    e. The maintenance loop to be supplied with all necessary appurtenances required to provide a functional system including but not limited to a Type 316 stainless steel cable, thimbles, cable clips, maintenance mooring loops snap hooks, and no less than 3 heavy-duty pulleys per unit.

2.16 ELECTRICAL SERVICE CABLE

A. Each unit shall be furnished with required meters of electrical service cable with continuous length (non-spliced). The cable shall have three power conductors and a ground conductor.

B. Aerator manufacturer to coordinate the electrical cable connections with the Contractor. Aerator manufacturer to provide the manufacturer supplied cables long enough to extend to a junction box at ground level on the exterior of the tank.

C. Conductors shall be flexible type annealed copper stranded. Each conductor, including the ground conductor, shall be insulated. Cables containing an un-insulated ground conductor will not be acceptable.

D. The insulated conductors shall be assembled together with a non-hygroscopic filler material.

E. Outer jacket shall be high quality CPE, PVC, TPE or equal, and shall be rated at a conductor operating temperature of not less than 90 degrees C.

F. The cable shall be rated for hard usage outdoor service and shall be resistant to oil, sunlight, ozone, grease, acids, water, abrasion and impact.

G. Aerator manufacturer shall provide two kellems grip strain reliefs per unit and two spiral wrap abrasion protection sleeves per unit.

2.17 FACTORY TESTING

A. Furnish advance written notice of any of the tests to the Engineer. The Engineer or his representative may witness tests.

B. Perform tests on all Floating Aerators actually furnished.

C. Balancing:

1. The entire rotating assembly including the motor rotor, shaft and impeller shall be dynamically balanced within 2.0 mils peak-to-peak horizontal displacement measured at the upper and lower motor bearing.
2. Measurements shall be taken at a frequency equivalent to the motor RPM.
3. Transducer pickup points shall be at the motor bearings on the motor frame perpendicular to the motor shaft.
4. Measurements shall be taken with the motor in a vertical, shaft down position and with the motor or the entire power section mounted on resilient pads.

D. Vibration Analysis:

1. The Floating Aerators, under operation in a liquid medium, at a power consumption level not less than 90 percent of nameplate shall be tested for operating vibration levels. Vibration levels shall not exceed 2.0 mils peak-to-peak maximum amplitude measured at the top and bottom motor bearing housing, and vibration velocity levels shall not exceed 0.30 inch/second at the top and bottom motor bearing and at the cutless housing.
2. Shall any one of the units fail to pass this test, that unit will be rejected, and will have to be rebalanced and retested, demonstrating to the Engineer that operating level of vibration is equal to or less than the levels specified herein.

E. Shaft Brake Power Test:

1. Each Floating Aerator shall deliver a minimum of 88 percent and a maximum of 94 percent of the nameplate kilowatts as evidenced by measured operating amp load and voltage readings.

2. Shall any one of the units fail to pass this test, that unit will be rejected, and will have to be readjusted and retested, demonstrating to the Engineer that operating level of brake power is within the levels specified herein.

F. Oxygen Transfer Performance Testing Procedure:

1. In accordance with ASCE 2. Use a Theta value of 1.024. Specific details of test procedure and any deviation from requirements stated below must be reviewed and approved by the Engineer.
2. Non-steady-state re-aeration test shall consist of three re-aeration test runs. SOTR shall be the average of SOTRs obtained for each re-aeration test run. Sodium sulfite catalyzed with cobalt chloride shall be used to strip residual dissolved oxygen between re-aeration test runs.
3. Test Facilities: provided by the Manufacturer and subject to Engineer's approval and capable of providing sidewater depth as per actual process conditions for this project.

G. Obtain approval of test reports from Engineer prior to shipment of any equipment.

2.18 FINISHES

A. For non-stainless steel and non-aluminum metal surfaces, prepare, prime, and finish coat in accordance Manufacturer's standard.

B. Exposed metal surfaces of motors and gear reducers shall be field finish coated in accordance with Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.01 INSTALLATION

A. All equipment specified herein shall be installed in accordance with Manufacturer's written instructions.

3.02 FIELD QUALITY CONTROL

A. Functional Test: conduct on each Floating Aerator supplied. Test shall include 6 hours continuous operation of each aerator.

3.03 MANUFACTURER'S SERVICES

A. The Manufacturer's Representative shall be present at jobsite for the number of days listed below, travel time excluded:

1. 1 person-day for installation supervision and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for startup and training of Owner's personnel.

B. See Section 01 43 33, Manufacturers' Field Services.

3.04 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.

1. Floating Aerator Data Sheet.
2. Induction Motor Data Sheet.

END OF SECTION

Floating Aerators for Aerobic Digesters 3 and 4 Data Sheet

(Asterisk (*) indicates that information needs to be supplied by the manufacturer)

Manufacturer*:
Equipment model number*:
Number of Floating Aerators included in bid*:
Brake power per Floating Aerator*:
Floor concrete pads required (Y or N)*:
Draft tube required (Y or N)*:
Flow direction panel required (Y or N)*:

Design Conditions

- Minimum dissolved oxygen level (mg/L): 2.0
- Alpha*:
- Beta*:
- Theta: 1.024
- Specific SOTR (kg/hr-KW)*:
- Operating torque (N/m)*:
- Maximum stall torque (N/m)*:
- Diameter zone of complete oxygen dispersion (m)*:
- Minimum water depth (ft):5
- Maximum water depth (ft): 5

Float

- Diameter (cm)*:
- Shell material: FRP or SST filled full of closed cell polyurethane foam
- Minimum shell thickness*:
- Floatation capacity (kg)*:
- Reserve floatation capacity (kg)*:

Propeller

- Blade tip diameter (cm)*:
- Material: 15-5 stainless steel
- Impeller submergence (m)*:
- Radial impeller tip clearance (mm)*:
- Is impeller shaft separate from motor shaft (Y/N): N
- Shaft diameter (cm)*: Min Max
- Shaft material: 17-4 PH stainless steel

Floating Aerators for Digesters 3 and 4 Data Sheet

(Asterisk (*) indicates that information needs to be supplied by the manufacturer)

Mooring

- Type: Pivot Mooring
- Length (ft): 29.5-ft (total assembly including the stand-off bracket and pivot arm) or as recommended by manufacturer for proper performance
- Diameter (in):*
- Material: SST
- Mooring frame required? (Y/N) Yes

Others

- Diffuser head material: 304 SST
- Is low trajectory diffuser required*? (Y/N) Y
- Low trajectory diffuser material: 304 SST
- Volute material: 304 SST
- Intake cone thickness*:
- Intake cone material: 304 SST
- Motor shaft diameter (mm)*:

Weights

- Total weight, each aerator (kg)*:
- Float (kg)*:
- Propeller (kg)*:
- Volute (kg)*:
- Diffuser assembly (kg)*:

INDUCTION MOTOR DATA SHEET FOR DIGESTER FLOATING AERATORS

Type:

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Motors shall be UR and CSA rated and stamped accordingly.

Motor Horsepower: 75

Voltage: 460

Phase: 3

Frequency: 60

Synchronous Speed: 1200 rpm

☐ Thermal Protection: _____

☐ Space Heater: ____ volts, single-phase

Guaranteed Minimum Efficiency at Full Load: ____ percent

Guaranteed Minimum Power Factor at Full Load: ____ percent

Service Factor (@ rated max. amb. temp.):

Enclosure Type: EXP

☐ Multispeed, Two-Speed: ____ / ____ rpm

Winding: ☐ One ☐ Two

Mounting Type: ☐ Horizontal ☐ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up ____ Down ____

Shaft material:

Shaft yield strength: _____ kPa

Shaft tensile strength: _____ kPa

Shaft diameter, Max ____ cm Min____ cm

Thrust bearing B-10 rating:

Thrust bearing B-10 rating:

Length of electric service cable supplied (m)

Additional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

SECTION 44 42 56.20
DOUBLE DISC PUMPS

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section covers the work necessary to furnish and install, complete, the double disc pumps and required valves specified herein, and as further specified in the Supplements hereinafter.

B. Unit Responsibility: The Contractor is responsible to the Owner for providing the equipment as specified herein.

C. General Requirements: See Division 01, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project, including, but not limited to, Codes and Standards.

1.02 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, Submittal Procedures.

B. Submittals shall be made as required in Section 01 33 00, Submittal Procedures. In addition, the following specific information shall be provided:

1. The following specific information shall also be provided:
   a. Complete manufacturer's drawings showing the dimensions and elevations of the pump, materials of construction, and accessories being provided for the specific installation.
   b. Installation instructions.
2. Shop Drawings: Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, and overall efficiency required at the guarantee point. Performance requirements shall be as defined in the Hydraulic Institute Standards.
3. General arrangement drawings showing layouts and dimensions of the pump systems, including air chambers and connection points.

4. Submit manufacturer's written certification that the factory-applied coating system(s) is identical to the requirements specified herein. Where, in the manufacturer's opinion, the coating system(s) exceeds the requirements specified herein, submit complete technical literature of the proposed system(s) to the Engineer for review.
5. Refer to Section 26 20 00, Low Voltage AC Induction Motors, for required AC induction motor submittals.
6. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
7. Power and control wiring diagrams, including terminals and numbers.
8. Product data sheets for each make and model of valve. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
9. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

C. Provide Quality Control Submittals as Follows:

1. Operations and Maintenance Data.
2. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
3. Manufacturer's Certificate of Proper Installation in conformance with Section 01 43 33, Manufacturers' Field Services.
4. Manufacturer's Training Program.
5. Equipment Testing and Field Startup Report.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Product delivery, storage, and handling shall comply with Section 01 61 00, Common Product Requirements.

B. Delivery of Material: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SPARE PARTS:

A. Provide the following spare parts:

1. Two discs.
2. Two trunnions.
3. One clack valve.
4. One set of gaskets.

2.03 CONTROL SYSTEMS

A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 99 90, Package Control Systems.

B. Control Systems Integrator Controls: Control Systems Integrator shall provide programming and controls for interface between the Biosolids Feed Pumps and belt filter press systems.

C. Panels:

1. Provide a free-standing or stanchion mounted control panel.
2. Material: Type 316 stainless steel.
3. NEMA Rating: 4X.
4. Tags: 25-LCP-10-1.

D. Operator Controls and Indicators: Provide the following panel mounted operator controls and indicators for 25-LCP-10-1:

1. On/Off/Remote hand switch.
2. System On Indicator.
3. Pump Fail Indicator.
4. Pump RUN Indicator.
5. Pump Rest pushbutton.

6. System RUN Indicator.
7. Digester Level (Four total).

E. External Interfaces (25-LCP-10-1):

1. System RUN command.
2. Pump Fail alarm.
3. Low suction pressure alarm.
4. High discharge pressure alarm.
5. System ON status.
6. System in remote status.
7. Digester 1 High Level (Pump Interlock) Alarm.
8. Digester 2 High Level (Pump Interlock) Alarm.

F. Functional Requirements:

1. Pumps programmable automatic controller (PLC) to operate based on ON/OFF/REMOTE control switch.
2. When in Remote:
   a. Pumps run in response to external System RUN command.
   b. Pump speed is adjusted in response to external pump speed adjust signal based on programmed setpoints. (for the Biosolids Feed Pumps).
3. Monitor for high discharge pressure. If high discharge pressure is sensed, turn the pumps off.
4. Monitor for high Digester Tank level in Digesters 1 and 2. If high level is active, disable the pumps.

2.04 ELECTRICAL

A. Provide wiring between pump controller's termination enclosure, pressure sensors and switches, and the pumps.

B. Provide circuit breakers and controllers for each pump.

C. Wiring shall be in a conduit.

D. Provide device fusing/circuit breakers as required.

E. Fuses and circuit breakers shall be housed in each respective control panel, which shall be NEMA 4X.

2.05 ACCESSORIES

A. Suction and discharge side pulsation dampeners.

1. Manufacturer's recommended.

B. Suction vacuum sensor and gauge assembly:

1. Mounts to top of dampener to provide indication of line pressure.
2. Consists of 1-inch NPT Type 316 stainless steel sensor with EPDM sleeve and 4-inch (0-100 psi) stainless steel gauge.
3. Model: PVP420V.

C. Discharge pressure assembly switch assembly:

1. Mounts to top of dampener to provide indication of line pressure.
2. Consists of 1-inch NPT Type 316 stainless steel sensor with EPDM sleeve, NEMA 4X adjustable switch and 4-inch (0-100 psi) stainless steel gauge.
3. Model: PVP420PS.

D. Adjustable Back Pressure Valve: Type 959 valve as specified in Section 40 27 02, Process Valves and Operators.

E. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die stamped equipment tag number securely mounted in a readily visible location.

F. Lifting Lugs: Equipment weighing over 100 pounds.

G. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.06 MANUFACTURERS

A. Pump equipment specified in this section shall be products of Penn Valley Pump Company, Inc. or equal as approved by the Owner and Engineer.

2.07 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.08 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

C. Factory Test Report: Include test data sheets, curve test results, certified correct by a registered professional engineer.

D. Functional Test: Perform manufacturer's standard test on equipment.

E. Hydrostatic Tests: Test pump casings at 150 percent of shutoff head for not less than 5 minutes.

F. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

G. Performance Test:

1. Conduct on each pump.
2. Conduct in accordance with Hydraulic Institute Standards.
3. Perform under simulated operating conditions.
4. Test for a continuous 3-hour period without malfunction.
5. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Install pump and associated valves in accordance with the Drawings.

C. Connect suction and discharge piping without imposing strain to pump flanges.

D. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

A. Shop and field painting shall be in accordance with and as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Test: Prior to plant startup, all equipment described herein and in the Supplements following shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test.

B. Performance Test:

1. The Contractor shall perform field tests on all completed pump assemblies to demonstrate their conformance to the Specifications to the satisfaction of the Engineer. A test log shall be presented to the Engineer upon the completion of each test that records the following:
   a. Flow, as measured by plant instrumentation and/or storage volumes.
   b. Pump suction and discharge pressures as measured by calibrated gauges, converted to feet of the liquid pumped and corrected to pump centerline, calculated velocity heads at the suction and discharge flanges, and total head, all tabulated in feet.
   c. Driving motor average voltage, amperage, power factor, and efficiency at test conditions.
2. Units failing to meet the Specifications to the satisfaction of the Engineer must be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the Contractor shall furnish a unit that will perform as specified.

3.04 MANUFACTURERS' SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation. (1 person-day per pump station).
3. 1 person-day for facility startup and training.

B. See Section 01 43 33, Manufacturers' Field Services.

3.05 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are part of this Specification.

1. Biosolids Feed Pump 1 and 2 Pump Data Sheet.
2. Intermediate Sludge Pump 1 and 2 Pump Data Sheet.

END OF SECTION

DOUBLE DISC PUMP DATA SHEET, 44 42 56.19

Tag Numbers: 30-PMP-30-1 and 30-PMP-30-2
Pump Name: Biosolids Feed Pump 1 and 2
Manufacturer and Model Number: (1)PVP 6" Model 6DDSX107
(2)No Substitutions

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Digested Sludge
Pumping Temperature (Fahrenheit): Normal: 60 Max 70 Min 50
Specific Gravity at 60 Degrees F: 1.0 Viscosity Range:
Abrasive (Y/N) Y Possible Scale Buildup (Y/N): N
Min. NPSH Available (Ft. Absolute): 31

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 200
Total Dynamic Head (Ft): Rated: 65
Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 50
Max. Pump Speed at Rated Capacity (rpm): Constant (Y/N): 300; N

DESIGN AND MATERIALS

Pump Type: Double Disc Pump
Housing Material: Cast Iron ASTM A48
Elastomers Material: Neoprene
Connecting Rods Material: High-tensile Aluminum
Drive Shaft Material: High-tensile 400 Series SS
Frame and Covers: 304 SST

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 10 Voltage: 460 Phase: 3
Synchronous Speed (rpm): 1200
Service Factor: 1.15 Inverter Duty (Y/N) Y
Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.
Enclosure: DIP ___ EXP ___ ODP ___ TEFC _X_ CISD-
TEFC ___ TENV ___ WPI ___ WPII ___ SUBM ___
Drive Arrangement: PVD728 Piggy Back

REMARKS:

DOUBLE DISC PUMP DATA SHEET, 44 42 56.19

Tag Numbers: 25-PMP-10-1 and 25-PMP-10-2
Pump Name: Intermediate Sludge Pump 1 and 2
Manufacturer and Model Number: (1) PVP 6" Model 6DDSX107
(2) No Substitutions

SERVICE CONDITIONS

Liquid Pumped (Material and Percent Solids): Digested Sludge
Pumping Temperature (Fahrenheit): Normal: 60 Max 70 Min 50
Specific Gravity at 60 Degrees F: 1.0 Viscosity Range:
Abrasive (Y/N) Y Possible Scale Buildup (Y/N): N
Min. NPSH Available (Ft. Absolute): 28

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 200
Total Dynamic Head (Ft): Rated: 25
Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 50
Max. Pump Speed at Rated Capacity (rpm): Constant (Y/N): 200; Y

DESIGN AND MATERIALS

Pump Type: Double Disc Pump
Housing Material: Cast Iron ASTM A48
Elastomers Material: Neoprene
Connecting Rods Material: High-tensile Aluminum
Drive Shaft Material: High-tensile 400 Series SS
Frame and Covers: 304 SST

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 10 Voltage: 460 Phase: 3
Synchronous Speed (rpm): 1200
Service Factor: 1.15 Inverter Duty (Y/N) N
Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.
Enclosure: DIP ___ EXP ___ ODP ___ TEFC _X_ CISD-TEFC ___ TENV ___ WPI ___ WPII ___ SUBM ___
Drive Arrangement: PVD728 Piggy Back

REMARKS:

SECTION 44 44 63.01
POLYMER FEED SYSTEM, LIQUID

PART 1 GENERAL

1.01 SUBMITTALS

A. Contractor's Drawings in accordance with Section 01 33 00, Submittal Procedures.

B. Action and informational submittals in accordance with Section 40 99 90, Package Control Systems.

C. Make, model, and weight of equipment item.

D. Schematic of piping layout showing all equipment, valves, and other accessories.

E. P&ID of system showing all equipment, valves, instrumentation, and other accessories. Equipment tagging scheme should be in coordination with the Contract Drawings.

F. Manufacturer's catalog information, descriptive literature, specifications, and materials of construction.

G. Information on rotameters and mixer chamber shaft seals indicating pressure rating and service requirements specified herein.

H. Retention time and Gt (mean velocity gradient multiplied by retention time) values for polymer mixing chamber.

I. Dimensions for system components.

J. Electrical control schematic and wiring diagrams that clearly show alarms, shutdowns, and contact closures for central control system.

K. Control Panel elevation drawings, including bill of materials.

L. Installation requirements.

M. Interconnection wiring diagrams showing 460-volt power distribution, 120-volt control interconnection, instrument connection, wire sizes and quantities, wire identification per control diagrams, and terminal block locations.

N. Test procedures.

O. Factory test report.

P. Manufacturer's installation instructions.

Q. Detailed mechanical and electrical drawings showing equipment fabrications and interface with other items. Include dimensions, size and locations of connections to other Work, and weights of associated equipment.

1. Record Drawings in accordance with Section 01 33 00, Submittal Procedures.

R. Operation and Maintenance Manuals in accordance with Section 01 78 23, Operation and Maintenance Data.

S. Manufacturer's Certificates for the following in accordance with Section 01 43 33, Manufacturers' Field Services.

1.02 QUALITY ASSURANCE

A. The polymer feed systems shall be furnished, coordinated, and tested by one supplier. The system shall be completely shop assembled**,** skid mounted, and shop tested prior to shipment.

B. All components shall be the standard product of a manufacturer regularly engaged in the production of required materials and equipment.

C. All equipment and material shall be designed and constructed in accordance with applicable standards as indicated.

1.03 PREPARATION FOR SHIPMENT

A. Insofar as is practical equipment specified herein shall be factory assembled and tested in the factory. Refer to Section 40 99 90, Package Control System specification section the unwitnessed and witnessed factory test requirements. Parts and assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect equipment from damage and facilitate final assemble in the field. Machined and unpainted parts shall be protected from damage by elements with application of a strippable protective coating.

1.04 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts shall be shipped in a wooden box and shall be protected from damage, from moisture and dirt accumulation. Parts shall be protected as for an extended storage period. The box shall be heavily constructed with hinged cover, hasp and lock, and designed as a permanent storage enclosure for the spare parts. The spare parts shall, if possible, be enclosed within an airtight membrane. Spare parts supplied in matched sets, such as drive belts, shall be wrapped, bound, or labeled to indicate a set.

B. Furnish one year supply of lubricants including oil and greases, as recommended by the product manufacturer. The lubricants shall include summer and winter grades along with alternative references to equal products of other manufacturers including specifications such as AGMA numbers, viscosity.

1. Furnish the following:

Item	Quantity
Mechanical seal	1
Mixing Chamber O-rings	1
Injection Check Valve	1
Stator (pump)	1
Special tools needed for maintenance	1

PART 2 PRODUCTS

2.01 GENERAL

A. The polymer feed systems shall be skid mounted assemblies consisting of one metering pump, mixing chamber, booster pump, and all piping, valves, and controls capable of delivering required minimum and maximum gallons per hour of polymer solution as shown on attached schedule. Included with each polymer feed system shall be a pressure relief valve and calibration chamber.

2.02 EQUIPMENT

A. Manufacturer/Model:

1. UGSI; PolyBlend MM2400-P10AA.
2. Velodyne; VM2400.
3. Prominent; ProMix-M 1200x2-10.
4. Or approved equal.

B. General:

1. Polymer feed system shall consist of an integrated equipment package system which shall meter, dilute, activate, mix, and feed liquid polymer and water. System shall not rely upon a static mixer as the means of polymer activation. Polymer shall not be exposed to a rotating centrifugal pump turbine or other machinery that would cause excessive shear.
2. Feed systems shall include a progressing cavity feed pump to provide the capability of pumping emulsion type liquid polymers, with maximum apparent viscosities of up to 6,000 centipoise. At no time shall liquid polymer or polymer solution be exposed to excessive shear, so as to degrade the effectiveness of the polymer molecular chains.
3. Polymer feed system shall be furnished with an integrally mounted control panel.
4. Provide SCR or VFD drive for pump to accept 4-20 mA signal.
5. Each polymer feed system shall be equipped with Type 304 stainless steel side frame and stainless steel base with nonskid feet.

C. Mixing Requirements:

1. Polymer mixing system shall be specifically designed to invert, disperse and activate in solution emulsion polymers which may vary in specific gravity from 0.98 to 1.18 and vary in viscosity from 80 to 6,000 cp.
2. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy. This design shall include a motor-driven impeller that will create high fluid sheer. Solution shall undergo a tapered mixing intensity slope as it exits the initial sheer zone and pass through a second zone, isolated by a baffle. Polymer activation efficiency shall be consistent over the entire dilution water range. Mixing chamber shall be transparent to allow viewing of mixing intensity.
3. Mixing energy shall be provided by a constant speed or variable speed, motor-driven impeller. Impeller shall rotate on a stainless steel shaft supported by double sealed ball bearings. Variable speed shall be achieved by variable frequency drive. Impeller shall be adjustable of a range of 900 rpm to 3,450 rpm to ensure complete flexibility in creating mixing energy. Systems not providing means of varying mixing intensities to compensate for different polymers will not be considered. Constant speed mixing shall be a minimum of 2,000 rpm.

D. Polymer Pump:

1. Type:
   a. Unit Shall have a neat polymer metering pump. Pump shall be progressive cavity type pump.
   b. Rotor shall be Type 316 stainless steel.
   c. Pump shall have mechanical seal. Pumps supplied with packing seals will be accepted.
   d. The metering pump shall have an output range between 0.5 – 10 gph minimum
   e. Rotor speed shall not exceed 500 rpms.
2. Motor:
   a. 1/2 hp, TEFC, AC motor.
   b. Variable speed with VFD controller.
   c. Direct-coupled
3. The pump shall be designed with a high viscosity wet end pump capable of pumping neat polymer solution to the mixing chamber.
4. Pump to be provided with pressure gauge and pressure relief valve located on the discharge side of the pump and is piped back to the pump suction.
5. Include a calibration cylinder mounted to the skid frame with PVC isolation ball valve. Cylinder to be calibrated in mL and constructed of clear PVC with slip on cap and 1/2-inch NPT vent connection.

E. Dilution Water System:

1. Polymer feed system shall have a solenoid valve for automatic OPEN/CLOSE control of dilution water supply. Solenoid valves shall be NEMA 4X with 120V ac coil. Solenoids shall be internally controlled.
2. Dilution water system shall contain primary dilution and post dilution assemblies. Dilution system shall have a rotameter type flow indicator equipped with integral rate-adjusting valves. Total water flow rate into unit shall be adjustable as shown in the attached schedule.
3. Dilution water shall feed into the motorized mixing chamber and be capable of 2,400 GPH. Primary and secondary dilution water feeds into the mixing chamber shall be capable of 120 – 1,200 gph each.
4. Dilution Water Booster Pump:
   a. Supply a water booster pump to increase the dilution water pressure through the polymer make-up unit.
   b. Booster pump to be capable of supplying the max design dilution water flowrate of 2,400 gph.
   c. Typical supply water system pressure from the City’s distribution system is between 30 to 40 psi. Contractor to verify and coordinate with manufacturer.

d. Booster pump to be sized to increase the water pressure to 70 psi or otherwise recommended by the polymer system manufacturer. Polymer system manufacturer to coordinate with Contractor and Belt Filter Press manufacturer for specific polymer solution pressure requirements at the polymer injection ring and mixing valve upstream of the belt filter press.

5. Polymer feed system to include a pressure reducing valve downstream of the booster pump to maintain the desired dilution water pressure.
6. All components in the system shall be designed for at least 100 psig working pressure.
7. Polymer feed system shall have a manufacturer's standard dilution water pressure differential type flow element and low flow switch. Flow switch and element assembly shall be installed as per manufacturer's recommendation.

2.03 CONTROL SYSTEMS

A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 99 90, Package Control Systems.

B. Systems Integrator: The Systems Integrator shall provide programming and controls for interface between the polymer systems and belt filter press systems.

C. Panels:

1. Provide a skid mounted control panel.
2. Material: FRP or Type 316 stainless steel.
3. NEMA Rating: 4X.
4. Tags: 40-LCP-40-1.

D. Operator Controls and Indicators: Provide the following panel mounted operator controls and indicators:

1. On/Off/Remote hand switch.
2. Pump Speed Indicator.
3. Potentiometer (to adjust pump speed in Internal Mode).
4. System on Indicator.

E. External Interfaces:

1. Pump speed adjustment control.
2. System RUN command.
3. Loss of water flow alarm.

4. System ON status.
5. System in remote status.
6. Polymer pump flow rate.

F. Functional Requirements:

1. Blending unit shall be controlled through an ON/OFF/REMOTE circuit controller by a three position ON/OFF/REMOTE control switch.
2. When in Remote:
   a. Unit runs in response to external System RUN command.
   b. Pump speed is adjusted in response to external pump speed adjust signal based on programmed setpoints.
   c. Polymer pump pacing shall be based on a 4-20 mA analog input signal.
3. Monitor for Low Flow of dilution water. If falling Low Flow is sensed, put the polymer pump in standby. Once dilution water flow resumes (rising Low Flow), restart the polymer pump.
4. Activate loss of water flow alarm if Low Flow of dilution water is sensed for a preset time (initial setting, 15 seconds).
5. Controller to include a pre-programmed auto-flush cycle to turn off polymer pump and allow dilution water to flow through the system for a pre-set time at each shutdown.

2.04 ELECTRICAL

A. Wiring:

1. Provide wiring between pump controller’s termination enclosure, solenoid valves, pressure switches, and the pumps.
2. Provide circuit breakers and controllers for each pump.
3. One 480V ac, 20-amp power feed will be brought to the polymer unit.
4. Wiring shall be in conduit.
5. Provide device fusing/circuit breakers as required.
6. Drives and solenoid valves shall be powered from the polymer blend unit.
7. Fuses and circuit breakers shall be housed in each respective control panel, which shall be NEMA 4X.

2.05 ACCESSORIES

A. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. Plate shall bear 1/4-inch die-stamped equipment identification name indicated in this Specification and/or as shown on Drawings.

B. Lifting Lugs: Equipment over 100 pounds in weight shall be provided with lifting lugs.

C. Graduated cylinder calibration kits complete with necessary control valves, connective tubing and fittings shall be furnished for each polymer feed system. Calibration columns shall be sized (capacity) as recommended by the polymer feed equipment manufacturer.

D. Pressure Relief Valve: Adjustable relief valve set at 100 psig for installation on polymer solution pipeline.

2.06 FACTORY TESTS

A. Shop Test: Each unit shall be shop-tested prior to shipment from the manufacturer's factory prior to installation.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Manufacturer of polymer feed equipment shall furnish a qualified representative who shall supervise installation of equipment, check for proper mounting, assembly, mechanical adjustment, lubrication, proper control sequencing, general functioning of equipment, and quality of workmanship. Polymer feed equipment shall be installed in strict conformance with manufacturer's recommendations.

B. Polymer equipment shall meet the requirements of applicable industrial standards or specifications as to design, construction, and performance.

C. Polymer feed system shall be installed to conform to general layout and alignment shown on Drawings.

3.02 PAINTING

A. All equipment shall be painted with manufacturer's standard painting system for corrosive service.

3.03 WARRANTY

A. Provide manufacturer's warranty for a period of 12 months from the date of equipment startup or 18 months from the shipment date, whichever occurs first.

3.04 MANUFACTURERS' SERVICES

A. A manufacturer's representative for equipment specified herein shall be present at Job Site and/or classroom designated by WSSC for the minimum person-days listed for services hereunder, travel time excluded:

1. 2 person-days for installation assistance, inspection, certification of installation, and functional and performance testing.
2. 1 person-day for prestartup classroom or Job Site training.
3. 1 person-day for startup services.

3.05 FIELD TESTING

A. Test in accordance with general requirements in Section 01 91 14, Equipment Testing and Facility Startup.

1. Preliminary Test
   a. Demonstrate valve operation:
      1) Check operation of OPEN/CLOSED indication lights at PLC.
      2) Open and close valves through full range and verify valve operation in manual and automatic modes. In remote mode, demonstrate that valves open and close in response to a PLC signal.
   b. Check electrical and operator controls:
      1) HAND/OFF/COMPUTER selector switch.
      2) Verify indicating lights.
      3) Unit responds to 4-20 mA signal.
         a) Test unit for a continuous 30-minute period without malfunction under simulated operating conditions. During this operating period, the pumps shall obtain suction from the chemical storage tanks, but the Contractor shall direct the discharge to a suitable clean container for collection of the chemical. Chemical shall then be returned to the chemical storage barrel or disposed of at the direction of the Owner. During the test, record the following:
         b) Neat polymer flow rate.
         c) Dilution water flow rate.

END OF SECTION

SECTION 44 46 13.02
SCREW CONVEYOR SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers' Association (ABMA): 11, Load Ratings and Fatigue Life for Roller Bearings.
2. American Gear Manufacturers Association (AGMA).
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
   a. A36A/36M, Standard Specification for Carbon Structural Steel.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   d. A385, Standard Practice for Providing High-Quality Zinc Coatings (Hot Dip).
   e. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
5. Conveyor Equipment Manufacturers Association (CEMA): 300, Screw Conveyor Dimensional Standards.
6. National Electric Manufacturers Association (NEMA):
   a. MG 1, Motors and Generators.
   b. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
7. Underwriters Laboratory (UL): 674, Electric Motors and Generators Used in Division 1 Hazardous (Classified) Locations.

1.02 SYSTEM DESCRIPTION

A. Dewatered Sludge Shaftless Spiral Conveyors.

B. Performance Requirements: Design conveyor system to meet service conditions outlined in Supplement No. 1. Each conveyor drive unit shall be designed for 100 percent of rated capacity.

C. Conveyor selection design standards shall be based on the operational experience of the manufacturer with shaftless spiral conveyors. Designs shall not be based on shafted conveyor performance formula or parameters.

D. Conveyor rotational speeds shall not be greater than specified, unless availability of the reducer ratio requires slight adjustment (plus 3 rpm). Deviations from specified speed shall not be utilized to reduce the conveyor trough and spiral size.

E. Design conveyors without a center shaft for conveying material with minimal maintenance. Spiral flights shall be designed to be self-guiding and aligning in the trough. Guide bearings shall not be permitted.

F. Prior to fabricating the screw conveyors, determine the requirements for and furnish brackets, chutes, and fitments required.

1.03 EQUIPMENT NUMBERS

A. Cake Conveyor: 40-CONV-30-1.

1.04 RELATED SECTIONS

A. Related sections include the following:

1. Division 1, General Requirements.
2. Division 26, Electrical.
3. Section 40 27 02, Process Valves and Operators.
4. Section 40 99 90, Package Control Systems.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detail drawings and specifications for components of equipment showing all dimensions, parts, construction details, and materials.
   b. Equipment performance specifications.
   c. Equipment process schematics.
   d. Fabricated items, equipment structural supports, platforms, handrails, and associated items.
   e. Design loadings, for load combinations, to be transmitted to foundations or supports.
   f. Size, length, and spacing of anchor bolts or attachments to the foundations or supports.
   g. Specific details of attachment of bracing members to concrete or steel structures.
   h. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

i. Conveyor support drawings signed and sealed by a professional engineer registered in the state of Florida.
j. Motor nameplate data for motors and actuators.
k. Control station elevation drawings, including complete Bill of Materials:
   1) Layout of control station face showing all pushbuttons, switches, instruments, indicating lights, and similar devices.
   2) Complete system schematic (elementary) wiring diagrams.
   3) Complete system interconnection diagrams between controller, drive motors, related components or controls external to system including wire numbers and terminal board point identification.
   4) Other submittals as required by Section 40 99 90, Package Control System.
l. Test procedures.
m. Test results, reports, and certifications.

B. Informational Submittals:

1. Design calculations for items covered by these Shop Drawings. Calculations shall show design stresses in structural members and connections for loading combinations.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Installation instructions.
4. Manufacturer's test reports.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.06 QUALITY ASSURANCE

A. Qualifications: Shop Drawings shall be stamped by a registered engineer of the state in which the conveyor will be installed.

B. All shop welding shall conform to the latest standards of the American Welding Society (AWS).

C. Unless otherwise noted: All equipment included in this section shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and the satisfactory operation of the system.

1.07 EXTRA MATERIALS

A. All Spare Parts shall be provided in protective packaging for long-term storage.

B. Manufacturer shall clearly identify and furnish any special tools required for routine service and maintenance of the equipment. Special Tools shall be provided in packaging designed for storage and repeated use.

C. The following spare parts shall be supplied, as a minimum:

1. One packing gland set, for each conveyor supplied.
2. One complete set of liner for all conveyors.

D. Conveyors shall be supplied by the manufacturer fully and completely lubricated and ready to be placed into operation. No spare lubricant shall be required for the gear reduction units within the warranty period.

E. Delivery: In accordance with manufacturer's instructions and with Section 01 61 00, Common Product Requirements.

1.08 WARRANTY

A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of 24 months after substantial completion. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

B. The shaftless spiral and replaceable wear liner shall be warranted for a period of 3 years after the equipment was first placed into operation at the jobsite against wear.

1. Spiral: Excessive wear on the screw shall be indicated by loss of more than 50 percent of the height of the main outer screw section over 30 percent of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw for installation by the owner to replace the screw in the conveyor that has excessive wear.
2. Liner: For a wear indicator (two color) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30 percent of the conveyor length during the first three years of service. If these wear indications occur the conveyor supplier shall provide new formed and banded liner for installation by the Owner to replace all the liner in the conveyor that has excessive wear.

1.09 SCREW CONVEYOR SYSTEM MANUFACTURER / BELT FILTER PRESS MANUFACTURER COORDINATION

A. Conveyor manufacturer shall provide chute and conveyor openings to capture sludge cake discharged from belt filter press. Contractor and Conveyor manufacturer shall coordinate opening size and spacing requirements with Belt Filter Press manufacturer.

1.10 CONTRACTOR / SCREW CONVEYOR SYSTEM MANUFACTURER / BUILDING MANUFACTURER COORDINATION

A. Conveyor supports to be sized, designed, and provided by conveyor manufacturer. Supports shown on Drawings are representative. Contractor shall coordinate final location of supports to prevent conflicts with nearby utilities and equipment. Contractor shall coordinate conveyor supports and wall penetrations with Conveyor manufacturer as well as the Building manufacturer supplying the prefabricated metal building as required.

B. Conveyor manufacturer to provide and coordinate equipment loads with the Building manufacturer for the hanging support(s) in the truck bay. Building manufacturer to supply necessary cross-bracing or other roof structural members for the conveyor support to mount to.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. See supplements to this section for additional product information.

2.02 SERVICE CONDITIONS

A. Material Conveyed: Sludge.

B. Material Density (typ): 70 lbs/ft3.

C. Volume: 204 ft3/hr.

D. Spiral Speed: 20 rpm.

E. Trough fill rate at Design: 40 percent.

F. Length: Per Drawings.

G. Incline: 25 percent.

H. Inlet Quantity: One.

I. Outlet Quantity: One.

J. Discharge Type: Vertical.

K. Trough ID (min): 12 inches.

L. Location of Drive: push.

M. Motor Power: 3 hp.

2.03 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. SPIRAC, Inc.
2. Keystone.
3. KWS.
4. Or approved equal.

2.04 COMPONENTS

A. Materials:

1. Steelplate and Shapes: ASTM A36/A36M.
2. Chutes, Troughs, End Plates, and Covers: ASTM A167, Type 304 stainless steel.
3. Supports: AISI 304 stainless steel, minimum 1/4-inch thick, structural shapes.
4. Spiral Flights: Cold-formed high tensile micro alloy steel (HTMAS), minimum hardness 200 Brinell with ability to transmit 32,000 inch-pounds of input torque.
5. Drive Shaft: Heat-treated alloy steel AISI, Grade 4150, of uniform diameter.
6. Wear Liner: Ultra high molecular weight (UHMW) polyethylene, and modified for wear applications. 1/2-inch minimum thickness installed on maximum 12-inch centers and a maximum of 2 inches from the liner top edge. Wear liner bars are not acceptable.
7. Fasteners, except for power transmission or drive components: ASTM A193, Type 316 stainless steel.

B. Fabrication:

1. All welds to be continuous unless otherwise specified. Facing surfaces of field-welded components shall be beveled and match marked.
2. Sharp corners of all cut and sheared edges shall be made smooth by edge grinding.

C. Surface Preparation:

1. All iron and mild steel surfaces to be painted shall be dry abrasive blasted in accordance with SSPC-SP6, and painted in accordance with manufacturer standards. Surfaces shall be painted or hot dip galvanized within 24 hours to prevent rusting and surface discoloration.
2. Stainless steel shall be cleaned with mild abrasive wheels and/or nonferrous blast media to remove heavy scale and welding carbon and passivated with stainless steel cleaner then rinsed.
3. After surface preparation, ferrous metal surfaces, if any, except for the spiral flighting shall receive a minimum of one coat of epoxy primer. Provide a total minimum dry film thickness of 3 mils prior to shipment to Jobsite.
4. The spiral shall be furnished with one coat of shop primer and a finish coat. Finish coat shall be manufacturer standard coating system for use with dewatered sludge.
5. Stainless steel surfaces do not require painting.

D. Chute(s):

1. Minimum #10 gauge ASTM A36/A36M steel.
2. Openings shall be flanged and bolted.
3. Rigidly supported following manufacturer’s recommendations.

E. Trough:

1. Fabricated from minimum #10 gauge, ASTM A167, Type 304 stainless steel.
2. A 2-inch drain tap outlet shall be integral to the conveyor trough at the bottom of the low end, in order to facilitate cleaning. The drain outlet shall be piped to a drain.
3. Horizontal conveyors to be sloped to facilitate draining.
4. Flange fittings for filling and discharge chutes.
5. Troughs shall conform to the dimensional standards of CEMA 300 and enclosure Classification IIIE.

6. Troughs shall be constructed with formed upper faces integral to the body of the trough, in order to provide optimum sealing of the gasketed connection between lid and trough. Designs incorporating structural angle welded to the trough body for the upper faces, shall be fully welded and ground smooth on the inside, with stitch welding on no greater than 6-inch centers on the outside.
7. Non-drive ends shall be provided with flanged bolted end plates, where not axially connected to following equipment.
8. Each trough shall be equipped with inlet and/or discharge openings as shown on the Contract Drawings. Each inlet and discharge opening shall be flanged suitable for interconnection to other devices. Any interconnecting devices such as chutes or hoppers shall be fabricated from the same grade of material as the troughs and with a gauge thickness to suit the application requirements.
9. Safety labeling shall be CEMA severe duty style, appropriate for the equipment, and affixed at the factory. In addition to warning of operation without covers, all warning labels shall include a callout for lockout of power before servicing. When indicated on the Contract Drawings, inspection hatches shall be provided with removable finger guards.
10. In order to avoid excessive wear and increased maintenance the conveyors shall be designed without the use of steel hold down bars or structural steel assemblies. Hold down liner segments which do not interfere with the flow of material are acceptable. Acceptable placement shall be limited to the underside of lids. Segments shall be removable without welding, and incorporate leading and trailing beveled edges.

F. Replaceable Wear Liner:

1. Conveyor troughs shall be lined with ultra-high molecular weight polyethylene (UHMW-PE) based material, which has been specifically modified for the reduced friction and wear requirements of the application. The wear liner for a shaftless conveyor system is of primary importance to functionality and maintainability. Unmodified UHMW or material not specifically designed for the application will not be considered.
2. Wear liner shall be supplied in maximum 4-foot sections, in order to provide for ease of replacement during servicing.
3. Each section of liner shall be a single piece, formed and bonded with two layers of the same material, each of a different color, to provide a visible indication when the liner is nearing the end of its useful life.
4. Each layer shall have been modified to have the same properties for reduced friction and wear. Liners which bond a second layer of unmodified UHMW can be readily dislodged after the primary layer is worn through, and will not be acceptable.

5. The liner shall be held in place with stainless steel cleats, permanently welded to the inside of the trough. No fasteners or penetrations through the trough wall shall be allowed.
6. Liner thickness shall be 1/2 inch for spiral up to 14-inch diameter, and 5/8 inches for larger spirals. On all sizes, the wear indicating color shall be at least 1/8-inch thick, in order to provide the strength to be retained in the trough while showing wear.
7. Replacement liner shall be readily available and stocked in the United States by the shaftless spiral conveyor equipment manufacturer.

G. Spiral Flighting: Design spiral flights with the stability to prevent distortion and jumping in the trough.

1. At its torsional rating, the stress in the spiral flighting shall not exceed 30 percent of the Fy value in the extreme fiber of the flight material.
2. Brake Horsepower: Produce less torque than the spiral flighting is rated for.
3. At 250 percent torque of the motor nameplate horsepower rating, the drive train shall not produce more torque than 250 percent of the spiral flighting's torsional rating.
4. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.
5. Spiral flights shall be formed from corrosion resistant HTMAS (High Tensile Micro Alloy Steel), and shall be concentric to within plus or minus 2mm.
6. Spiral shapes shall be cold formed from continuous bar, in two distinct stages, in order to achieve optimum hardness. Shaftless spiral flighting shall not be fabricated from plate.
7. For increased efficiency, a second, inner spiral, concentric with the outside spiral shall also be provided.
8. Spiral strength calculations shall be supplied by the manufacturer, to show that torsional ratings of completed spirals exceed the torque load produced within the trough at 150 percent of the design load.
9. Spiral deformation calculations shall supplied by the manufacturer. Calculations shall be based on the formula for cylindrical helical springs of rectangular cross section, found in the latest edition of Marks' Standard Handbook. Calculations cannot rely on use of a correction factor for close coils, and must result in demonstrating a "spring effect" of the completed spiral which does not exceed plus or minus 1/8-inch per linear foot of spiral under conditions of 100 percent through fill.
10. The minimum outer spiral thickness shall be 0.50 inch.

11. Spiral flighting shall have full penetration welds at all splice connections, to present a continuous and complete spiral upon installation.
12. Limit field welds at the jobsite to only those required due to shipping constraints. Field welds are to be performed by the manufacturer's representative and be certified for proper installation as part of the Certification of Proper Installation and Certificate of Compliance.

H. Spiral Mounting:

1. The driveshaft with integral coupling disc, shall penetrate the end plate through a guarded, serviceable, gland packing housing prior to insertion to the gear reducer. The coupling disc shall be machine faced after fabrication, to include centering hub for spiral mounting and alignment.
2. The connection of the spiral to the drive system shall be through fastening of the driveshaft and spiral coupling discs. Fasteners shall be readily accessible and of a corrosion resistant high strength material.
3. The spiral coupling plate, shall be reinforced with a welded gusset, shaped and formed to provide a transition of load forces from the plate to the spiral. Connections which use torsion arms with point load connections to the spiral shall not be acceptable.
4. The drive shaft assembly shall incorporate a grease lubricated labyrinth seal, serviceable from the exterior of the conveyor, which is shaft mounted internally between the back plate and spiral coupling connection.

I. Bearings:

1. ABMA 11, high capacity roller bearings located in the reducing drive housing with an L-10 life rating of 100,000 hours.
2. Designed to support thrust loads and provide angular alignment with the trough.
3. When recommended by the manufacturer, furnish tail and end bearings. If deflection of the spiral flights in the vertical direction exceeds 1 inch, furnish end bearings.
4. End Bearings: Double pillow block or flange and pillow block type mounted outside the trough; completely serviceable from outside the conveyor; no intermediate bearings.

J. Seals: Compression packing gland between the drive shaft and sleeve.

K. Cover:

1. Bolted covers shall be furnished for any portion of each trough that is not covered by the filling chute. Covers shall be manufactured in maximum 4-foot lengths to allow for ease of access during replacement of the (shorter) sectioned wear liner. Quick opening covers will not be allowed unless they are also bolted, in order to discourage direct access to the shaftless spiral during normal operation.
2. Minimum 12-gauge, ASTM A167, Type 304 stainless steel.
3. Gaskets between trough and cover.
4. Conform to Screw Conveyor Standards CEMA 300.

L. Gear Reducing Drive:

1. Gear reducers, motors, and other ancillary items shall be designed and rated for the severe environment of this application.
2. Design for full thrust loads from spiral flights.
3. Bearings: Operating life of L-10 30,000 hours.
4. Manufacturer shall provide bearing service life calculations compiled by the gear reducer supplier. Results shall be based on the specific design load of the application, as calculated by the manufacturer. Bearing life shall not be based on a modified value from the specific drive manufacturer.
5. AGMA, Class II, single or double reduction helical gears. Constant speed gear reduction units, with high capacity roller bearings.
6. Aircooled, no auxiliary cooling allowed.
7. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate at the driven shaft speed, whichever is greater.
8. Applied Torque: To allow for system upset, the drive system shall be designed at a minimum, to operate the conveyor with a trough filled to 1.5x the theoretical design load.
9. Close coupled with drive motor.
10. Drive systems incorporating V-belts or separately supported drives and motors, shall not be acceptable.
11. Drives shall be completely supported by direct mounting to a dual flanged bellhousing adapter, providing connection to the drive end plate of the shaftless spiral conveyor.
12. Bellhousing adaptors shall set off the drive from the trough, in order to allow seepage of any material from the conveyor trough to atmosphere rather than onto the output seal of the gear reducer/ motor drive unit. Directly attaching the gear reducer to the drive end plate of the conveyor will not be acceptable.

13. The drive unit mounting to the end of the trough shall require no additional supports, and there shall be no visible “wobble” movement under any operating condition.

M. Conveyor Supports:

1. Minimum 1/4-inch rectangular Type 304 stainless steel shapes and plates.
2. Ratio of unbraced length to least radius of gyration shall not exceed 240 for tensile members and 120 for compression members.
3. Designed to not exceed 1/3 of AISC allowable stresses when loaded to twice the running torque of the motor.
4. Support Loads: Based on completely filled trough, weight of the conveyor, and dynamic loading when operating.
5. Conveyors shall be furnished complete with supports suitable for mounting at a minimum as shown on the Contract Drawings.
6. Coordinate support locations with facility structure. Supports shall not restrict access to other process systems.
7. Supports shall be fabricated, assembled and fit to the conveyor prior to its delivery to the jobsite. Supports and conveyor segments shall be clearly match marked by the manufacturer for ease of installation by the Contractor.
8. For design of floor supports with imbedded anchors, manufacturer shall allow for up to 1-inch of grout beneath each support foot pad for the Contractor to compensate for unevenly poured elevations.
9. Coordinate all reinforcing of floor pad and integrate into design of the sump around the belt filter press if there is an overlap between the footprint of the sump and the floor pad.

N. Motion Detector:

1. Detect underspeed or zero speed.
2. Noncontacting motion sensing unit; lid or trough mounted on the conveyor and away from the drive.
3. Adjustable time delay for startup.
4. One SPDT Form C dry relay alarm contact, rated at 5A at 250V ac, fail-safe operation.
5. NEMA 4X rated enclosure with aluminum probe and neoprene gasket. Includes red LED display for verification of pulses.
6. Operate on 120V ac, 60-Hz provided by the associated motor starter.
7. Manufacturer:
   a. Siemens Sitrans, Model WM100.
   b. Or approved equal.

O. Drive Motors:

1. All motors shall be 460 volt, 60 Hz, 3 phase, comply with the motor specification and be rated for the operational area noted in the Contract Drawings.
2. Motors shall be of energy efficient design meeting or exceeding the most current edition of NEMA MG1-Table 12-10.
3. Motors shall have a 1.15 nameplate service factor, a TEFC enclosure, and be designed with torque characteristics in accordance with NEMA MG1-12.35 and 12.38.
4. See Section 26 20 00, Low-Voltage AC Induction Motors.

P. Emergency Pull Cord Switch:

1. Pull cords shall activate a dual relay, trough mounted emergency stop switch, intended to provide a signal to immediately stop the conveyor, and any feeding devices, when activated.
2. Pull cords shall run the full length of each conveyor in a straight path, guided through eyebolts spaced on not greater than 12-foot centers. Cording shall be orange colored, nylon coated, corrosion resistant safety cabling.
3. The pull cord switch shall be housed in an enclosure suitable for the environment.
4. Manufacturer:
   a. Conveyor Components Company, model RS.
   b. Or approved equal.

2.05 CONTROL AND INTERFACES

A. Provide the following Operator Controls and Indicators:

1. Hand/Off/Remote hand switch.
2. Forward/Reverse hand switch.
3. Emergency Stop pushbutton.

B. External Interfaces:

1. System RUN command.
2. Conveyor Fail alarm.
3. Conveyor loss of speed alarm.
4. System ON status.
5. System in remote status.

2.06 ACCESSORIES

A. Anchor Bolts: ASTM A193, Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

C. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number indicated in this Specification and as shown.

D. Furnish lubricants required for startup, initial operation, and testing of the equipment until final acceptance by the Owner.

2.07 SOURCE QUALITY CONTROL

A. Performance Tests: Completely shop assemble prior to shipment and run for a minimum of 2 hours to ensure proper operation.

B. Factory Tests and Adjustments: Inspect equipment and test for proper alignment, quiet operation, proper connection, and satisfactory performance of components and controls by means of a functional test conducted using material approved by the Engineer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Anchor Bolts: Accurately place using templates furnished by conveyor manufacturer and as specified in Section 05 50 00, Metal Fabrications.

B. Install in accordance with manufacturer’s recommendations.

3.02 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
3. 1/2 person-day for facility startup.
4. 1/2 person-day for post-startup training of Owner’s personnel.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.03 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Data Sheet: Induction motors.

END OF SECTION

INDUCTION MOTOR DATA SHEET

Project: Crestview WWTP Biosolids Handling Improvements

Owner: City of Crestview, Florida

Equipment Name: Conveyor 1

Equipment Tag Number(s): 40-CONV-30-1

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: 3

Voltage: 460

Phase: 3

Frequency: 60

Synchronous Speed: _____ rpm

☐ Thermal Protection: _____

☐ Space Heater: _____ volts, single-phase

Guaranteed Minimum Efficiency at Full Load: NA percent

Guaranteed Minimum Power Factor at Full Load: NA percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Enclosure Type: TEFC

☐ Multispeed, Two-Speed: _____ / _____ rpm

Winding: ☐ One ☐ Two

Mounting Type: ☐ Horizontal ☐ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up _____ Down _____

☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: ☐ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

SECTION 44 46 16
BELT FILTER PRESS DEWATERING EQUIPMENT

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Work of this section covers the work necessary to provide one belt filter press including accessories, water booster pump, controls, control panel adjustable frequency drives (AFD), and all appurtenances as specified herein.

B. The Work of this section also covers the work necessary to provide press accessories, water booster pump, controls, control panels with adjustable frequency drive and all appurtenances necessary to facilitate installing the new skid-mounted belt press to the new Dewatering Building.

C. The belt filter press manufacturers are advised to familiarize themselves with the overall plant process in order to evaluate the compatibility of the manufacturer's equipment to dewater the particular sludge generated.

D. The system shall consist of an independent gravity belt thickener and a continuous belt press. It shall be designed to receive secondary aerobically digested sludge, concentrate it and dewater the sludge by means of three belts of synthetic fiber mesh arranged to perform the conveying, pressing, and dewatering functions. Each belt press, as described in this section, shall have no less than three distinct dewatering zones. The three zones shall be independent gravity drainage at operator level, wedge, and pressure/shear sections.

E. Standardization of Similar Equipment: Provide belt filter presses that are the end product of one responsible system manufacturer or supplier to accommodate standardization of similar equipment operation and maintenance, spare parts, and replacement and manufacturer's services.

1.02 EQUIPMENT NUMBERS

A. Belt Filter Press(es): 40-M-20-1.

B. Control Panel(s): 40-VCP-20-1.

C. Adjustable Frequency Drive(s) located in control panel for:

1. Sludge Distributor: 40-M-20-1A.
2. Belt Drive: 40-M-20-(1C and 1D).
3. Gravity Belt: 40-M-20-1B.

D. Sludge Distributor: 40-M-20-1A.

E. Gravity Belt: 40-M-20-1B.

F. Belt Drive: 40-M-20-1C and 40-M-20-1D.

G. Hydraulic Tensioning System: 40-M-20-1E.

H. Washwater Booster Pump: 40-P-20-1.

1.03 GENERAL

A. Unit Responsibility: Minimum responsibilities of experienced belt press manufacturer named in qualification submittal include:

1. Supply belt filter press (BFP) equipment, complete with all accessories and appurtenances (including, but not necessarily limited to, electric motors, adjustable speed drives, control panels, AFD panels, shafting, safety guards, speed reducers, polymer injection ring/mixer and spare parts).
2. Design, assembly, delivery, installation supervision, startup, and testing of BFP equipment.
3. Furnish all components and accessories of the system to enhance compatibility, provide for ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions.
4. Produce and assemble BFP equipment at a facility owned and operated by BFP manufacturer and under the direct supervision and control of BFP manufacturer.

B. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

C. Adjustable Frequency Drive Requirements: Conform to the requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System. Submit a letter verifying compatibility of AFDs with the motor and coordination of AFD sizing requirements.

D. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems.

1. The control functions contained and described herein provide minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or equipment required by a manufacturer to achieve the specified performance. Reflect components and interfaces required to meet performance criteria in submittals.

E. System Interfaces: Coordinate the interfaces between the dewatering belt filter press, Biosolids Feed Pumps, washwater booster pump, screw conveyor and polymer makeup unit.

1.04 REFERENCES

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

1. Anti-Friction Bearing Manufacturers Association (AFBMA).
2. American Gear Manufacturers Association (AGMA).
3. American National Standards Institute (ANSI).
4. American Society of Mechanical Engineers (ASME): PTC-36, Measurement of Industrial Sound.
5. American Welding Society (AWS).
6. ASTM International (ASTM): G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.
7. British Standards Institute (BSI): BS 5490.
8. German Industrial Standards (DIN).
9. Institute of Electrical and Electronics Engineers (IEEE).
10. Instrument Society of American (ISA).
11. National Electric Code (NEC).
12. Occupational Safety and Health Act (OSHA).

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Document modifications to manufacturer’s standard design to meet specified requirements and identify elements of manufacturer’s standard design that do not comply with performance, features, functions, and materials of construction specified herein.
   b. Make, model, weight, and horsepower of each equipment assembly.

c. List of BFP model reference installations including location, sludge stream, number of units, starting date of operation, and reference contact information.
d. Manufacturers:
    1) Catalog information, descriptive literature, specifications.
    2) Identification of materials of construction for BFP, motors, adjustable speed drives, control panel, AFD panel, power supply, lubrication system, and flexible connectors.
        a) Listing of materials of construction to confirm compliance with requirements specified herein.
e. Certification that structural and mechanical calculations have been completed, signed, and sealed by a professional engineer, including:
    1) Calculations to indicate all loads and stresses generated in the BFP framework conform to the specified minimum factor of safety.
    2) Calculations to indicate that all bearings comply with the specified requirements for minimum L-10 bearing life based on maximum loadings.
    3) Calculations to indicate that all roller shaft deflections are less than “or-equal” to specification.
    4) Finite element model for rollers and frame with maximum deflection values for each element.
f. Finalized dimensional plan and sections of the complete equipment.
g. Proposed dimensional plan and sections of the complete BFP unit mounted on concrete curbs, showing all pipe connections and anchor bolt locations.
h. Filtrate and washwater collection pans and piping details.
i. Doctor blade, discharge chute, and details of equipment placement with respect to the downstream conveyor(s).
j. Detailed descriptive literature and complete specifications on each electrical control, pilot, or monitoring device. Provide detailed description of interlock, control, or protective function provided by each item.
k. Wiring and interconnection diagrams and control elementaries for all electrical, instrumentation, and control devices.
l. Electric motor nameplate data for all drives. See Section 26 20 00, Low-Voltage AC Induction Motors, for motor submittal requirements.
m. Hydraulic or pneumatic control system layout and details, including arrangement drawing, piping diagrams, schematic and wiring diagrams, complete bill of materials, and description of control functions and features.

n. Bill of materials listing major system components, special tools, and spare parts.
o. Outside utility requirements such as air, water, power, drain, etc., for each component.
p. Motor submittals in conformance with Section 26 20 00, Low-Voltage AC Induction Motors.
q. AFD submittals in conformance with Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
r. Certificate(s) demonstrating that the BFP production and assembly facilities are currently ISO 9001 certified.
s. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
t. Sequential description of operation under various modes of control, describing the complete control circuit and equipment operation and logic, including interlocks and permissives.
u. Description of all automatic shutdown features and interfaces with the plant instrumentation and control systems, in both word and schematic form. Use Standard Instrument Society of America symbols on all schematics.
v. Control and AFD Panel interconnection diagrams showing wiring interconnections between all BFP system components and between BFP system components and remote components provided by others.
w. Control and AFD panel elevation drawings showing construction and placement of operator interface devices and other elements.
x. Instrumentation and Control Submittals: In conformance with Section 40 99 90, Package Control Systems.
y. Power and control wiring diagrams, including terminals and numbers.
z. Shop and Field Painting Systems Proposed: Include manufacturer's descriptive technical catalog literature and specifications, and hazardous communication data sheets.
aa. Anchorage and bracing drawings and cutsheets as specified in Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Factory Quality Control Submittals:
   a. Obtain Engineer's review and approval of the information listed below prior to equipment shipment.
   b. Manufacturer's Certificate of Compliance.
   c. Factory Test Results, Reports, and Certifications: Include:
      1) Functional test reports and certificates.

2) For each ac motor, provide a certified copy of a test report for an identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B. The test report shall show full-load efficiency and power factor meeting or exceeding the specified minimum guaranteed values. Motors not as specified will be rejected.

d. Submit certified copies of mill test results for the stainless steel castings and abrasion-resistant materials to be used. Certify that the materials supplied are in accordance with the applicable standards.
e. Test results of the control panels and AFD panels for proper operation, construction, electrical connection, and function.
f. Shipping, storage and protection, and handling instructions.
g. Manufacturer's written/printed installation instructions.
h. Routine maintenance requirements prior to plant startup.

2. Anchorage and bracing calculations as specified in Section 01 88 15, Anchorage and Bracing.
3. Provide Operation and Maintenance Manual with Maintenance Summary Form in accordance with Section 01 78 23, Operation and Maintenance Data, and the following requirements:
   a. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this section.
   b. Set of complete as-reviewed Shop Drawing submittals.
   c. As-built electric and instrumentation and control wiring diagrams and equipment drawings.
   d. Index of all equipment suppliers listing current names, addresses, and telephone numbers of contacts for service, information, and assistance.
   e. Detailed operational procedures including step-by-step startup, normal operation, shutdown, and troubleshooting procedures.
   f. Detailed preventative maintenance requirements and recommended schedule.
4. Equipment Testing Procedure Submittals: Submit test procedures for the following tests for review, comment, and approval at least 30 days in advance of the notice to conduct the testing:
   a. Functional testing.
   b. Pre-performance testing.
   c. Performance testing.
   d. Optimization testing.
5. Field Quality Control Submittals:
   a. Obtain Engineer's review and approval of documents listed below prior to project completion. Submit test reports within 20 days after completing field testing.

b. Field Test Results, Reports, and Certifications: Include:
   1) Functional test report and certificates.
   2) Manufacturer's Certificate of Proper Installation.
   3) Pre-performance test report and certificates.
   4) Performance test report and certificates.

1.06 EXTRA MATERIALS

A. Spare Parts and Special Tools: Furnish spare parts and special tools as follows prior to the start of the guarantee period and maintain the spares in full stock during the guarantee period by the manufacturer. Provide and install (except belts as specified) all replacement parts required during the guarantee period. Suitably mark and package the spare parts and tools for shipment and storage.

Item	Quantity
Upper and Lower Belts	1 belt each size for each press
Sensor Paddles	1 set for each press
Doctor Blades	1 complete set for each press
Roller Bearings with seals	1 bearing of each size and type
All seals, Skirts, and Splash Guards shower seals (excluding motor and bearing seals)	1 complete set for each press
Metric Tool Kit with Metal Toolbox	Bearing puller kit, sockets and open ends for each size bolt and bearing
Touchup Paint	One gallon, each type

B. Replacement Belts:

1. In addition to the spare belts provided, furnish all belts used during the guarantee period. Install the first set of belts. All replacement belts will be installed by Owner.
2. The replacement belts shall remain the property of Contractor during the guarantee period. Label belts as manufacturer's replacement belts. Package belts to prevent damage or deterioration during prolonged storage. Provide all belts used by the manufacturer and/or Owner prior to the start of the guarantee period.
3. Owner will discard all used belts after installing spare belts, unless otherwise requested by Contractor. Pay all costs for shipping new spare belts and return of used belts.
4. Order spare belts only after the optimum filter fabric has been ascertained by the manufacturer. Provide a letter of recommendation from manufacturer for the selected fabric style.

C. Lubricants: Furnish and install all lubricants for initial belt press startup and testing. Change lubricants upon completion of installation, during test period, and as required in accordance with manufacturer's recommendations prior to final acceptance. Install new lubricants into all components of the equipment at the beginning of the guarantee period (by Contractor). Owner will provide and maintain lubricants during guarantee period.

D. Hand Tools: Set of special tools required to install, operate and maintain the belt filter press.

E. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.07 SAFETY REQUIREMENTS

A. Construct all equipment with due regard to safety of operation, accessibility, and durability of parts, in compliance with all applicable OSHA, state, and local safety regulations.

1. Provide emergency stop cords around the full perimeter of each BFP.
2. Provide emergency stop push button on the face of each BFP control panel.

1.08 BASIS OF DESIGN

A. Design of the BFP equipment as shown on Drawings is based on equipment from the first-named manufacturer listed in this Specification.

B. Make all necessary changes to facility design to accommodate equipment if a manufacturer other than the first-named manufacturer is selected, including but not limited to:

1. Layout changes.
2. Interface connections to other work and equipment which are different than that shown on Drawings.

C. Provide required redesign, submit changes for approval, coordinate, and complete revised Work. Resulting changes to other equipment and cost and schedule impacts are Contractor's responsibility.

1. At a minimum, these changes may include:
   a. Size of motors associated with the equipment.
   b. Layout and mounting of the equipment, including concrete equipment pads.
   c. Coordination of equipment elevations.
   d. Changes in electrical requirements of any kind.
   e. Instrumentation and control interface requirement changes.

f. Rerouting of any piping required to meet the manufacturer's system requirements.

1.09 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or removal and replacement of Work provided under this Specification section (including but not limited to the belt filter press, drive motors, control panel, AFD panel, and adjustable frequency drives) found defective during a warranty period of 3 years. With the exception of warranty period, all other requirements specified in the General Conditions remain in effect. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

B. Guarantee equipment provided meets or exceeds all requirements of the Specification at the specified feed conditions. Furnish all equipment and auxiliary items from one equipment manufacturer who shall be wholly responsible for their design, performance, and coordination. Warrant and guarantee the mechanical integrity and engineering design, including but not limited to warranty against defective materials, workmanship, and ordinary wear and tear, of all parts and components of the belt filter presses supplied herein for a minimum period of 1 (industry standard) year from the date the units have been accepted by Owner. Extend additional warranty and guarantee for the following:

1. BFP framework and coating for 8 years; the manufacturer shall repair any defects or corrosion during the warranty period. This shall cover both parts and labor.
2. Bearings for 5 years; replace any bearing that fails during the warranty period provided Owner has lubricated the bearings in accordance with manufacturer's instructions.
3. Rollers for 3 years; replace any roller or roller coating that fails during the warranty period provided the roller has not been damaged by external actions such as fire, weld splatter, etc., beyond the manufacturer's control. This shall cover both parts and labor.
4. Belts for 2,000 operating hours; repair any belt that fails during the warranty period. Splicing of belts does not constitute a belt failure unless excessive splicing is required. Excessive splicing of belts is defined as more than two splices required during the warranty period.

PART 2 PRODUCTS

2.01 GENERAL

A. Employ Three Distinct Dewatering Zones: A gravity drainage zone, a wedge pressure zone, and a shear-pressure zone in the BFP design. At the end of the shear-pressure zone, use doctor blades to cleanly discharge dewatered cake onto a screw conveyor, provided by others. Completely wash the belts as they return to the head end of the unit, showing no visible cake solids adhering to the belt.

B. Provide dewatering by the following sequence:

1. Gravity Zone: Horizontal zone of gravity drainage through the filter belt.
2. Wedge Zone: Entrain the sludge between two continuous open meshed belts.
3. Shear–Pressure Zone: Sandwich the cake between the belts and alternately apply compression and shear to the cake as it passes over perforated and solid drums and rollers; provide a belt tensioning system to act on these rollers to provide ever increasing pressure as the sludge advances toward the discharge end.

C. Provide complete BFP including frames, distribution troughs, drainage and dewatering belts, belt drives, belt tensioning systems, belt alignment systems, belt tracking and hydraulic tensioning system, doctor blades, belt washing systems, control and instrumentation devices, drainage components, drum-roller assemblies and bearings, motors, terminal junction boxes, pneumatic control system, and polymer injector, as specified.

D. Design and amply proportion all parts of the mechanism for all stresses which may occur during fabrication, erection, and operation.

E. Allow easy access to internal BFP components and ensure all operating adjustments to be made without interrupting operation of the BFP.

F. Provide L grade stainless steel for components constructed of stainless steel, if welding is required.

G. The BFP will be designated as either a right- or left-hand unit as part of the Shop Drawing review process. Right- and left-hand unit shall mean that all piping and maintenance activities can be performed from only one side of the BFP. The other side of the BFP will require minimal visual observation on a periodic basis.

2.02 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Alfa Laval, AS-H; KPZ 2-meter.
2. BDP Model-3DP, 70 PLI.

B. BFP Manufacturer Qualifications: The belt manufacturer shall have provided heavy duty 70 PLI belt filter presses with a minimum belt width of 2 meters at a minimum of 20 municipal wastewater sludge thickening/dewatering reference installations in North America with units representative of those to be supplied, with each unit operational for a minimum of 5 years. Manufacturers not meeting minimum reference installation requirement shall not be acceptable. Submit list of reference installations including model number, location, sludge stream and characteristics, number of units, starting date of operation, and reference contact information.

2.03 SERVICE CONDITIONS

A. Suitable for installation indoors or outdoors, for exposure to continuous 100 percent relative humidity conditions, for operation in ambient air temperature from 40 degrees F to 110 degrees F, and for exposure to biological sludge, splash, spill, and washdown conditions.

B. The material to be dewatered (wastewater sludge) will be aerobically digested sludge, ranging from 0.5 to 3.0 percent solids by mass.

C. Provisions shall be made to inject one polymer into the BFP sludge feed lines and mix the polymer and sludge prior to discharging of the sludge on the belt filter press gravity deck. The manufacturer shall, therefore, provide one polymer injection ring with an adjustable in-line variable orifice mixer for each BFP.

2.04 PERFORMANCE REQUIREMENTS

A. Continuously receive, flocculate, condition and dewater the feed sludge specified herein, and neatly discharge the dewatered sludge cake to a screw conveyor.

B. Operate continuously or intermittently on demand. Suitable for dewatering the specified sludge continuously for 24 hours per day, 7 days a week, and shall perform the required dewatering operations at the loading and operating conditions specified herein without side extrusion of sludge between the belts or spillage of sludge beyond the BFP envelope.

C. Numeric Performance Requirements:

1. Guarantee to match or exceed by the following numeric performance requirements during performance testing:

BFP Performance Requirements	
Item	**Required**
Influent Sludge Characteristics (Aerobically Digested)	Waste Activated Sludge
Influent Solids Concentration (percent)	1.0% - 3.0%
Minimum cake solids concentration, dry weight, percent total solids	16
Minimum overall solids capture, percent	95
Maximum polymer dose in pounds active polymer per dry ton of feed solids	25
Design Solids Loading Rate (lb/hr/meter) – Average	750
Design Solids Loading Rate (lb/hr/meter) – Maximum	900

2.05 EQUIPMENT

A. General:

1. The equipment covered by these Specifications is intended to be belt filter press dewatering equipment of proven ability as manufactured by reputable concerns having long term experience in the production of such equipment. The equipment shall be designed and constructed in accordance with the best practice and methods.
2. All components of the sludge dewatering equipment shall be engineered for long continuous and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, or replacement of all parts. Corresponding parts of multiple units shall be interchangeable. Except as otherwise specified, steel plates and shapes shall have a minimum thickness of 1/4 inch and bolts shall have a minimum diameter of 1/2 inch.
3. All welding shall be in accordance with the latest acceptable codes of the American Welding Society ANSI/AWS D1.1.
4. All material used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the ASTM standard specification for structural steel, designation A 500. All iron casting shall conform to the ASTM A48 standard specification for gray iron casting, and shall be of a class suitable for the purpose intended. Other materials

shall conform to ASTM specifications where such specifications exist; the use of such material shall be based on continuous and successful use under the similar conditions of service.

5. Unless otherwise specified herein, all metal parts in contact with polyelectrolyte or sludge shall be Type 316L stainless steel. All fasteners, pins, and anchor bolts shall be Type 316L stainless steel.
6. All fiberglass-reinforced plastics (FRP) shall be manufactured in conformance with NBS standards PS15-69.

B. Frame:

1. Designed to accommodate all operating and static loads plus the specified factors of safety at 70 PLI (pounds per lineal inch of each belt) belt tension without significant deflection, deformation, or vibration during operation; no disassembled components (other than the BFP frame) shall weigh more than 6,000 pounds. Provide lifting lugs as necessary to afford convenient access to maintenance points throughout the BFP.
2. Contain all horizontal loads within the BFP frame. Only vertical loads may be imposed on the BFP supporting structure.
3. Frame Structural Members:
    a. Type 316L stainless steel with minimum flange thickness of 3/8 inch and minimum web thickness of at least 1/4 inch. Tubular sections are not permitted.
    b. Provide minimum safety factor under maximum load of five times the design yield strength of any frame member.
    c. Provide minimum design load for belt tension of 70 PLI which is equivalent to 200 pounds per inch of belt width in the pressure zone.
    d. Provide load-bearing frame members with moments of inertia not less than 52 inches to the fourth power for the beams that support the pressure rollers in the tower section. All other frame members shall be no less than 25.3 inches to the fourth power.
    e. Maximum unsupported frame spans of 8.5 feet.

C. Sludge Conditioning:

1. Furnish an in-line, manually adjustable, 4-inch nonclog venturi mixer for contacting polymer solution with sludge feed for each BFP. Equip each mixer with a vortex polymer injection ring with four tangentially mounted polymer injectors. Locate mixer upstream of the BFP in the sludge feed piping to provide the polymer detention period required. Mixer to include the following features:
    a. 4-inch diameter flanged, Type 316L stainless steel housing with a weighted, carbon steel hot-dipped galvanized (4 mils to 7 mils).

b. Adjustable auxiliary mixing device with shaft and O-ring seal.
c. Removable side plate for inspection and cleaning.
d. Position indicator which identifies the percent open at the throat. Approximately 3.8-square inches open throat area and infinitely adjustable downward with the auxiliary mixing device.
e. Readily accessible parts that require cleaning, maintenance, or operational adjustments.
f. Tygon tubing with stainless steel fittings for polymer solution piping for interconnection of the four tangentially mounted polymer injectors to the polyethylene distribution manifold. Provide a 1-1/2-inch threaded coupling at the polyethylene manifold to accept the polymer supply line.
g. Stainless steel ball valve for each polymer injector feed line.

2. Inlet Distributor:
   a. Provide a distribution assembly to gently distribute conditioned sludge onto the gravity dewatering zone, and to prevent spillage or leakage by means of seals against the gravity belt. Include the following features:
      1) Design the assembly to minimize turbulence of the conditioned sludge and provide for maximum hydraulic loading of 300 gallons per minute.
      2) Extend discharge channel from the full pipe or tank diameter and fan out to a rectangular discharge of the same width as the gravity zone.
      3) Design arrangement to minimize velocity and overflow in an even manner onto the gravity zone.
      4) Fabricate of 12-gauge, Type 316 stainless steel, with adjustable baffles, or similar devices to uniformly distribute the sludge feed across the entire working width of the belt.
      5) Provide perimeter of assembly with a skirt to prevent leakage or splashing from the box.
      6) Bolts or other members used to mount the assembly shall not protrude into the sludge flow stream. There shall be no vertical edges within the sludge flow stream that could collect material.

D. Gravity Drainage Zone:

1. Include a gravity drainage zone to accept sludge from the inlet distributor. Design to prevent spillage or leakage and easy accessibility for operating, viewing, cleaning, and adjusting. Contain sludge within the gravity zone by a barrier or headbox equipped with specially designed seals that prevent sludge leakage and also prevent seal wear and belt wear. Fabricate barrier assembly of 14-gauge, Type 316 stainless steel.

2. To ensure effective free water removal, provide a minimum of 81 square feet of effective gravity drainage zone for each BFP. Inclined (above 2 degrees from the horizontal) or vacuum-assisted gravity zone or rotary gravity zone is unacceptable. Effective gravity drainage zone area is defined as the horizontal area between the belt seals, where sludge is on the belt, and where the belt is supported by a slotted grid. All belt area on rollers shall be excluded from this area computation.
3. Employ a series of plows, or similar devices, to ensure an even distribution of sludge across the entire width of the gravity drainage belt. Size and design the devices such that the entire length of each device rides flat on the belt. Provide a minimum of eight rows of plows, or similar devices to ensure that all of the sludge on the gravity zone contacts the devices to achieve maximum drainage of free water. Design the devices of sufficient strength to prevent the devices from deflecting and breaking under high loadings.
4. Provide a stainless steel tubular lifting handle so that each row of plows can be easily raised for cleaning and balancing and stay in the raised position, if desired. Construct shaft supporting a row of plows of Type 316 stainless steel with bushing mount for lateral movement flexibility. Include locking set screw to firmly attach the plow to the shaft.
5. Support belt in the gravity drainage zone by means of a slotted grid. Construct grid of replaceable high-density polyethylene members, nylon, or ultra-high molecular weight polyethylene and support with a Type 316 stainless steel frame. Size grid minimum 2 inches wider than the width of the belt and designed to reduce belt wear. Rollers for support of the gravity zone are not allowed. Extend grid a minimum of 3 inches upstream at the point of application of sludge on the belt surface. Prevent deflection in any direction along or across the grid at maximum sludge loadings to 0.05 inches. Utilize replaceable support strips. Fabricate Type 316 stainless steel drainage pans for the gravity drainage zone in a manner to enable connection of drain water piping at a single low point on each BFP within the press envelope. Refer to Paragraph Drainage Collection and Paragraph Belt Washing contained herein, for additional requirements.
6. Provide device(s) for positive detection of NO CAKE condition. Utilize adjustable device(s) with SPDT dry contact output.

E. Wedge Zone:

1. After gravity drainage, provide an adjustable wedge zone with a minimum effective belt area of 25 square feet. Design transition from the gravity zone to the wedge zone to evenly distribute sludge across the wedge zone and to prevent spillage or overflow of sludge.

2. Provide upper and lower belts that uniformly converge to squeeze the sludge and exert continuously increasing pressure. A multi-nip roller assembly and/or stationary pipes are not acceptable as a wedge zone. At the maximum BFP performance requirement loading condition, no extrusion or spillage of sludge from the belt is allowed at any point in the wedge zone. Provide splash guards to contain any leakage from the wedge zone within the press envelope. Provide adjustable wedge angle for process flexibility. The effective wedge zone area is the belt surface area in square feet where the sludge is confined between two belts with the width limited to the width of seals in the gravity zone excluding all areas where two belts are not in simultaneous contact with the sludge.
3. Define wedge zone pressure as the transitional pressure between the gravity zone and first high pressure roller (0.1 psi to 2 psi).
4. Fabricate all wedge zone framework or supporting structures of Type 316 stainless steel.

F. Pressure Zone:

1. After the wedge zone, provide a perforated Type 316 stainless steel roll, minimum diameter of 16 inches, as the initial roll in contact with sludge to allow for the gradual buildup of belt pressure. Design to prevent extrusion or spillage of sludge from between the belts at any point in the pressure zone. Provide minimum roll diameter of 12 inches in the remainder of the pressure zone. Use S-shaped roll configuration to apply maximum pressure and shear.
2. To ensure maximum pressure time and shear forces necessary to produce the desired cake dryness under a range of operating conditions, provide a minimum of 128 square feet of effective belt area in the pressure zone. Effective belt area within the pressure zone is defined as the total roller surface area in contact with a medium of belt/sludge sandwich and with the sludge under pressure to remove water. Provide a minimum of eight rollers that apply pressure to the sludge including the perforated roller in the pressure zone.

G. Belt Material:

1. Fabricate and seam belts of monofilament polyester, wear-resistant plastic materials. Select mesh design for optimum dewatering of the sludge to be processed without binding of the filter belt.
2. Base belt selection on the manufacturer’s experience at other installations dewatering similar sludge using similar polymer conditioning.

3. Provide belt widths and effective area as hereinbefore specified and with minimum life of 2,000 operating hours at the BFP performance requirement loading condition. Belt life guarantee to include replacement of belts damaged due to defects in the manufacture of the BFP or any of its components, and failure of connecting splice.
4. Design each belt and connecting splice or seam for a minimum tensile strength equal to five times the normal maximum dynamic tension of 50 PLI to which the belt is subjected. Design splice or seam to fail before the belt. Construct belt splice or seam closure of ASTM A167, Type 316 stainless steel. Splice or seam shall not produce interference with doctor blades.
5. Design machine such that belt replacement possible without requiring disassembly of machine components.
6. Material and design of auxiliary systems used in conjunction with the belts as selected by the manufacturer to assure maximum operating life and to minimize maintenance. Chamfer all fixed edges along belt operating surfaces. Provide 1-inch wide plastic coating on each side of the belts.

H. Belt Tracking and Tensioning:

1. Provide the BFP with an individual, independent, self-contained hydraulic belt tracking and tensioning system. Use of electrical servos or mechanical takeup systems is not acceptable.
2. Size all tubing within the system according to the intended use. Use ASTM A320, Type 316 stainless steel for all piping, tubing, pressure rams, cylinders, and fittings. Connect the pressure rams on each end of the tension roller to each other by a Type 316 stainless steel rack and pinion system to ensure proper alignment of the roller.
3. Continuously and automatically monitor belt positioning by Type 316 stainless steel regulator valves, installed with guide devices. The guide device shall ride the edge of the belt. Utilize regulator valves to continuously sense belt alignment and upon misalignment automatically walk the belt back to the normal operating position by means of a live pneumatic actuator. Design belt tracking system so that all belt position adjustments are performed smoothly without sharp sudden movements of the belt or alignment roller. Incorporate self-aligning pillow block bearings on opposite end of tracking rolls which should conform to the bearing design features as specified under Paragraph Roller Bearings, herein. Limit the angular movement between the bearing centerline and alignment shaft centerline to roller shaft deflection. Automatically operate belt tracking by a pneumatic or hydraulic system.

4. Equip each belt with a system to automatically ensure preset belt tension while dewatering varying sludge concentrations in the pressure zone. Assure parallel and simultaneous movement of the tension rollers. Fabricate all thrust arms and mechanical interconnects of Type 316 stainless steel.
5. Provide devices for positive detection of belt misalignment and belt break. Device output shall be SPDT dry contacts.
6. Hydraulic Power Unit: Provide each BFP with a dedicated hydraulic power system to provide pressurized oil for the steering and tensioning. The unit shall consist of a 1-gallon reservoir; variable-displacement pressure compensated hydraulic oil pump and drive motor, hydraulic oil filter, pressure gauges, piping, valves and cylinders to make a complete operational system.
7. Mount the pump, motor, reservoir, oil filter, and valves directly to the belt press frame to minimize excess piping runs, fittings, and hoses. Properly size all hydraulic lines for the pressure and flow of the unit. Construct pressurized hydraulic lines of Type 316 stainless steel tubing and rigidly support the lines on the structural frame of the press. Construct flexible lines to cylinders, low-pressure connections to the reservoir, etc., from hose of the material and construction appropriate to the application. Construct the hydraulic reservoir of translucent high-density polyethylene (HDPE) to allow visual inspection of the oil level.
8. Supply pump motor of maximum 2 hp with maximum noise level of 70 dBA. Utilize cast iron TEFC 1,200 rpm, NEMA B design motor with a “C” face mounting for the hydraulic pump adapter.

I. Drainage Collection:

1. Construct filtrate, washwater, and drainage collection pans of a minimum 14-gauge Type 316 stainless steel. Fiberglass drainage collection pans are not acceptable. Provide separate collection pans and piping for the gravity, wedge, and pressure zones. Use self-venting drain connections to prevent overflow. Pans shall not emit vibration noise. Provide drainage pans to collect all free and spray water under all gravity, wedge, and pressure zones of the BFP. Extend drainage pans a minimum of 3 inches beyond the edge of all belts and include vertical sides with a minimum height of 2 inches.
2. Provide separate drainage piping from each pan to convey all drainage and filtrate flows from the drainage pans to Contractor-furnished filtrate piping. See Drawings for piping interface location. Provide Schedule 10 Type 316 stainless steel or Schedule 40 PVC for all drainage piping from collection pans and belt washing stations.

J. Water Booster Pump:

1. Provide one pressure boosting system per BFP complete with pumps, motors, controls, and appurtenances as specified.
2. Manufacturers:
   a. Goulds.
   b. Or approved equal.
3. Components:
   a. End-suction centrifugal pump; configured as shown on the Drawings.
   b. Pump shall be supplied with an adjustable frequency drive to maintain programmed washwater flow and pressure at various suction side pressures.
   c. Plant reuse water supply pressure: 85 to 100 psi.
   d. Design pump discharge pressure: 125 psi or per manufacturer's recommendation.
   e. Design pump flow rate: 100 gpm or per manufacturer's recommendation.
   f. Motors:
      1) 460-volt, 15 horsepower, 3-phase.
      2) TEFC enclosed motor.
   g. Pump motor shall be powered and controlled from BFP control panel.

K. Belt Washing:

1. Provide BFP with three separate and integral belt washing stations suitable for cleaning the gravity drainage and two dewatering belts as they return to the head of the BFP. Provide separate connections, isolation and control valving, and piping to regulate and divert the belt spray washwater to each wash station within the BFP. Provide electrically actuated ball valves for control. Design the belt washing system to operate at a maximum of 120 gpm and at water pressures of 130 psi.
2. Interconnect all components of washwater system by Type 316 stainless steel piping or Schedule 80 PVC with the entire washwater system receiving water from a single connection point located at the periphery of the BFP for connection by others to the filtrate drain.
3. Include at each wash station a high pressure spray pipe header, flat jet spray nozzles, nozzle cleaning unit, and containment to eliminate spray from the work area. Cleaning unit shall be a Spraco Showers Washwater Cleaning Unit, Appleton Manufacturing, Menasha, Wisconsin, or approved equal. Construct spray headers and nozzles of ASTM A320, Type 316 stainless steel. Provide built-in nozzle cleaning unit design suitable for cleaning nozzles without disassembly of wash station or

interruption of sludge dewatering operations. Fabricate wash station enclosure of ASTM A167, Type 316 stainless steel.

4. Include collection pans and drain piping to prevent spray water from discharging outside of the BFP containment area, if wash station is not totally leakproof.
5. Provide spray header housing that totally encloses the belt, with replaceable seals where the belt enters and exits the housing. Adequately brace the spray piping nozzles and ensure sufficient pressure rating to withstand pressure transients caused by sudden valve closures.
6. Utilize chain operators or servo motors to actuate shower cleaning brush and purge system handwheels located above a height of 6 feet.

L. Drum and Roller Assemblies:

1. Roller and Shafts:
   a. 1045 carbon steel in accordance with ASME Code B17c-1927.
   b. Shaft Minimum Design Safety Factor: 5.0.
   c. Minimum Stock Shaft Diameter for Pressure Zone Roller Shafts: 5 inches with a minimum through bearing diameter of 2.95 inches for rollers.
   d. Minimum Through Bearing Diameter for Other Rollers: 2.18 inches.
   e. Minimum Wall Thickness: 1/2 inch for all nonperforated rolls less than 14 inches.
   f. End Plates: ASTM A36 steel with minimum wall thickness of 1 inch.
2. Rollers: Concentric to 0.01 inches and balanced to within 5 pounds. Machine all roller surfaces prior to coating. Machine roller coatings to the same tolerance after application and curing.
3. Solid Rollers: Double separated plate stub end shaft type or forged end type construction. Weld the stub end shafts and the roller heads in place. Bolted in-place stub end roller shafts are unacceptable. Design all rollers to have a maximum deflection of 0.05 inches at their center, as measured from the bearing centerline when under maximum loading.
4. Forged Stub Shaft Unit:
   a. ASTM A572, Grade 50, Type 2, “or-equal”.
   b. Roller Shells: ASTM A53, “or-equal”.
   c. Shell and Radial Vanes: ASTM A36 “or-equal”, or stainless steels may be substituted on special order.
5. Maximum Loading: Based on the maximum summation of all forces applied to the roller including, but not limited to, the forces exerted by the tension on the belts from the belt drive and belt tensioning devices, friction forces, elasticity forces, roller mass forces of the belts caused by the inner belt having shorter travel distance than the other belt as the

belt and sludge sandwich travel around the roller, and by motor torque at startup.

6. Coat all nondrive rollers with a minimum 1/4-inch thickness of vulcanized Buna-N rubber or 25 mils or thermoplastic nylon suitable for continuous duty in a wet, corrosive environment (pH 4.0 or higher) with organic oils and grease. The materials shall provide for complete protection of the carbon steel rollers from the wet, corrosive environment.
   a. Buna-N Rubber Hardness: 92-94 Shore ”A”.
7. Coat rollers up to the point of insertion into the bearing block, or provide shafts and heads of Type 316 stainless steel. Carbon steel roller surfaces shall not be exposed to sludge or moisture. Rollers constructed entirely of Type 316 stainless steel, in lieu of rollers of carbon steel with protective coatings, shall be considered equivalent.
8. Coat all drive rollers with 1/4-inch thick vulcanized Buna-N rubber covering. Turn on a lathe drive roller covering after curing to within 0.01-inch concentricity and balance to within 5 pounds.
   a. Rubber Hardness: greater than 90 Shore ”A”.
9. Perforated Drum Rollers (Where Used):
   a. Corrosion resistant with shells fabricated of minimum 0.25-inch thickness, Type 316L stainless steel.
   b. End Plates and Stiffener Thickness: 0.50 inch.
   c. Perforation Diameter: Not less than 1.25 inches.
   d. Total Open Area: 35 percent to 40 percent.
   e. Through-shaft design.
   f. Minimum Through Shaft Stock Diameter: Not less than 5 inches.

M. Roller Bearings:

1. Support shafts of all drums and rollers by a greaseable type, high capacity “E” design spherical roller bearing equipped with a brass retainer in sealed, splashproof, horizontal split case pillow block housing. Attach bearings to turned, ground, and polished shaft by direct mounting with an interference fit.
2. Bearings Supporting the Steering Rollers: Nonself-aligning cylindrical roller bearings in pivot-mounted pillow block housings. Support all rollers by 222E series spherical bearings having a minimum self-aligning capability of plus or minus 3/8 of a degree and mounted in expansion and nonexpansion pillow block housings.
3. Bearing Life: Minimum L-10 life of 200,000 hours at a minimum belt speed of 15 feet per minute, calculated by using the ANSI/AFBMA latest standard. Base the L-10 life on the summation of all forces applied to the bearings, including, but not limited to, roller mass forces, elasticity forces, drive motor load (50 percent of drive motor load assumed distributed to the drive roller), and belt

tension on the rollers. Include a minimum load of 280 PLI of belt width, which equates to a belt tension of 70 PLI for belt tension forces exerted on the pressure zone rollers.

4. Provide certified calculations, based on AFBMA ISO capacity formula demonstrating compliance that all bearings meet the specified requirements for a minimum L-10 life at maximum loadings. Submit to Engineer as set forth in the Contract Documents.
5. Bearing Housings: Class 30 cast iron, conform to ASTM A48 standards and have four cap bolts and two or four mounting bolts. Provide solid outer housing without end caps or filler plugs. Utilize triple lip seal design that rotates with the shaft. Primary seal face will contact a stainless steel solid seal plate.
6. Clean, iron phosphate, and coat housings with a heat-treated thermoplastic nylon to a thickness of 8 mils to 12 mils. Use Type 316L stainless steel hardware unless specified otherwise.
7. Bearings: Manufactured by SKF; Dodge-Master-Reeves, Division of Reliance Electric Industrial Company, Greenville, SC; “or-equal”.
8. BFP Manufacturer-Bearing Warranty: 5 years from date of acceptance of the equipment. Includes all parts and labor for repairing or replacing any bearing that fail during the warranty period, providing that Owner has properly lubricated the bearings.
9. Provide capability to grease all bearings while BFP is operating.
    a. Bearing Lubrication Frequency: Maximum of two times per year.

N. Doctor Blades:

1. Equip each BFP with two doctor blades for assisting in removal of adherent sludge cake from each belt at the upper and lower discharge rolls.
2. Independently operate each blade and equip each blade with devices to enable quick release from the belt for rag removal.
3. Mount doctor blades so that the cake is continuously removed from the belt.
4. Extend each blade at least 3 inches wider than the belt.
5. Bottom Blade Angle: At least 60 degrees from the horizontal plane to prevent cake buildup on the blade.
6. Doctor Blade Assemblies: Adjustable counter-weighted or spring-loaded design, fabricated with sufficient stiffness so that blades do not warp, distort, or bow in the middle under normal service conditions, or in the event sludge sticks to the belts or rollers.
7. Leading Edges of Blades: Easily replaceable and constructed of high-density polyethylene. Fiberglass reinforced polyester is unacceptable.
8. Doctor Blade Support Frames, Fastener and Hardware: Type 316L stainless steel.

O. Power Transmission:

1. Couplings: Falk Steelflex spring-grid couplings or approved equal.
2. Sprockets and Sheaves: Standard quick-detachable hubs.
3. Provide all chain and belt drives and couplings with safety guards in accordance with applicable safety codes.

P. Anchor Bolts:

1. Provide ASTM A320, Type 316 stainless steel anchor bolts not less than 3/4 inch in diameter.
    a. Coating: 100 percent solids, thermosetting, fusion bonded, dry powder epoxy, or polyurethane resin suitable for intended service manufactured by Fletcher Pipe Coating, Orange, CA, Western Coating, Inc., Ogden, UT, “or-equal”.

Q. Electrical:

1. Prewire all BFP-mounted devices, and other electrical equipment and instruments to a terminal junction box mounted on the BFP. Provide one terminal junction for 120V controls.
2. Enclosures: NEMA 4X Type 316 stainless steel.
3. Identify all wiring with permanent labels at both ends, terminate with solderless lug numbered terminal blocks.
4. Instruments: 120V ac rated.
5. Terminate at numbered terminal blocks all interconnecting wires between panel-mounted equipment and external equipment. Identify all wires with permanent heat impregnated PVC alpha-numeric labels at both ends.
6. Provide EMERGENCY STOP cords around the full perimeter of each BFP. Provide a DPDT dry contact output for each cord suitable for control safety interlock functions provided by others.
7. List and label all electrical components in accordance with the National Electrical Code (NEC).
8. Panelboards: Constructed by UL-approved manufacturer and compliant with UL-508 requirements.
9. Throughout the system, various kinds of electrical wiring may be required. In addition to NEC requirements, comply with the following requirements for all wiring:
    a. Only 480V and 120V ac circuits with wire insulation rated 600V may be run together in the same raceway (conduit) or enclosure.
    b. Low voltage dc and 4 mA to 20 mA signal wiring may be mixed in the same raceway and enclosure, but not run in the same multi-circuit control cable.
    c. Run 4 mA to 20 mA signals in twisted shielded pair cables.

d. Raceways and Fittings: PVC-coated galvanized rigid steel conduit.
e. Raceway Support Systems: PVC-coated steel.
f. Washers, Bolts, Nuts, Etc.: Type 316 stainless steel.

10. Adjustable Frequency Drive: Provide adjustable frequency drives, as required, for each BFP. Mount adjustable frequency drives in the local BFP control panel. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System, for requirements.

R. BFP Drive:

1. Provide each BFP with a suitable drive mechanism sized to accommodate the speed and torque requirements of the belt during all operating conditions. Supply input power to the drive roller shaft through an ac variable frequency drive unit. Control speed through cyclical variation in motor current, which is operator set at the control panel. The drive roller speed reduction is obtained through a helical gear reducer. Transmit the variable input power through a helical bevel gear reducer connected to the drive roller.
2. Drive Speed Range: 10:1 with the minimum frequency limited to 8 Hz and the maximum frequency limited to 80 Hz. The drive motors shall meet the requirements specified herein.
3. Select drive rollers to permit slip-free transmission of driving torque to the belt. Provide roller shafts and heads as specified above.

S. Motors: Provide squirrel cage induction motors designed, manufactured, and tested in accordance with NEMA MG 1. Use inverter-duty rated motors when combined with adjustable frequency drives.

1. Motors: Chemical-industry severe-duty type. See Section 26 20 00, Low-Voltage AC Induction Motors.
2. Motor Insulation: Class F.
3. Equip each motor with a thermistor imbedded within the motor.
4. Adjustable Frequency Drives: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System, for requirements.

2.06 INSTRUMENTATION AND CONTROLS

A. Perform all instrumentation and control work of this section in accordance with the control, signal, and component requirements specified in Section 40 99 90, Package Control Systems. Provide panels and controls as follows:

Panel No.	Name	NEMA 250 Rating	Material
40-VCP-20-1	Belt Filter Press No. 1 Control Panel	4X	Type 316 stainless steel

B. Each BFP Control Panel shall include an appropriately sized, filtered, side panel-mounted air conditioner unit. Air conditioning unit shall be in accordance with and as specified in Section 40 99 90, Package Control Systems.

C. Each belt filter press control panel shall include the following electrical components:

1. An appropriately sized main circuit breaker. The main circuit breaker shall include a short circuit rating of 65,000A.
2. A surge protection device (SPD) located immediately downstream of the main circuit breaker for the BFP control panel.
3. An integral 480V-120V control power transformer (CPT) for all controls related to the operation of the associated BFP. The CPT shall also be sized to provide external 120V power to the flow meter 40FE/FIT-20-1 located downstream upstream of the BFP. A dedicated 20A, 120V circuit breaker shall be included within each BFP control panel to allow an operator to manually de-energize the 120V power to the associated flow meter if desired for maintenance.
4. Dedicated 6-pulse adjustable frequency drive (AFD) for the associated sludge distributor (40-M-20-1A).
5. Dedicated 6-pulse adjustable frequency drive (AFD) for the associated gravity belt (40-M-20-1B).
6. Dedicated 6-pulse adjustable frequency drive (AFD) for the associated belt drive (40-M-20-1C and 40-M-20-1D).
7. An appropriately sized circuit breaker that is used to distribute power to the panel-mounted air conditioner used to cool each BFP control panel. The power feed for the panel-mounted air conditioner shall be derived from the incoming 480V, three phase power feed to each BFP control panel.
8. All wiring and devices over 120V shall be segregated or partitioned from lower voltage devices to limit electrical exposure by controls technicians while performing routine panel maintenance.

D. The control system for all equipment and components of each Belt Filter Press shall be provided by a dedicated Programmable Logic Controller (PLC), mounted in each Belt Filter Press Control Panel. The PLC shall provide all control and monitoring functions required for the operation and monitoring of the belt filter press and associated equipment including, but not limited to, timing, interlocks, startup sequencing, normal and emergency shutdowns, and permissive functions required for safe operation of each belt filter press.

1. The PLC programming for the Belt Filter Press control system shall include documented description of all functions and logic.
2. The PLC I/O signal types and voltages shall be as specified in Section 40 99 90, Package Control Systems.

3. Provide uninterruptable power supply (UPS) backup power for all PLC equipment, network components, network components, and instrument components of the Belt Filter Press control system. The UPS shall be in accordance with and as specified in Section 40 99 90, Package Control Systems.
4. The Ethernet switch and PLC equipment shall be in accordance with and as specified in Section 40 99 90, Package Control Systems.
5. The fiber optic Patch Panel, Connectors, and patch cords shall be provided as specified in Section 40 95 80, Fiber Optic Communication System.
6. Provide application software (programming) for all digital, programmable components of the belt filter press systems including submittals, documentation, communication, and testing as specified in Section 40 99 90, Package Control Systems.

E. Operator Controls and Indications: Provide the following control devices on the front of the control panel:

1. Provide externally operable main breaker integral to each belt filter press control panel. The main circuit breaker shall include a short circuit rating of 65,000A.
2. Panel mounted operator interface unit (OIU).
3. Emergency STOP pushbutton.
4. Alarm horn and Silence pushbutton.
5. Belt tensioning adjustment and indication.

F. Operator Controls: Provide the following control features through an Operator Interface Unit (OIU):

1. Provide a panel-mounted OIU on the Belt Filter Press Control Panel.
2. The OIU manufacturer shall be as specified under Section 40 99 90, Package Control Systems.
3. The OIU shall provide the primary method for an operator to monitor the status of the Belt Filter Press and associated equipment and to affect its operation by command or directive entry. The OIU shall provide the graphics-based interface between the operator and Belt Filter Press PLC.
4. Belt Filter Press AUTO/MANUAL control selection shall be provided at the OIU.
    a. In MANUAL mode, the Belt Filter Press PLC shall monitor only the equipment listed under number 5, where the Operator shall start and stop the equipment at the OIU. Manual speed control is also provided for equipment with AFDs.

b. In AUTO mode, the Belt Filter Press and ancillary equipment shall start/stop in a programmed sequence when all equipment is in the remote mode and without fault alarms.
c. See letter G below for additional requirements.

5. The OIU shall provide control of the following:
   a. BFP Control (Auto Start/Stop).
   b. Biosolids Feed Pump 1 Control (Start/Stop and Speed).
   c. Biosolids Feed Pump 2 Control (Start/Stop and Speed).
   d. Biosolids Feed Pump selector switch (software). Provide operator warning message to verify field valves.
   e. Washwater Booster Pump Control (Start/Stop).
   f. Sludge Distributor Control (Start/Stop and Speed).
   g. Gravity Belt Control (Start/Stop & Speed).
   h. Main Belt Drives Control for 40-M-20-1C and 40-M-20-1D (Start/Stop and Speed).
   i. Hydraulic Tensioning System Control (Start/Stop).
   j. Polymer System Control (Start/Stop).
   a. Alarm Reset Control.
   b. Conveyor Run Forward Control (Start/Stop).
6. The OIU shall provide the following statuses and displays:
   a. System Control Power: ON.
   b. System Control Power: RESET.
   c. Auto Mode: AUTO.
   d. Auto Start: PREWASH CYCLE.
   e. Auto Stop: POST-WASH CYCLE.
   f. Air Supply Valve: OPEN.
   g. Belt Tension/Tracking: ON.
   h. Hydraulic Pump: ON.
   i. Belt Conveyor: ON.
   j. Washwater Booster Pump: ON.
   k. Washwater Solenoid: OPEN.
   l. Main Belt Drive: ON.
   m. Belt Filter Press: IN STANDBY MODE.
   n. Polymer Feed Unit: ON.
   o. Biosolids Feed Pump: ON.
   p. Biosolids Feed Pump: PERMISSIVE.
   q. Main Belt Drive Speed: PERCENT.
   r. Polymer Feed: LBS. ACTIVE/DRY TON SLUDGE.
   s. BFP Sludge Feed Flow: gpm.
   t. Screw Conveyor: ON Forward and ON Reverse.
   u. Screw Conveyor: IN REMOTE.
7. Alarms:
   a. Low Hydraulic Pressure.
   b. Belt Limit: FAULT.
   c. Low Washwater Pressure: FAULT.

d. Main Drive VFD: FAULT.
e. Machine E-Stop: FAULT.
f. Belt Break: FAULT.
g. Screw Conveyor: NOT RUNNING.
h. Screw Conveyor: ALARM.
i. Screw Conveyor: E-STOP

G. Provide the following hard-wired interface signals between the Polymer System Panel (40-LCP-40-1) and Belt Filter Press Panel (40-VCP-20-1):

1. Inputs:
   a. Polymer System On Status.
   b. Polymer System Low Flow Alarm.
   c. Polymer System Run Status.
   d. Polymer System Speed Feedback, 4-20mA signal.
2. Outputs:
   a. Polymer System Run Command.
   b. Polymer System Speed Control, 4-20mA signal.

H. External Interfaces to the Plant SCADA System via Ethernet communication link (Data Exchange) on the Programmable Logic Controller (PLC):

1. Outputs from Plant SCADA PLC CP-B:
   a. BFP run permissive.
   b. Selected BFP Biosolids Feed Pump: ON.
   c. Selected BFP Biosolids Feed Pump: PERMISSIVE.
   d. Selected BFP Biosolids Feed Pump: Speed Status.
2. Inputs to Plant SCADA PLC CP-B:
   a. BFP on.
   b. BFP fault.
   c. Biosolids Feed Pump Selected for use.
   d. Selected BFP Biosolids Feed Pump: Speed Output.
   e. Polymer feed unit on.
   f. Polymer feed unit low flow alarm.
   g. BFP sludge feed flow indication.
   h. E-Stop activated.
   i. Screw Conveyor In Remote.
   j. Screw Conveyor Run Forward and Run Reverse Status.
   k. Screw Conveyor Alarm.
   l. Screw Conveyor E-STOP.
3. Any other data exchange or statuses considered by manufacturer as essential for safe operation and monitoring.

4. Coordinate data exchange with the Plant SCADA System Supplier. Provide a detailed data exchange list as specified under Section 40 99 90, Package Control Systems.

I. Provide SPDT dry alarm contacts to indicate PLC or adjustable frequency drive failure.

J. Provide 120V power for the respective washwater valve (40-FV-20-1) located upstream of the corresponding washwater booster pump.

K. Functional Requirements: Provide the following functional requirements for each belt filter press:

1. Provide EMERGENCY STOP pushbuttons and pull cords (maintained type) and provide for hard wired instant shutdown of belt filter press equipment at all times.
2. MANUAL Mode: In MANUAL mode, system components can be started at their respective starters without sequence interlocks being satisfied. Emergency stop and belt limit alarms will always be active.
3. AUTO Mode: In AUTO mode, startup and shutdown can be controlled from either AUTO START/AUTO STOP pushbuttons for an automatic sequential timed startup, or components can be controlled with their respective pushbuttons, interlocks must be satisfied.
    a. Operating the AUTO START pushbutton will initiate the following sequence of events:
        1) Hydraulic pump energizes (instantly).
        2) Open washwater valve (instantly).
        3) Start washwater booster pump (instantly).
        4) Start Screw Conveyor (5-second delay from auto start initiate/adjustable delay from auto start initiate).
        5) Start Belt Conveyor and sludge distributor (15-second delay from auto start initiate/adjustable delay from auto start initiate).
        6) Start main belt drives (90-second delay from auto start initiate/adjustable delay from auto start initiate).
        7) Start polymer feed unit (5-minute delay from auto start initiate/adjustable delay from auto start initiate).
        8) Start Biosolids Feed Pump (15-second delay from polymer pump start/adjustable delay from auto start initiate).
    b. While AUTO START is in progress “AUTO START” shall be indicated.
    c. Operating the AUTO STOP pushbutton will initiate the following sequence of events:
        1) Biosolids Feed Pump stops (instantly).
        2) Polymer feed unit stops (instantly).

3) Main belt drives, washwater valve/booster pump, belt conveyor and hydraulic pump, (45-minute delay from auto stop initiate).
4) Screw conveyor stops (50-minute delay from auto stop initiate//adjustable delay from auto start initiate)
5) AUTO STOP indicator light will flash while in progress and go on steady when complete.

4. Alarms: Alarm conditions are indicated with amber pilot lights and will cause alarm horn to sound. Alarm lights will go on steady as long as condition is still in fault condition. Operating acknowledge pushbutton will silence horn and cause indicator light to flash if condition has been cleared. Operating reset button will clear alarm indicator and allow system startup.
   a. Following conditions will immediately shutdown the complete system automatically:
      1) Emergency stop.
      2) low hydraulic pressure.
      3) Belt misalignment.
      4) Belt broken.
      5) Main belt drive fail.
      6) Low washwater pressure.
      7) Loss of Permissive from PLC.
   b. Following conditions will shut down polymer and Biosolids Feed Pump automatically:
      1) Low washwater pressure.
      2) If sludge pump is not detected “on” 1 minute after polymer unit run confirm. Lack of cake alarm.
      3) Belt conveyor fail.

L. Instrumentation, monitoring, and controls included shall interface with the BFP panel, via hardwired signals, as specified and shown on the Drawings.

M. Pressure Switches:

1. Tags:
   a. Washwater Booster Pump: 40-PSL-20-1.
   b. Hydraulic Tensioning System: 40-PSL-20-1C.
2. Piston-actuated, adjustable deadband, with repeatability of plus or minus 1 percent of range.
3. SPDT contacts rated 10 amps, minimum at 120V ac.
4. NEMA 4X construction with Buna-N actuator seal.
5. Manufacturer: Ashcroft L or P series, United Electric, or approved equal.

N. Pressure Gauges:

1. Tags:
   a. Washwater Booster Pump: 40-PI-20-1.
   b. Hydraulic Tensioning System: 40-PI-20-1C.
2. Ranges:
   a. Washwater Booster Pump: 0 – 160 psi.
   b. Hydraulic Tensioning System: manufacturer recommended.
3. Glycerin case filled.
4. NEMA 4X construction, 4-inch diameter dial.
   Manufacturers: Ashcroft, 1259/1279 series, WIKA, or approved equal.

2.07 ACCESSORIES

A. Equipment Identification Plates: 16-gauge, Type 316 stainless steel or plastic, securely mounted on each separate equipment component and control panel(s) in a readily visible location. Plate shall bear 3/8-inch high engraved block type equipment identification number and letters.

B. Lifting Lugs: Provide lifting lugs for equipment weighing over 100 pounds.

C. Equipment Anchor Bolts: Type 316 stainless steel, sized by manufacturer, and at least 5/8 inch in diameter and as specified in Section 05 50 00, Metal Fabrications.

2.08 FABRICATION

A. Thickener Mounted Electric Devices (Excluding Motors): Factory prewired to terminal strips in a frame mounted, NEMA 250, Type 4X 316 stainless steel terminal junction box.

2.09 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Piping Connections: Use U.S. standard pipe sizes with 150-pound flanges for pipes 2-inch diameter and larger and NPT for pipe 1-1/2-inch diameter and smaller.

B. Corrosion Protection:

1. All parts of the equipment in contact with the belts including doctor blade support frames shall be Type 316L stainless steel or coated as specified under Paragraph Drum and Roller Assemblies hereinbefore.
2. Coatings: Suitable for the expected service conditions.
3. Wetted Parts: Suitable for the service conditions specified.
4. Splash Guards: Type 316L stainless steel.

5. Miscellaneous Hardware Including Bolts, Nuts, Washers, and Fastener Clips: Type 316L stainless steel.
6. Drives and Motors: Factory painted with the manufacturer's standard epoxy enamel finish suitable for indoor exposed, wet corrosive service.
    a. Primer, Intermediate, and Finish Coats: Continuous heat resistance of 90 degrees C.
    b. Intermediate Coat: 12-hour heat resistance of 125 degrees C.

C. Dissimilar Metals: Properly electrically insulate any dissimilar metals or connectors in direct contact. Provide 1/8-inch thick continuous neoprene gaskets to isolate aluminum from all steel members.

D. Equipment Identification Plates: 16-gauge, Type 316L stainless steel or plastic identification plate securely mounted on each press with stainless steel panhead screws. Locate identification plate in a readily visible location with 1/2-inch die-stamped equipment identification number indicated in this section and shown on the P&IDs. Refer to Nameplates and Name Tags hereinbefore for identification of I&C components.

E. Lifting Lugs: Provide equipment and removable equipment components weighing over 100 pounds with lifting lugs to permit easy handling.

2.10 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating, System No. 5, unless items are stainless steel or galvanized or are otherwise specified herein.

2.11 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Satisfactorily test all equipment and control panels prior to shipment.

C. Functional Test: Perform on equipment according to procedures accepted by Engineer.

PART 3 EXECUTION

3.01 GENERAL

A. Manufacture and test the BFP system in accordance with the applicable trade and industry practices and in compliance with state, OSHA, and other governing code requirements.

B. Install equipment in conformance with the manufacturer's written instructions, with supervision and inspection performed by manufacturer's representative.

C. Anchor and mount equipment in accordance with manufacturer's requirements for the load criteria specified in Section 01 61 00, Common Product Requirements.

D. Accurately place anchor bolts using templates furnished by the manufacturer in accordance with Section 05 50 00, Metal Fabrications.

3.02 FIELD TESTS

A. Field Motor Tests: Megger test (500-volt megger) each motor phase-to-phase and phase-to-ground prior to startup, Contractor or manufacturer's representative to perform test in the presence of Engineer. Engineer will make a record of these values. Values of resistance less than 1 megohm will not be acceptable.

3.03 FIELD QUALITY CONTROL

A. Coordinate timing and schedule test with Owner and be dependent upon quantity of sludge available for testing.

B. Functional Test (and Clean Water Test):

1. Inspect equipment for proper alignment, quiet operation, proper connection, and satisfactory performance of all components by means of a functional test conducted by the manufacturer's representative, assisted by the installing contractor and Owner, and as approved by Engineer, prior to startup.
2. Conduct functional testing after the installation of the BFP equipment and all appurtenances.
3. Perform functional test on completed BFP system without sludge feed prior to startup.
4. Demonstrate complete normal start, normal stop, and controlled shutdown cycles on each unit.
    a. Conduct an uninterrupted 2-hour running test on each unit.
        1) At the beginning and end of the test, and at periodic intervals between, observe and record all thermometer readings.
    b. Adjust belt tension at the start of the test, check and readjusted if necessary at the end of the test.
    c. Check all safety devices for satisfactory operation.
    d. Check instrumentation and control systems for conformance with Specifications.

5. Measure operating amperage and kilowatts per phase of all motors for overload condition. Report measured values to Engineer.
6. Develop proposed test procedures and submit for review, comment, and approval. Begin testing only after test procedures are approved by Engineer.
7. Provide a qualified manufacturer's representative to supervise each test, analyze data, and certify the BFP's performance during the test.
8. Submit test log to Engineer upon completion of each test.
9. Complete and sign Manufacturer's Certificate of Proper Installation, as specified in Section 01 43 33, Manufacturers' Field Services.
10. Complete successful functional testing prior to pre-performance testing.

C. Pre-performance Test:

1. Following successful completion of functional testing, conduct testing by manufacturer's representative, assisted by installing contractor and Owner, to demonstrate continuous, reliable operation, not performance, while dewatering the liquid biosolids at the flow rates and having the characteristics as specified in Article Service Conditions.
2. Notify Owner and Engineer in writing at least 14 days prior to scheduled pre-performance test.
    a. Provide complete Operation and Maintenance Manuals and conduct prestartup classroom training on the BFPs prior to pre-performance test.
    b. Field training may occur during the pre-performance test.
3. Conduct pre-performance test of the BFPs for a period of 2 working days (minimum of 6 hours operation per day) without shutdown due to equipment, control, or system failures.
4. Shutdown is defined as:
    a. Stoppages due to any failure of provided equipment and instrumentation, such as the BFP control panel, in excess of 30 minutes.
    b. More than one stoppage(s) over the 2-day period for all BFPs.
    c. Stoppages caused by Owner may occur without causing failure of the test.
5. Develop proposed test procedures and submit to Engineer for review, comment, and approval. Begin testing only after test procedures are approved by Engineer.
6. Provide a qualified manufacturer's representative to supervise each test, analyze data, and certify the BFP's performance during the test.
7. If, in the opinion of Engineer, the pre-performance test is successful and meets the requirements specified herein, Engineer will accept the pre-performance test in writing and identify that BFPs may begin the performance test, providing other prerequisites for the performance test are satisfied.

8. If a shutdown occurs or the BFP is otherwise unable to achieve the pre-performance test requirements:
    a. Perform whatever equipment modifications are necessary to achieve the performance specified.
    b. Document modifications and submit to Engineer.
    c. Repeat pre-performance test in its entirety.
9. Owner will provide polymer, power, feed sludge, and cake disposal during testing.

D. Performance Test:

1. Demonstrate through performance testing actual system operating conditions and verify that BFPs meet or exceed minimum performance requirements specified in Article Performance Requirements, while dewatering the sludge stream specified in Article Service Conditions.
    a. Conduct testing at the solids loading rates specified in Article Service Conditions.
2. Notify Owner in writing at least 14 days prior to scheduled performance test.
    a. Successful completion of the pre-performance test is a prerequisite of performance testing.
3. Manufacturer's representative, assisted by installing contractor and Owner, shall startup and operate each BFP on the sludge stream specified herein, for a period of 8 hours per day for 2 days, with no interruptions allowed during the 8-hour period.
    a. Provide BFP operations and associated manufacturer's field services required to adjust machine settings prior to and exclusive of the above specified performance test duration.
4. Develop proposed test procedures and submit for review, comment, and approval. Begin testing only after test procedures are approved by Engineer.
5. Provide qualified manufacturer's representative to supervise each test, analyze data, and certify the BFP's performance during the test.
6. Maintain steady state operation at the specified sludge feed solids rates throughout the test, and all hourly quantities shall be the average during the test period.
    a. Maintain acceptable performance while dewatering feed sludge with properties within plus or minus 10 percent of the specified criteria listed in Article Service Conditions.
7. During each performance test, take measurements and collect all required samples for analysis to make the following determinations:
    a. Sludge Feed Rate: gpm.
    b. Sludge Feed Concentration: The total dry solids concentration of the feed sludge entering the BFP (percent TS).

c. Dewatered Cake Concentration: The total dry solids concentration of the dewatered sludge cake discharged from the BFP (percent TS). Take two duplicate samples per sample interval.
d. Centrate Concentration: The total suspended solids concentration of the filtrate discharged from the BFP (percent TSS).
e. Solids Capture: Percent.
f. Feed Hydraulic Loading Rate (Exclusive of Polymer): gpm.
g. Feed Solids Loading Rate (Exclusive of Polymer): Pounds per hour of total dry solids.
h. Polymer Feed Rate: gpm.
i. Polymer Dose: Pounds active per dry ton of feed solids.

8. Collect samples at approximate 1-hour intervals.
9. Variations in Sludge Feed Characteristics:
   a. Make compensating calculations for the effects if feed sludge characteristics are not within the ranges specified herein. Provide supporting data to be considered by Engineer in determining conformance with the specified design conditions. Engineer will be sole judge of conformance with performance testing requirements.
   b. If retesting to document compliance is required due solely to feed sludge characteristics outside of the specified range, Owner may waive retesting or may compensate Contractor for reasonable costs to witness retesting at Owner's sole option.
10. Performance will be based upon the arithmetic average of the test results obtained during the test period.
    a. Owner reserves the right to discard obviously high or low erroneous test results.
    b. As specified below, laboratory testing will be performed by Owner.
    c. Turnaround time for cake concentration samples are approximately 24 hours.
    d. Laboratory standard methods results will be used for performance evaluation.
11. Prepare a formal test report including all laboratory analysis reports, all measured flows, the mass balance calculations, and the percent capture.
    a. Submit six copies of final report to Engineer within 20 days after completion of the test.
12. If a BFP does not meet the requirements of Specifications during the performance test:
    a. Make changes to equipment and methods of operation as recommended by manufacturer and as approved by Engineer as soon as practical, but within a period not to exceed 30 days.
    b. Following adjustments, perform a second test run similar to the first run.

c. If BFP still does not achieve specified performance during the second test, equipment will be subject to rejection.
d. The BFP manufacturer retains responsibility for the BFPs until the acceptance test has been successfully completed.
e. After initial startup, Owner shall have the right to use the BFP as needed to process sludge.

13. If, after a maximum of two test runs, in the opinion of Engineer, a BFP meets the performance requirements specified herein, Engineer will recommend acceptance of the BFP. If, in the opinion of Engineer, performance test results do not meet the requirements specified herein, Engineer will notify the BFP manufacturer and Owner of nonacceptable performance.
14. Should the BFP be unable to achieve performance specified under Article Performance Requirements, perform whatever equipment modifications are necessary for the equipment to achieve the performance specified. Submit for review by Engineer all modifications and pay review costs at Engineer's standard billing rate. Following completion of equipment modifications, run the performance test again in its entirety.
15. Laboratory tests necessary to confirm the sludge characteristics for the initial performance test on a BFP will be provided by Owner.
    a. Laboratory tests for performance testing will be performed by Owner in conformance with applicable portions of standard methods.
    b. If retesting is required, BFP manufacturer shall pay Owner for all laboratory tests subsequent to the initial test.
16. BFP manufacturer to recommend emulsion polymer to be used.
17. Owner will provide power, water, feed sludge, and disposal for the initial test.

E. Manufacturer's Field Services:

1. Manufacturer's Authorized Representative: Present at Work site or classroom designated by Owner, for the minimum person-days listed below, travel time excluded. A minimum of two trips required.
2. Minimum services to include:
    a. 2 person-days for installation assistance, inspection, and certification of installation.
    b. 1 person-day for functional testing.
    c. 1 person-day for prestartup classroom or Job Site training.
    d. 4 person-days for performance testing and operator training during facility startup.
3. Video record all classroom training sessions and provide original video recordings and three copies of recordings on CD or DVD.

4. The periods stated above are minimums only and the manufacturer is required to be onsite for all of the functions listed above to the extent that is required to complete those functions to the satisfaction of Owner and Engineer.
5. For additional field services regarding the AFDs, see Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

3.04 SUPPLEMENTS

A. Supplement listed below, following "End of Section," is a part of this Specification.

1. Induction Motor Data Sheet.

END OF SECTION

INDUCTION MOTOR DATA SHEET

Project: Crestview WWTP Biosolids Handling Improvements

Owner: City of Crestview, Florida

Equipment Name: Belt Filter Press

Equipment Tag Number(s): Belt Filter Press No. 1

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: Alfa-Laval

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: Sludge Distributor 40-M-20-1A: 0.75
Gravity Belt 40-M-20-1B40: 3
Pressure Belt -M-20-1C and 40-M-20-1D: 3 (Each)
Tensioning Unit 40-M-20-1E: 1
Washwater Booster Pump 40-P-20-1: 15

Voltage: 460

Phase: 3

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Frequency: 60

Enclosure Type: CISD-TEFC

Synchronous Speed: _____ rpm

☐ Multispeed, Two-Speed: __ / __ rpm

☒ Thermal Protection: _____

Winding: ☐ One ☐ Two

☐ Space Heater: ___ volts, single-phase

Mounting Type: ☒ Horizontal ☐ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up ___ Down ___

☒ Adjustable Speed Drive

Operating Speed Range: 50 to 100 % of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: ☒ See Section 26 20 00, Low-Voltage AC Induction Motors.

Special Features:

Water booster pump 40-P-20-1 and Hydraulic Tension System 40-M-20-1E are constant speed motors.

DRAWINGS

(BOUND SEPARATELY)

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS

Prepared for the

City of Crestview
Crestview, Florida

Volume 3 of 3
Drawings

For information regarding
this project, contact:
SCOTT JERNIGAN
25 WEST CEDAR STREET,
SUITE 350
PENSACOLA, FL 32502
PHONE: 850-941-7282

Jacobs

Project No. D3403200

APRIL 2021

BID DOCUMENTS

N

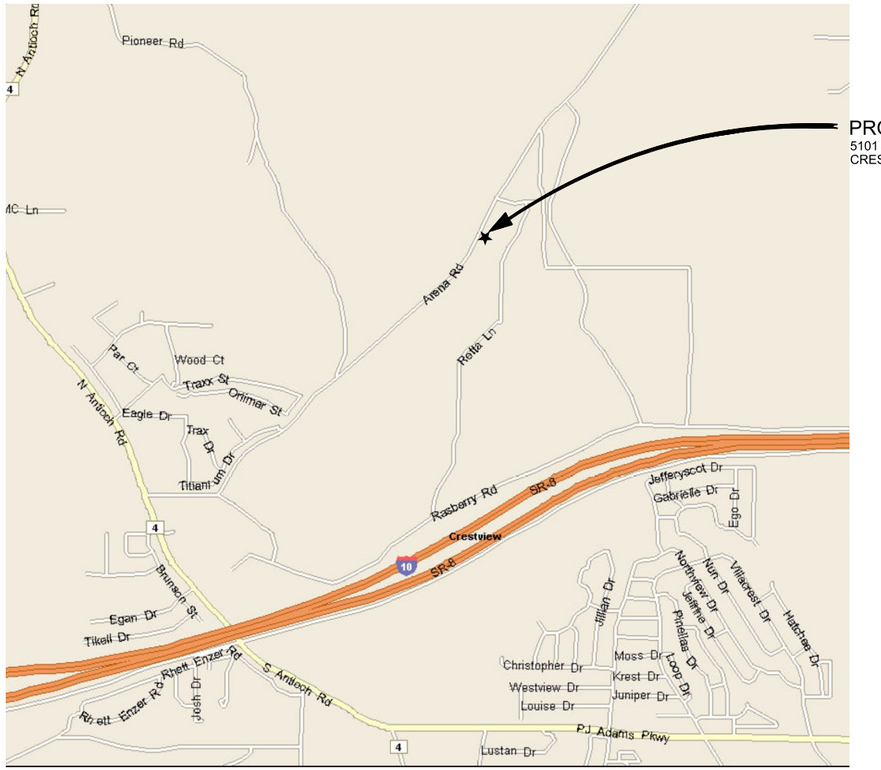
VICINITY MAP
NTS

THE DRAWING NUMBERS FOR THIS PROJECT FOLLOW THE FOLLOWING GUIDELINE:

XX – N - # ###

- FACILITY NUMBER (2 DIGITS)
- DISCIPLINE DESIGNATOR
- SHEET TYPE (1 DIGIT)
- SEQUENTIAL NUMBERING (4 DIGITS)

FACILITY NUMBERS	DESIGNATOR	DISCIPLINE	SHEET TYPE	SEQUENTIAL NUMBERS
01 - GENERAL	C	CIVIL	0 - GENERAL	001
05 - SITE	A	ARCHITECTURAL	1 - DEMOLITION	002
08 - INSTRUMENTATION AND CONTROL	S	STRUCTURAL	2 - PLANS	003
20 - AEROBIC DIGESTERS #3 AND #4	E	ELECTRICAL	3 - SECTIONS AND/OR ELEVATIONS	(etc.)
25 - INTERMEDIATE SLUDGE TRANSFER PS	G	GENERAL	4 - LARGE SCALED VIEWS	
30 - BIOSOLIDS FEED PS	D	PROCESS MECHANICAL	5 - DETAILS	
40 - DEWATERING BUILDING	M	MECHANICAL HVAC	6 - SCHEDULES OR DIAGRAMS	
99 - STANDARD DETAILS	P	PLUMBING	9 - ISOMETRICS	
	N	INSTRUMENTATION AND CONTROL		



PROJECT SITE
5101 ARENA ROAD
CRESTVIEW, FL

LOCATION MAP
NTS

INDEX OF DRAWINGS

NO.	DATE	REVISION	BY	APVD
DSGN	KL DIAZ	DR KL DIAZ / CHK K WADDELL	APVD	S JERNIGAN

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

Jacobs

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL
VICINITY MAP, LOCATION MAP, AND DRAWING INDEX

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	01-G-0001
SHEET	01 of 76

BID DOCUMENTS

SURVEY NOTES

1. THE TOPOGRAPHIC SURVEY, DATED NOVEMBER 11, 2009, SERVING AS THE BASE MAP FOR THE PROJECT WAS PREPARED BY RUBEN SURVEYING & MAPPING (850-916-7382). ADDITIONAL MAPPING FROM AS-BUILT SURVEY DATA AND PREVIOUS CH2M HILL DESIGN FILES WERE ADDED TO THE BASE FILE.
2. THE BOUNDARY SURVEY INFORMATION ASSOCIATED WITH THE RIB SITE WAS PREPARED BY RUBEN SURVEYING & MAPPING, DATED JULY 21, 2008.
3. THE PROJECT VERTICAL DATUM IS BASED ON THE NORTH AMERICAN DATUM OF 1988.
4. THE PROJECT HORIZONTAL DATUM IS REFERENCED TO THE FLORIDA NORTH STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM OF 1983 (1990 ADJUSTMENT).
5. THE SURVEY AND THE DRAWINGS SHOW SEVERAL CONTROL POINTS AND BENCHMARKS. CONTRACTOR SHALL USE AT LEAST THREE OF THE POINTS TO ESTABLISH VERTICAL AND HORIZONTAL CONTROL. NOTIFY ENGINEER IMMEDIATELY IF DISCREPANCIES ARE ENCOUNTERED.
6. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION.
7. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED.
8. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.

CIVIL NOTES

1. STAGING AREA SHALL BE FOR CONTRACTOR'S EMPLOYEE PARKING, CONTRACTOR'S TRAILERS AND ON-SITE STORAGE OF MATERIALS. PROVIDE TEMPORARY FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES. CONTRACTOR SHALL RESTORE AND SEED AND MULCH THE CONTRACTOR STAGING AREA AFTER CONSTRUCTION IS COMPLETE.
2. COORDINATES AND DIMENSIONS SHOWN FOR ROADWAY IMPROVEMENTS ARE TO THE EDGE OF PAVEMENT. COORDINATES FOR STRUCTURES ARE TO THE OUTERWALL OR EDGE OF PAD. COORDINATES FOR STORMWATER INLETS AND MANHOLES ARE TO THE CENTER OF STRUCTURE.
3. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS AS SHOWN.
4. EXISTING UNDERGROUND UTILITIES OBTAINED FROM AS-BUILTS AND FROM FIELD SURVEY. CONTRACTOR SHALL FIELD VERIFY DEPTH AND LOCATION PRIOR TO EXCAVATION. PROTECT ALL EXISTING UTILITIES DURING CONSTRUCTION.
5. UNLESS OTHERWISE SHOWN ALL PIPING SHALL HAVE A MINIMUM OF 3 FEET COVER.
6. ALL PIPES SHALL HAVE A CONSTANT SLOPE BETWEEN INVERT ELEVATIONS UNLESS A FITTING IS SHOWN.
7. CONTRACTOR SHALL NOT DISTURB AREAS OUTSIDE EXISTING RIGHTS-OF-WAY OR TEMPORARY CONSTRUCTION EASEMENTS.
8. CONTRACTOR TO ADJUST ALL EXISTING UTILITY CASTINGS INCLUDING VALVE BOXES, MANHOLES, HAND HOLES, PULL BOXES, INLETS AND SIMILAR STRUCTURES WITHIN PAVED AREAS TO MATCH FLUSH WITH FINISHED GRADE.
9. THE CONTRACTOR SHALL REPAIR AND RESTORE EXISTING PAVEMENT, SIDEWALKS, CURBS, DRIVEWAYS, PIPES, IRRIGATION LINES, CONDUIT, CABLES, ETC. AS A RESULT OF THE CONSTRUCTION ACTIVITIES.
10. NO DEBRIS OR CONSTRUCTION MATERIALS WILL BE BURIED OR DISPOSED OF ONSITE. ALL SUCH MATERIAL SHALL BE DISPOSED OF IN ACCORDANCE WITH LOCAL AND STATE REGULATIONS.

EROSION AND SEDIMENT CONTROL NOTES

1. CONTRACTOR SHALL PREPARE AND OBTAIN APPROVAL FOR A GENERIC PERMIT FOR STORMWATER DISCHARGE FROM LARGE AND SMALL CONSTRUCTION ACTIVITIES (FDEP DOCUMENT 62-621.300[4][A]). THE CONTRACTOR SHALL PREPARE AND SUBMIT THE SUPPORTING GENERIC PERMIT DOCUMENTATION INCLUDING A SITE SPECIFIC STORMWATER POLLUTION PREVENT PLAN, NOTICE OF INTENT (FDEP FORM 62-621.300[4][B]), AND PROCESSING FEE.
2. CONTRACTOR SHALL IMPLEMENT EROSION CONTROL MEASURES IN ACCORDANCE WITH THE FLORIDA STORMWATER, EROSION, AND SEDIMENT CONTROL INSPECTOR'S MANUAL.
3. IF ADDITIONAL EROSION CONTROL MEASURES ARE REQUIRED TO PREVENT OFFSITE MIGRATION OF STORMWATER RUNOFF, THE CONTRACTOR SHALL INFORM THE OWNER AND ENGINEER AND IMPLEMENT ADDITIONAL CONTROL MEASURES AS REQUIRED.
4. SITE WORK SHALL ENSURE THAT EXISTING VEGETATION IS PRESERVED AND THAT DISTURBED PORTIONS OF THE SITE ARE STABILIZED. STABILIZATION MEASURES MAY INCLUDE: TEMPORARY SEEDING, PERMANENT SEEDING, MULCHING, SOD STABILIZATION, PROTECTION OF TREES, AND OTHER APPROPRIATE MEASURES.
5. STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS PRACTICABLE IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, BUT IN NO CASE MORE THAN 14 DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT PORTION OF THE SITE HAS TEMPORARILY OR PERMANENTLY CEASED.
6. STRUCTURAL PRACTICES SHALL BE IMPLEMENTED TO DIVERT FLOWS FROM EXPOSED SOILS AND STORM DRAINS OR OTHERWISE LIMIT RUNOFF AND THE DISCHARGE OF POLLUTANTS FROM EXPOSED AREAS OF THE SITE TO THE DEGREE ATTAINABLE. SUCH PRACTICES MAY INCLUDE SILT FENCES, EARTH DIKES, DRAINAGE SWALES, SEDIMENT TRAPS, CHECK DAMS, AND STORM DRAIN INLET PROTECTION. STRUCTURAL PRACTICES SHOULD BE PLACED ON UPLAND SOILS TO THE DEGREE ATTAINABLE.
7. LOCAL, STATE AND MANUFACTURER'S METHODS FOR SPILL CLEANUP WILL BE CLEARLY POSTED AND PROCEDURES WILL BE MADE AVAILABLE TO SITE PERSONNEL. MATERIAL AND EQUIPMENT NECESSARY FOR SPILL CLEANUP WILL BE KEPT IN THE MATERIAL STORAGE AREAS. TYPICAL MATERIALS AND EQUIPMENT INCLUDES, BUT IS NOT LIMITED TO BROOMS, DUSTPANS, MAPS, RAGS, GLOVES, GOGGLES, CAT LITTER, SAND, SAWDUST AND PROPERLY LABELED PLASTIC AND METAL WASTE CONTAINERS.
8. ALL SPILLS WILL BE CLEANED UP IMMEDIATELY UPON DISCOVERY. ALL SPILLS WILL BE REPORTED AS REQUIRED BY LOCAL, STATE AND FEDERAL REGULATIONS.
9. EROSION AND SEDIMENT CONTROL MEASURES SHALL BE MAINTAINED AT ALL TIMES UNTIL PERMANENT STABILIZATION OF THE SITE IS ACHIEVED.
10. EROSION AND SEDIMENT CONTROL MEASURES SHALL BE CHECKED AFTER EACH RAIN EVENT, AND SHALL BE IMMEDIATELY REPAIRED OR REPLACED IF FOUND TO BE DEFECTIVE.
11. CONTRACTOR SHALL INSPECT EROSION AND SEDIMENT CONTROL MEASURES EACH DAY TO ENSURE THAT THEY ARE WORKING PROPERLY.
12. SILT FENCE SHALL BE INSPECTED FOR DEPTH OF SEDIMENT, TEARS, TO SEE IF THE FABRIC IS SECURELY ATTACHED TO THE FENCE POSTS, AND TO SEE THAT THE FENCE POSTS ARE FIRMLY IN THE GROUND. BUILT UP SEDIMENT SHALL BE REMOVED FROM SILT FENCE WHEN IT HAS REACHED ONE-HALF THE HEIGHT OF THE FENCE.
13. EROSION CONTROL MEASURES WILL BE MAINTAINED AT ALL TIMES. IF FULL IMPLEMENTATION OF THE APPROVED PLAN DOES NOT PROVIDE FOR EFFECTIVE EROSION CONTROL, ADDITIONAL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE IMPLEMENTED TO CONTROL OR TREAT THE SEDIMENT.

CIVIL LEGEND

EXISTING TOPOGRAPHY AND OTHER AS-BUILT SITE FEATURES ARE SHOWN SCREENED. SEE TOPOGRAPHIC SURVEY PREPARED BY RUBEN SURVING & MAPPING FOR EXISTING LEGEND.

- ⊗ 158.5 — SPOT ELEVATION
- 155 — CONTOUR LINE
- 3:1 — EMBANKMENT AND SLOPE
- DRAINAGEWAY OR DITCH
- CATCH BASIN OR INLET
- TRENCH DRAIN
- OR — SIGN
- MANHOLE
- POST OR GUARD POST
- GUY ANCHOR
- UTILITY POLE
- LIGHT POLE
- SURVEY CONTROL POINT OR BENCHMARK
- BRUSH/TREE LINE
- TREE
- PROPERTY LINE
- CENTER LINE, BUILDING, ROAD, ETC.
- STAGING OR WORK AREA LIMITS
- N 1000.00 / E 1000.00 — STRUCTURE, BUILDING OR FACILITY LOCATION POINT - COORDINATES
- B-1 — BORING LOCATION AND NUMBER
- TP-2 — TEST PIT LOCATION AND NUMBER
- P-3 — PIEZOMETER LOCATION AND NUMBER
- OR — DEMOLITION
- OR — STRUCTURE, BUILDING OR FACILITY
- ASPHALT CONCRETE PAVEMENT
- GRAVEL SURFACING OR LIMEROCK STABILIZATION OR RIPRAP
- CONCRETE PAVEMENT/SIDEWALK
- CURB
- CURB AND GUTTER
- SINGLE SWING GATE
- DOUBLE SWING GATE
- SLIDING GATE
- GUARD RAIL
- CHAIN LINK FENCE
- SEDIMENT FENCE
- CULVERT

SECTION / DETAIL DESIGNATIONS

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION — A — DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET)

ON DRAWING WHERE SECTION OR DETAIL IS TAKEN: 1 — DRAWING NUMBER WHERE SHOWN — 100-A-10010A1

B — SECTION — SCALE — 100-S-3001

ON DRAWING WHERE SECTION IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

2 — DETAIL — SCALE — 200-M-10B10A

ON DRAWING WHERE DETAIL IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

DRAWING TITLE — SCALE

ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (eg: ELEVATIONS)

- B — SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT
- B / 450-S-1002 — SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET
- 1 — GRID LINE INDICATOR
- 1 — KEYNOTE NUMBER
- 1 — REVISION / ADDENDA NUMBER
- N — NORTH ARROW; CAN BE MODIFIED TO INCLUDE MAGNETIC NORTH ALONG WITH PROJECT NORTH

DESIGN DETAIL DESIGNATION

DESIGN DETAIL DESIGNATION (NUMERAL) — 1234-567 — SHOWN ON DESIGN DETAIL DRAWING(S)

NOTES:

1. ALL DESIGN DETAILS ARE TYPICAL AND MUST BE USED IF DESIGN DETAIL DESIGNATION IS NOT SHOWN
2. THE TERM STANDARD DETAIL, OR A FORM OF IT, IS SYNOMONOUS WITH DESIGN DETAIL AND REFERS TO THE DESIGN DETAILS FOUND IN THIS SET OF CONTRACT DOCUMENTS.
3. THE DESIGN DETAILS REPRESENT THE CHARACTER AND NATURE OF THE WORK REQUIRED THROUGHOUT THE PROJECT. ALL ASSOCIATED WORK SHALL BE IN ACCORDANCE WITH THE DESIGN DETAILS SHOWN WHETHER THE DETAILS ARE SPECIFICALLY REFERENCED OR NOT.

NO.	DSGN	DATE	BY	APVD	REVISION	CHK	DR
	R MORRISON	R MORRISON		APVD		A MALONE	C CHILDRESS

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CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL

CIVIL GENERAL NOTES AND LEGENDS

BID DOCUMENTS

NTS	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
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ARCHITECTURAL ABBREVIATIONS

ABBREVIATION	DEFINITION
A	AWNING
AC	ACOUSTICAL CEILING
ACFL	ACCESS FLOORING
ACMU	ACOUSTICAL CMU
ACT	ACOUSTICAL TILE
AJ	ADJUSTABLE
AL	ALUMINUM
AS	AS SELECTED
BRK	BRICK
BNZ	BRONZE
BV	BLOCK VENT
C	CASEMEMT
CLR	CLEAR
CLSR	CLOSER
CMU	CONCRETE MASONRY UNITS
CNTR	COUNTER
COL	COLOR
CONC	CONCRETE
CONSTR	CONSTRUCTION
CPT	CARPET
CRC	CHEMICAL-RESISTANT COATINGS
CT	CERAMIC TILE
DA	DUAL ACTION
DB	DRAINABLE
DH	DOUBLE HUNG
EIFS	EXTERIOR INSULATION AND FINISH SYSTEM
EXP	EXPOSED STRUCTURE
FCTY	FACTORY
FNSH	FINISH
FRP	FIBERGLASS REINFORCED PLASTIC
FWC	FABRIC WALL COVERING
FX	FIXED
GALV	GALVANIZED STEEL
GCMU	GLAZED CONCRETE MASONRY
GH	GREENHOUSE
GLZ	GLAZING
GMU	GLASS MASONRY UNITGRY GRAY
GSB	GYPSUM SOFFIT BOARD
GWB	GYPSUM BOARD
HC	HOLLOW CORE
HDNR	HARDENER
HGT	HEIGHT
HM	HOLLOW METAL
HS	HORIZONTAL SLIDING
J	JALOUSIE
JA	JAL-AWNING
KEY	KEY GROUP
KPL	KICK PLATE
LD	COMBINATION LOUVER/DAMPER
MATL	MATERIAL
MDO	MEDIUM DENSITY OVERLAY
MET	METAL
MO	MANUALLY OPERABLE
MS	MANUFACTURER'S STANDARD
P	PROJECTED
PAVT	PAVER TILE
PLAM	PLASTIC LAMINATE
PLAS	PLASTER
PLWD	PLYWOOD
PNL	PANELING
PP	PUSH-PULL
PTN	PARTITION
QT	QUARRY TILE
RESIL	RESILIENT
RFS	ROLL-UP FIRE SHUTTER
RRUB	RADIAL RUBBER FLOORING
RUB	RUBBER SHEET FLOORING
SC	SOLID CORE WOOD
SIM	SIMILAR
SMLS	SEAMLESS EPOXY
SOI	SPRAY-ON INSULATION
SP	STORMPROOF
SST	STAINLESS STEEL
STL	STEEL
SVIN	SHEET VINYL
TCTG	TRAFFIC COATING
TH	TOP HINGED
TR	TRANSOM
TSHD	THRESHOLD
TWP	TRANSLUCENT PANEL SYSTEM
VCT	VINYL COMPOSITION TILE
VINT	VINYL TILE
VNL	VINYL
VP	VERTICAL PIVOTED
VS	VERTICAL SLIDE
VWC	VINYL WALL COVERING
WD	WOOD
WHT	WHITE
WRB	WATER RESISTANT GWB
WS	WEATHERSTRIPPING
WW	WINDOW WALL
X	OPEN

ARCHITECTURAL/STRUCTURAL LEGEND

SYMBOL	LEGEND
A	GRID / COLUMN INDICATOR
ROOM NAME XX101 OR ROOM NAME 101	ROOM IDENTIFIER
"XX" = FACILITY INDICATOR (IF SHOWN); DOOR LETTER; ROOM NUMBER; XX101A	DOOR IDENTIFIER
XXL-1 OR L-1	LOUVER IDENTIFIER
S-1	SIGNAGE IDENTIFIER
QUANTITY AND DIRECTION OF POINTERS AS REQUIRED; A B C D E; 1 XX-A-301	INTERIOR ELEVATION INDICATOR
⊗ 110.50	SPOT ELEVATION INDICATOR (IN FEET)
XXXX EL XX.XX	ELEVATION DATUM (IN FEET)
	DIRECTION OF SLOPE DOWN
HINGE SIDE	HATCH SWING INDICATOR
ACTIVE; XX101A; INACTIVE	INDICATES PAIR OF DOORS (DOOR # ON ACTIVE)
F.EXT-X (IN CABINET); F.EXT-X (ON BRACKET)	FIRE EXTINGUISHER "X" = NUMBER IN SPECIFICATIONS
CJ	CONTROL JOINT
X" EJ	EXPANSION JOINT X" = DIMENSION
POST	RAILINGS
P-1	PRECAST PANEL IDENTIFIER
S-X	SLAB INDICATOR
X	COLUMN INDICATOR
W-X	WALL INDICATOR
B-X	BEAM INDICATOR

ARCH/STRUCT MATERIAL SYMBOLS

SYMBOL	LEGEND	SYMBOL	LEGEND
	GRATING, SPAN DIRECTION INDICATED		WOOD STUD WALL (PLAN)
	CHECKERED PLATE		RIGID INSULATION
	GROUT		BATT INSULATION
	GRANULAR FILL		STEEL
	EARTH OR FINISH GRADE		ALUMINUM
	CONCRETE		PLYWOOD
	CMU WALL (PLAN)		GYPSUM WALLBOARD
	CMU WALL (SECTION)		ACOUSTICAL TILE
	MASONRY WALL		WOOD, ROUGH CONTINUOUS
	METAL STUD WALL (PLAN)		WOOD, ROUGH NON-CONTINUOUS
			WOOD, FINISHED

GENERAL ARCHITECTURAL NOTES

1. UNLESS OTHERWISE INDICATED, PLAN DIMENSIONS ARE TO COLUMN GRID ON CENTERLINES, NOMINAL SURFACE OF MASONRY, FACE OF STUDS AND FACE OF CONCRETE WALLS.
2. VERIFY ALL ROUGH-IN DIMENSIONS FOR EQUIPMENT PROVIDED IN THIS CONTRACT, OR BY OTHERS.
3. REFER TO ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL AND OTHER CATEGORIES OR DRAWINGS FOR ADDITIONAL NOTES.
4. VERIFY SIZE AND LOCATION OF, AND PROVIDE: REQUIRED OPENINGS THROUGH FLOORS AND WALLS, ACCESS DOORS, FURRING, CURBS, ANCHORS AND INSERTS. PROVIDE ALL BASES AND BLOCKING REQUIRED FOR ACCESSORIES, MECHANICAL, ELECTRICAL AND OTHER EQUIPMENT.
5. FOR APPLICABLE CODES AND LIFE SAFETY PLAN, SEE DRAWING 40-A-2001.
6. FOR DOOR AND HARDWARE DESCRIPTIONS SEE SPECIFICATION SECTION 08 06 01.
7. FOR LOUVERS DESCRIPTION, SEE SPECIFICATION SECTION 08 90 00.
8. NIC MEANS "NOT IN CONTRACT".
9. FOR GUARD POSTS LOCATIONS, SEE STRUCTURAL DRAWINGS.

NO.	DATE	DSGN	DR	CHK	APVD
			R HUSERIK	M MOLKA	A DOLSAK

REVISION

BY	APVD
	A DOLSAK

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CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL
ARCHITECTURAL LEGEND

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
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BID DOCUMENTS

DESIGN CRITERIA

1. APPLICABLE CODE: FLORIDA BUILDING CODE, 7TH EDITION (2020).
2. REFER TO THE DRAWINGS FOR ADDITIONAL AND SPECIFIC STRUCTURE LOADINGS AND REQUIREMENTS.
3. ALL LOADS SHOWN ARE SERVICE LEVEL (UNFACTORED) UNLESS SPECIFICALLY NOTED OTHERWISE.
4. DEAD LOADS:
   A. SELF WEIGHT
5. ROOF COLLATERAL LOADS:
   A. 40 - DEWATERING BUILDING = 15 PSF
6. LIVE LOADS:
   A. ROOF LIVE LOAD: 40 - DEWATERING BUILDING = 20 PSF (NON-REDUCIBLE)
   B. FLOOR LIVE LOAD: 40 - DEWATERING BUILDING = 300 PSF
   C. WALKWAYS AND PLATFORMS = 100 PSF
   D. DEFLECTION CRITERIA FOR CONTRACTOR DESIGNED ROOF FRAMING MEMBERS UNLESS OTHERWISE NOTED:
      TOTAL LOAD: = L/180
      LIVE LOAD: = L/240
      SNOW LOAD: = L/240
   E. DEFLECTION CRITERIA FOR CONTRACTOR DESIGNED FLOOR FRAMING MEMBERS UNLESS OTHERWISE NOTED:
      TOTAL LOAD: = L/180
      LIVE LOAD: = L/240
7. SNOW LOADS:
   GROUND SNOW LOAD, Pg = 0 PSF
8. WIND LOADS:
   ASCE 7 METHOD = DIRECTIONAL
   BASIC WIND SPEED, Vult = 150 MPH
   NOMINAL WIND SPEED, Vasd = 117 MPH
   RISK CATEGORY = III
   EXPOSURE CATEGORY = C
   INTERNAL PRESSURE COEFFICIENT, GCpi
      ENCLOSED BUILDINGS = +/- 0.18
      PARTIALLY ENCLOSED BUILDINGS = +/- 0.55
   COMPONENT AND CLADDING ELEMENTS (WINDOWS, DOORS, LOUVERS, SIDING, ETC.) a = 5.4 FT

COMPONENTS AND CLADDING PRESSURES - WALL (ASCE 7-16, TABLE 30.3-1)

Effective Area (sf)	Zone	+GCp	-GCp	Pres (+ve) (psf)	Pres (-ve) (psf)
10	4	0.9	-0.99	49.2	-53.3
50	4	0.79	-0.88	44.1	-48.2
200	4	0.69	-0.78	39.8	-43.9
500	4	0.63	-0.72	36.9	-41
10	5	0.9	-1.26	49.2	-65.6
50	5	0.79	-1.04	44.1	-55.5
200	5	0.69	-0.85	39.8	-46.7
500	5	0.63	-0.72	36.9	-41

COMPONENTS AND CLADDING PRESSURES - ROOF (ASCE 7-16, TABLE 30.3-2A)

Effective Area (sf)	Zone	+GCp	-GCp	Pres (+ve) (psf)	Pres (-ve) (psf)
10	1	0.3	-1.7	21.9	-85.6
100	1	0.2	-1.29	17.3	-66.8
200	1	0.2	-1.16	17.3	-61.2
500	1	0.2	-1	17.3	-53.7
10	2	0.3	-2.3	21.9	-112.9
100	2	0.2	-1.77	17.3	-88.8
200	2	0.2	-1.61	17.3	-81.5
500	2	0.2	-1.4	17.3	-71.9
10	3	0.3	-3.2	21.9	-153.9
100	3	0.2	-2.14	17.3	-105.7
200	3	0.2	-1.82	17.3	-91.1
500	3	0.2	-1.4	17.3	-71.9

9. SEISMIC LOADS:
   RISK CATEGORY = III
   SEISMIC IMPORTANCE FACTOR, Ie = 1.25

   MAPPED SPECTRAL RESPONSE ACCELERATIONS
      Ss = 0.080g
      S1 = 0.056g
   DESIGN SPECTRAL RESPONSE ACCELERATIONS
      SDS = 0.086g
      SD1 = 0.090g
   SITE CLASS = D
   SEISMIC DESIGN CATEGORY = B
10. SPECIAL LOADS: SEE PLANS FOR STRUCTURE SPECIFIC LOADS
11. HYDRAULIC LOADS: SEE PLANS FOR STRUCTURE SPECIFIC LOADS

GENERAL INFORMATION

1. FOR ABBREVIATIONS NOT LISTED, SEE ASME Y14.38 "ABBREVIATIONS AND ACRONYMS: PUBLICATION AS DISTRIBUTED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME).
2. DESIGN DETAILS ARE INTENDED TO BE TYPICAL AND SHALL APPLY TO SIMILAR SITUATIONS OCCURRING THROUGHOUT THE PROJECT, WHETHER OR NOT THEY ARE INDIVIDUALLY CALLED OUT.
3. VERIFY FINAL OPENING DIMENSIONS IN WALLS, SLABS, AND DECKS WITH OTHER DISCIPLINE DRAWINGS PRIOR TO CONSTRUCTION OF THESE ELEMENTS.
4. FOR NUMBER, TYPE, SIZE, ARRANGEMENT, AND/OR LOCATION OF EQUIPMENT PADS, SEE OTHER DISCIPLINE DRAWINGS. COORDINATE WITH EQUIPMENT SUPPLIER PRIOR TO PLACING SLABS, WALLS AND FOUNDATIONS. COORDINATE PIPING OPENINGS WITH OTHER DISCIPLINE DRAWINGS.
5. DO NOT CUT OR MODIFY STRUCTURAL MEMBERS FOR PIPES, DUCTS, ETC, UNLESS SPECIFICALLY DETAILED OR APPROVED IN WRITING BY THE ENGINEER.
6. VISITS TO THE JOB SITE BY THE ENGINEER TO OBSERVE THE CONSTRUCTION DO NOT IN ANY WAY MEAN THAT ENGINEER IS GUARANTOR OF CONSTRUCTOR'S WORK, NOR RESPONSIBLE FOR THE COMPREHENSIVE OR SPECIAL INSPECTIONS, COORDINATION, SUPERVISION, OR SAFETY AT THE JOB SITE.

FOUNDATIONS

1. REFER TO GEOTECHNICAL DESIGN MEMORANDUM: CRESTVIEW SOLIDS HANDLING IMPROVEMENTS, DATED FEBRUARY 11, 2021, BY JACOBS.
2. SOIL DESIGN PARAMETERS:
   A. ALLOWABLE SOIL BEARING PRESSURES:
      20 - AEROBIC DIGESTERS #3 AND #4: = 2,000 PSF
      40 - DEWATERING BUILDING = 2,000 PSF
      UNLESS OTHERWISE NOTED = 1,500 PSF
   B. GROUND WATER TABLE (GWT) ELEVATION IS EXPECTED TO BE WELL BELOW EXCAVATIONS.
   C. FLOOD ELEVATION: PROJECT SITE IS OUTSIDE THE 500-YR AND 100-YR FLOOD ELEVATIONS
3. EXCAVATIONS SHALL BE SHORED TO PREVENT SUBSIDENCE AND DAMAGE TO ADJACENT EXISTING STRUCTURES, ROADS, UTILITIES, ETC.
4. FOUNDATION SLABS AND SLABS-ON-GRADE SHALL BEAR ON COMPACTED GRANULAR FILL THICKNESSES AS NOTED ON DRAWINGS.
5. FOUNDATION BEARING SURFACES SHALL BE OBSERVED BY THE GEOTECHNICAL ENGINEER OR QUALIFIED DESIGNEE PRIOR TO PLACEMENT OF FORMWORK OR REINFORCING STEEL. THE OBSERVATION SHALL VERIFY IF THE ACTUAL EXPOSED SUBGRADE IS AS ANTICIPATED BY THE SITE SPECIFIC BORINGS AND DATA REPORTS AND MEETS THE ALLOWABLE SOIL BEARING PRESSURES NOTED ON THE DRAWINGS.
6. NO BACKFILL SHALL BE PLACED AGAINST CANTILEVERED WALLS UNTIL THE CONCRETE HAS ATTAINED 100 PERCENT OF SPECIFIED 28 DAY COMPRESSIVE STRENGTH.
7. NO BACKFILL SHALL BE PLACED AGAINST WALLS UNTIL THE CONCRETE HAS ATTAINED 100 PERCENT AND TOP SUPPORTING SLAB'S CONCRETE HAS ATTAINED 80 PERCENT OF THEIR SPECIFIED 28 DAY COMPRESSIVE STRENGTH.
8. NO BACKFILL SHALL BE PLACED BEHIND CANTILEVERED, FREE TOP WALLS UNTIL THE CONCRETE HAS ATTAINED 100 PERCENT OF ITS SPECIFIED 28 DAY COMPRESSIVE STRENGTH.

FORMWORK, SHORING, AND BRACING

1. STRUCTURES SHOWN ON THE DRAWINGS HAVE BEEN DESIGNED FOR STABILITY UNDER FINAL CONDITIONS ONLY. DESIGN SHOWN DOES NOT INCLUDE NECESSARY COMPONENTS OR EQUIPMENT FOR STABILITY OF THE STRUCTURES DURING CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR WORK RELATING TO CONSTRUCTION ERECTION METHODS, BRACING, SHORING, RIGGING, GUYS, SCAFFOLDING, FORMWORK, AND OTHER WORK AIDS REQUIRED TO SAFELY PERFORM THE WORK SHOWN.
2. TEMPORARY SHORING SHALL REMAIN IN PLACE UNTIL ELEVATED CONCRETE FLOOR OR SLABS HAVE REACHED 80 PERCENT OF THE 28 DAY COMPRESSIVE STRENGTH AS DETERMINED BY FIELD CYLINDER BREAKS.
3. "BURY"BARS OR "CARRIER"BARS ARE NOT ALLOWED FOR THE BOTTOM MATS OF REINFORCING IN ALL ELEVATED SLABS AND ARE NOT ALLOWED FOR THE TOP MATS OF REINFORCING IN ELEVATED SLABS LESS THAN 12 INCHES THICK.

CONCRETE REINFORCING

1. REINFORCING STEEL: = ASTM A615, GRADE 60
2. FABRICATION AND PLACEMENT OF REINFORCING STEEL SHALL BE IN ACCORDANCE WITH CRSI MSP-1 "MANUAL OF STANDARD PRACTICE"AND ACI 301 "SPECIFICATIONS FOR STRUCTURAL CONCRETE".
3. MINIMUM REINFORCING FOR CONCRETE WALLS AND SLABS SHALL BE AS FOLLOWS:

THICKNESS	REINF EACH WAY	LOCATION
6"	#4@12"	CENTERED
8"	#5@12"	CENTERED
10"	#4@12"	EACH FACE
12"	#5@12"	EACH FACE

   PROVIDE LARGER SIZES AND MORE REINFORCING IN SECTIONS OF CONCRETE WHERE REQUIRED BY THE DETAILS ON THE DRAWINGS OR BY THE SPECIFICATIONS.
4. CONCRETE COVER FOR REINFORCING, UNLESS SHOWN OTHERWISE, SHALL BE:
   WHEN CAST AGAINST EARTH: = 3"
   UNLESS OTHERWISE NOTED: = 2"
5. REFER TO WALL CORNER AND WALL INTERSECTION REINFORCING DETAIL 0330-003. WALL CORNER REINFORCING SIZES AND SPACINGS SHALL BE AS SHOWN ON THE DRAWINGS AND REFERENCED TO THIS DETAIL. TYPICAL HORIZONTAL WALL REINFORCING SHALL LAP WITH THE CORNER HORIZONTAL REINFORCING.
6. 90 DEGREE BENDS, UNLESS OTHERWISE SHOWN, SHALL BE ACI 318 STANDARD HOOKS.
7. WALL FOOTING CORNER AND INTERSECTION REINFORCEMENT BARS SHALL BE EXTENDED INTO CONNECTING FOOTINGS AND LAPPED ON THE OPPOSITE FACE OF THE CONNECTING FOOTING. OUTSIDE FACE WALL FOOTING REINFORCEMENT SHALL BE LAPPED WITH CORNER BARS. ALL WALL FOOTING REINFORCEMENT SHALL BE CONTINUOUS THROUGH COLUMNS OR PILASTERS FOOTINGS.
8. LAP VERTICAL WALL BARS WITH DOWELS FROM BASE SLABS AND EXTEND INTO TOP FACE OF ROOF SLABS AND LAP WITH TOP SLAB REINFORCEMENT. PROVIDE A MINIMUM OF FOUR FULL HEIGHT VERTICAL BARS WITH MATCHING DOWELS AT WALL ENDS, CORNERS AND INTERSECTIONS WITH SIZE TO MATCH TYPICAL VERTICAL REINFORCING STEEL SHOWN OR REQUIRED BY NOTES ABOVE.
9. LOCATE ELEVATED SLAB AND BEAM TOP BAR SPLICES AT MIDSPAN AND BOTTOM BAR SPLICES AT SUPPORTS.
10. REINFORCING STEEL FOR FOOTINGS AND SLABS ON GRADE SHALL BE ADEQUATELY SUPPORTED ON BAR SUPPORTS WITH SPACERS TO KEEP REINFORCING ABOVE THE PREPARED GRADE. LIFTING REINFORCING OFF GRADE DURING CONCRETE PLACEMENT IS NOT PERMITTED.
11. REFER TO OPENING REINFORCING DETAILS 0330-001.
12. REINFORCEMENT BENDS AND LAPS, UNLESS OTHERWISE NOTED, SHALL SATISFY THE FOLLOWING MINIMUM REQUIREMENTS:

CONCRETE REINFORCING CONTINUED

CONCRETE DESIGN STRENGTH = 4,000 PSI MIN AT 28 DAYS GRADE 60 REINFORCING STEEL									
BAR SIZE		#3	#4	#5	#6	#7	#8	#9	#10	#11
LAP SPLICE LENGTH									
SPACING < 6"	TOP BAR [2]	1'-4"	1'-8"	2'-1"	3'-0"	5'-2"	6"-8"	8'-6"	10'-10"	13'-4"
	OTHER BAR	1'-4"	1'-4"	1'-8"	2'-4"	4'-0"	5'-2"	6'-7"	8'-4"	10'-3"
SPACING ≥ 6"	TOP BAR [2]	1'-4"	1'-8"	2'-0"	2'-5"	3'-6"	4'-0"	5'-0"	6'-2"	7'-5"
	OTHER BAR	1'-4"	1'-4"	1'-7"	1'-10"	2'-9"	3'-1"	3'-10"	4'-9"	5'-8"
EMBEDMENT LENGTH										
SPACING < 6"	TOP BAR [2]	1'-0"	1'-3"	1'-8"	2'-4"	4'-0"	5'-2"	6'-7"	8'-4"	10'-3"
	OTHER BAR	1'-0"	1'-0"	1'-3"	1'-10"	3'-1"	4'-0"	5'-1"	6'-5"	7'-11"
SPACING ≥ 6"	TOP BAR [2]	1'-0"	1'-3"	1'-7"	1'-10"	2'-9"	3'-1"	3'-10"	4'-9"	5'-8"
	OTHER BAR	1'-0"	1'-0"	1'-3"	1'-5"	2'-1"	2'-5"	3'-0"	3'-8"	4'-5"

1. LAP LENGTHS ARE BASED ON MINIMUM CONCRETE COVER OF 2". LONGER LENGTHS ARE REQUIRED FOR CONCRETE COVER LESS THAN 2".
2. TOP BARS SHALL BE DEFINED AS ANY HORIZONTAL BARS PLACED SUCH THAT MORE THAN 12 INCHES OF CONCRETE IS CAST IN THE MEMBER BELOW THE BAR IN ANY SINGLE POUR. HORIZONTAL WALL BARS ARE CONSIDERED TOP BARS.

CAST IN PLACE CONCRETE

1. 28-DAY COMPRESSIVE STRENGTHS AND MIX DESIGNS:
   LIQUID CONTAINING STRUCTURES = CMD1 - 4500 PSI
   UNLESS OTHERWISE NOTED = CMD2 - 4500 PSI
   DUCT BANKS AND PIPE ENCASEMENTS NOT INTEGRAL WITH FOUNDATIONS = CMD3 - 3500 PSI
   FIBER REINFORCED CONCRETE FILL (FRCF) = CMD4 - 3500 PSI
2. CONTINUOUS WATERSTOP AS SPECIFIED SHALL BE INSTALLED IN CONSTRUCTION JOINTS OF HYDRAULIC STRUCTURES, CHANNELS, AND BELOW GRADE STRUCTURES, EXCEPT WHERE SPECIFICALLY NOTED OTHERWISE.
3. CONSTRUCTION JOINTS INDICATED ARE SUGGESTED LOCATIONS. CONTRACTOR MAY REVISE LOCATION OF JOINTS, SUBJECT TO SPECIFIED REQUIREMENTS. LAYOUT SHOWING ALL CONSTRUCTION JOINT LOCATIONS SHALL BE SUBMITTED FOR REVIEW BY ENGINEER.
4. ROUGHEN AND CLEAN CONSTRUCTION JOINTS IN WALLS AND SLABS AS SPECIFIED PRIOR TO PLACING ADJACENT CONCRETE.
5. COORDINATE PLACEMENT OF OPENINGS, PIPE PENETRATIONS, CURBS, DOWELS, SLEEVES, CONDUITS, BOLTS AND INSERTS PRIOR TO PLACEMENT OF CONCRETE.
6. NO ALUMINUM CONDUIT OR PRODUCTS CONTAINING ALUMINUM OR ANY OTHER MATERIAL INJURIOUS TO THE CONCRETE SHALL BE EMBEDDED IN THE CONCRETE.
7. DO NOT PLACE CONDUIT PARALLEL TO BEAM OR COLUMN REINFORCEMENT UNLESS SPECIFICALLY INDICATED IN DRAWINGS.

NO.	DATE	DSGN	REVISION	CHK	APVD
		DR EVERSON	DR	PA KARABAN	C ANSON

BY APVD
DR EVERSON

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CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL
STRUCTURAL NOTES
SHEET 1 OF 2

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	01-G-0004
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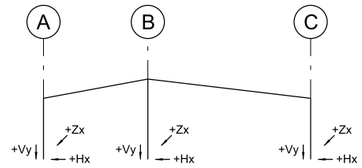
BID DOCUMENTS

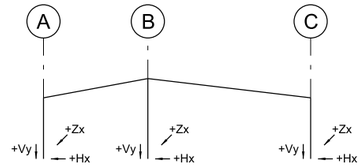
METAL BUILDING SYSTEMS

1. METAL BUILDING FOUNDATIONS HAVE BEEN DESIGNED FOR PRELIMINARY METAL BUILDING COLUMN REACTIONS SHOWN ON THE DRAWINGS. DO NOT CAST METAL BUILDING FOUNDATIONS UNTIL THEIR SIZES HAVE BEEN VERIFIED BY THE ENGINEER FOR THE ACTUAL COLUMN REACTIONS TO BE PROVIDED BY THE METAL BUILDING MANUFACTURER.
2. COLUMN ANCHOR BOLTS SHALL BE DESIGNED BY THE METAL BUILDING MANUFACTURER. ANCHORAGE DESIGN SHALL INCLUDE DETERMINATION OF ANCHOR BOLT MATERIAL, DIAMETER, EMBEDMENT DEPTH, QUANTITY, AND LAYOUT.
3. METAL BUILDING MANUFACTURER TO VERIFY THAT CONCRETE COLUMN PIER DIMENSIONS SHOWN ON THE DRAWINGS ARE LARGE ENOUGH TO ACCOMMODATE METAL BUILDING COLUMN BASE PLATES AND PROVIDE SUFFICIENT EDGE DISTANCE FOR COLUMN ANCHOR BOLTS.



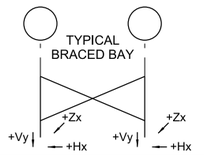
MAXIMUM SERVICE-LEVEL
COLUMN REACTION TABLE AT GRIDS 1 & 4

GRID	A			B			C		
TYPE	Hx	Vy	Zx	Hx	Vy	Zx	Hx	Vy	Zx
DL	0.1	1.4	-	0.3	3.3	-	-0.3	2.1	-
CLL	0.1	2.0	-	0.4	5.0	-	-0.4	3.1	-
RLL	0.1	2.7	-	0.5	6.6	-	-0.6	4.1	-
WL1	0.1	-9.2	-	5.3	-15.8	-6.6	-2.2	-12.4	-6.0
WL2	-0.7	-9.6	-	-12.2	-27.7	6.6	-13.0	-19.4	6.0



MAXIMUM SERVICE-LEVEL
COLUMN REACTION TABLE AT GRIDS 2 & 3

GRID	A			B			C		
TYPE	Hx	Vy	Zx	Hx	Vy	Zx	Hx	Vy	Zx
DL	0.1	2.7	-	0.5	6.6	-	-0.6	4.1	-
CLL	0.1	4.0	-	0.8	10.0	-	-0.9	6.1	-
RLL	0.1	5.3	-	1.1	13.3	-	-1.1	8.2	-
WL1	0.1	-18.5	-	10.4	-31.6	-	-4.3	-24.9	-
WL2	-1.4	-19.2	-	-24.4	-55.4	-	-25.8	-38.8	-



BRACE REACTIONS

GRID	A			B			C		
TYPE	Hx	Vy	Zx	Hx	Vy	Zx	Hx	Vy	Zx
WL 3	-10.6	-9.3	-	-14.4	-12.6	-	-11.4	-10.0	-

NOTES:
1. SEE DIAGRAM FOR DIRECTION OF LOADS APPLIED TO FOUNDATION.
2. CONTRACTOR SHALL SUBMIT FINAL COLUMN REACTIONS FROM BUILDING MFR PRIOR TO FOUNDATION CONSTRUCTION.

WELDING

1. WELDS SHALL CONFORM TO AMERICAN WELDING SOCIETY (AWS):
   D1.1, STRUCTURAL WELDING CODE STEEL
   D1.2, STRUCTURAL WELDING CODE ALUMINUM
   D1.3, STRUCTURAL WELDING CODE SHEET STEEL
   D1.4, STRUCTURAL WELDING CODE REINFORCING STEEL
   D1.6, STRUCTURAL WELDING CODE STAINLESS STEEL
2. REPAIR WELDS FOUND DEFECTIVE IN ACCORDANCE WITH AWS D1.1 SECTION 5.26.
3. USE INTERMITTENT WELDS AT FIELD WELDS OF EMBED PLATES AND ANGLES TO AVOID SPALLING OR CRACKING OF THE EXISTING CONCRETE.
4. BUTT JOINT WELDS SHALL BE COMPLETE JOINT PENETRATION (CJP) UNLESS INDICATED OTHERWISE.

STRUCTURAL STEEL AND METAL FABRICATIONS

1. STRUCTURAL STEEL SHALL CONFORM TO THE FOLLOWING ASTM STANDARDS:

W-SHAPES	A992
MISCELLANEOUS SHAPES INCLUDING ANGLES, CHANNELS, PLATES, ETC.	A36
HOLLOW STRUCTURAL SECTIONS (HSS)	A1085
STEEL PIPE	A53, GRADE B
STAINLESS STEEL SHAPES	A276

2. ALUMINUM SHALL CONFORM TO THE FOLLOWING ASTM STANDARDS:

STRUCTURAL SHAPES	B308 ALLOY 6061 T-6
PLATES	B209 ALLOY 6061 T-6

3. STRUCTURAL STEEL SHALL BE FABRICATED AND ERECTED IN CONFORMANCE WITH THE AISC MANUAL OF STEEL CONSTRUCTION, CURRENT EDITION, AND CURRENT OSHA STANDARDS.
4. FASTENERS SHALL BE HIGH STRENGTH BOLTS CONFORMING TO THE FOLLOWING ASTM STANDARDS EXCEPT WHERE SPECIFICALLY INDICATED OTHERWISE:

UNLESS SHOWN OTHERWISE	A325-N
SLIP CRITICAL	A325-SC
DIRECT TENSION INDICATORS OR LOAD INDICATOR WASHERS	ASTM F959
TENSION CONTROL (TC) BOLTS	ASTM A325 AND ASTM F1852
ANCHOR BOLTS (AB)	
STAINLESS STEEL	F593, AISI TYPE 316, CONDITION CW
STEEL OR GALVANIZED STEEL	F1554, GR 36 / A153
MACHINE BOLTS (MB)	
STEEL	A307
STAINLESS STEEL	F593, AISI TYPE 316, CONDITION CW
GALVANIZED STEEL	A307 / A153
ALUMINUM	F468, ALLOY 2024-T4

5. ITEMS TO BE EMBEDDED IN CONCRETE SHALL BE CLEAN AND FREE OF OIL, DIRT AND PAINT.
6. NO HOLES OTHER THAN THOSE SPECIFICALLY DETAILED SHALL BE ALLOWED THROUGH STRUCTURAL STEEL MEMBERS. NO CUTTING OR BURNING OF STRUCTURAL STEEL IS PERMITTED WITHOUT THE APPROVAL OF THE ENGINEER.

DEFERRED SUBMITTALS

1. DEFERRED SUBMITTALS ARE THOSE PORTIONS OF THE DESIGN WHICH ARE NOT SUBMITTED AT THE TIME OF PERMIT APPLICATION AND WHICH ARE TO BE SUBMITTED TO THE PERMITTING AGENCY FOR ACCEPTANCE PRIOR TO INSTALLATION OF THAT PORTION OF THE WORK OR ARE REQUIRED TO BE SUBMITTED FOR REVIEW ONLY BY THE ENGINEER.
2. WHERE DEFERRED SUBMITTALS INCLUDE ADDITIONAL MATERIALS, INSTALLATION, ANCHORAGE, OR CERTIFICATION OF COMPONENTS THAT REQUIRE SPECIAL INSPECTION AND/OR STRUCTURAL OBSERVATION TO MEET CODE REQUIREMENTS, THE DEFERRED SUBMITTAL SHALL INCLUDE SPECIFIC LINE ITEMS TO BE ADDED TO THE APPROPRIATE TABLES IN THE PROJECT'S STATEMENT OF SPECIAL INSPECTIONS PLAN IF THEY ARE NOT ALREADY IDENTIFIED.
3. THE FOLLOWING IS A LIST OF DEFERRED SUBMITTALS PER IBC SECTION 107.3.4.1 THAT ARE EXPECTED TO CONTAIN STRUCTURAL CALCULATIONS OR SAFETY RELATED SYSTEM INFORMATION FOR REVIEW TO MEET BUILDING PERMITTING REQUIREMENTS FOR DESIGNED SYSTEMS. PRIOR TO INSTALLATION OF THE INDICATED STRUCTURAL ELEMENT, EQUIPMENT, DISTRIBUTION SYSTEM, OR COMPONENT OR ITS ANCHORAGE, THE CONTRACTOR SHALL SUBMIT THE REQUIRED CALCULATIONS AND SUPPORTING DATA AND DRAWINGS FOR REVIEW AND ACCEPTANCE BY THE ENGINEER. ADDITIONALLY, ACCEPTANCE INDICATED ON THE ENGINEER'S COMMENT FORM, ALONG WITH THE COMPLETED, FINAL SUBMITTAL SHALL THEN BE SUBMITTED BY THE CONTRACTOR TO THE PERMITTING AGENCY AND APPROVED PRIOR TO INSTALLATION OF THESE ITEMS.

SPECIFICATION SECTION	CODE REQUIRED DEFERRED SUBMITTALS FOR REVIEW BY PERMITTING AGENCY
01 88 15	ANCHORAGE AND BRACING
05 50 00	METAL FABRICATIONS
05 52 16	ALUMINUM RAILING
06 82 00	GLASS FIBER REINFORCED PLASTIC
13 34 19	METAL BUILDING SYSTEMS
33 16 13.15	PRESTRESSED CONCRETE TANK WITH STEEL DIAPHRAGM
OTHER	ANY EQUIPMENT OR COMPONENT IN WHICH A TECHNICAL SPECIFICATION REQUIRES SUBMITTAL OF EQUIPMENT OR ANCHORAGE SYSTEM CALCULATIONS

STRUCTURAL ABBREVIATIONS

@	AT
AB	ANCHOR BOLT
ACI	AMERICAN CONCRETE INSTITUTION
ADDL	ADDITIONAL
ADJ	ADJACENT
AFF	ABOVE FINISH FLOOR
AHR	ANCHOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AL	ALUMINUM
ALLOW	ALLOWABLE
ALTN	ALTERNATE
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH.	ARCHITECTURAL
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWS	AMERICAN WELDING SOCIETY
BETW	BETWEEN
BF	BOTTOM FACE
BLDG	BUILDING
BM	BEAM
BO	BOTTOM OF
BOT	BOTTOM
BRG	BEARING
C	CHANNEL OR C-SHAPE
C TO C	CENTER TO CENTER
CHKD PL	CHECKERED PLATE
CIPC	CAST-IN-PLACE CONCRETE
CJ	CONSTRUCTION JOINT
CJP	COMPLETE JOINT PENETRATION (WELD)
CL	CENTERLINE
CLR	CLEARANCE, CLEAR
CMU	CONCRETE MASONRY UNIT
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUOUS
COORD	COORDINATE
CRSI	CONCERTE REINFORCING STEEL INSTITUTE
CTLJ	CONTROL JOINT
CTR	CENTER
CTRD	CENTERED
CU	CUBIC
d	PENNY (NAIL SIZE)
DBA	DEFORMED BAR ANCHOR
DBL	DOUBLE
DEG	DEGREE
DET	DETAIL
DF	DOUGLAS FIR
DIA	DIAMETER
DIAG	DIAGONAL
DIM.	DIMENSION
DIR	DIRECTION
DL	DEAD LOAD
DO	DITTO
DTI	DIRECT TENSION INDICATOR
DWG	DRAWING
DWL	DOWEL
EA	EACH
EF	EACH FACE
EJ	EXPANSION JOINT
EL	ELEVATION
ELEC	ELECTRICAL
ELEV	ELEVATOR
EMBED	EMBEDMENT, EMBED
ENGR	ENGINEER
EQL	EQUAL

STRUCTURAL ABBREVIATIONS CONTINUED

EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
EQUIV	EQUIVALENT
EW	EACH WAY
EXP JT	EXPANSION JOINT
EXST	EXISTING
EXT	EXTERIOR
FAB	FABRICATE, FABRICATION
FB	FLAT BAR
FD	FLOOR DRAIN
FDN	FDN
FF	FINISH FLOOR
FG	FINISH GRADE
FL	FLOOR
FRP	FIBERGLASS REINFORCED PLASTIC
FT	FEET, FOOT
FTG	FOOTING
FV	FIELD VERIFY
GA	GAUGE, GAGE
GALV	GALVANIZED (HOT DIP)
GLB	GLUE LAMINATED BEAM
GRTG	GRATING
GVL	GRAVEL
H.A.S.	HEADED ANCHOR STUD
HDR	HEADER
HORIZ	HORIZONTAL
HPT	HIGH POINT
HSS	HOLLOW STRUCTURAL SECTION
HVAC	HEATING , VENTILATION, AND AIR CONDITIONING
IBC	INTERNATIONAL BUILDING CODE
ID	INSIDE DIAMETER
I.F.	INSIDE FACE
IN.	INCH(ES)
INSUL	INSULATION
INTMD	INTERMEDIATE
INTR	INTERIOR
J	JOIST
JB	JOIST BEARING
JT	JOINT
KIP(S)	THOUSAND POUNDS
KSF	KIPS PER SQUARE FOOT
KSI	KIPS PER SQUARE INCH
L	ANGLE OR L-SHAPE
LB(S)	POUND(S) FORCE
LF	LINEAR FEET
LIW	LOAD INDICATING WASHER
LL	LIVE LOAD
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LNTL	LINTEL
LONG.	LONGITUDINAL
LPT	LOW POINT
LSL	LONG SLOTTED HOLE
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MECH	MECHANICAL
MET.	METAL
MFD	MANUFACTURED
MFR(S)	MANUFACTURER (MANUFACTURER'S)
MIN	MINIMUM
MISC	MISCELLANEOUS
MO	MASONRY OPENING
NA	NOT APPLICABLE
NIC	NOT IN CONTRACT
NO.	NUMBER
NTS	NOT TO SCALE
O TO O	OUT TO OUT
OC	ON CENTER
OD	OUTSIDE DIAMETER
O.F.	OUTSIDE FACE
OPNG(S)	OPENING(S)
OPP	OPPOSITE
P	PILASTER
PERIM	PERIMETER
PJF	PREMOLDED JOINT FILLER
PJP	PARTIAL JOINT PENETRATION (WELD)
PKG	PACKAGE
PL	PLATE
PLCS	PLACES
PLF	POUNDS FORCE PER LINEAR FOOT
PLYWD	PLYWOOD
PNL	PANEL
PRCST	PRECAST
PREFAB	PREFABRICATE(D)
PRELIM	PRELIMINARY
PRI	PRIMARY
PSF	POUNDS FORCE PER SQUARE FOOT
PSI	POUNDS FORCE PER SQUARE INCH
PT	PRESSURE TREATED
PVC	POLYVINYL CHLORIDE
R	RADIUS, RISER
RAD	RADIUS
RC	REINFORCED CONCRETE
RDAA	REBAR DOWEL ADHESIVE ANCHOR
RDW	REDWOOD
RECT	RECTANGULAR, RECTANGLE
REF	REFERENCE
REINF	REINFORCE, REINFORCEMENT
REQD	REQUIRED
RST	REINFORCING STEEL
S	I-BEAM
SC	SLIP CRITICAL (BOLTS)
SCHED	SCHEDULE
SECT.	SECTION
SH	SHEET
SIM	SIMILAR
SOG	SLAB ON GRADE
SP	SPACE
SPEC(S)	SPECIFICATION(S)
SPECD	SPECIFIED
SPG	SPACING
SQ	SQUARE
SSL	SHORT SLOTTED HOLE
SST	STAINLESS STEEL
STD	STANDARD
STIF	STIFFENER
STIR.	STIRRUP
STL	STEEL
STR	STRAIGHT
STRL	STRUCTURAL
STRUCT	STRUCTURE
SYMM	SYMMETRICAL
T	TREAD
T&B	TOP AND BOTTOM
TAS	THREADED ANCHOR STUD
TC	TOP OF CONCRETE, TOP OF CURB
TEMP	TEMPERATURE
TF	TOP OF FOOTING, TOP FACE
THK	THICK
THKNS	THICKNESS
THRU	THROUGH
TM	TOP OF MASONRY
T.O.	TOP OF
TRANSV	TRANSVERSE
TST	TOP OF STEEL
TW	TOP OF WALL
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UNIF	UNIFORM, UNIFORMLY
UON	UNLESS OTHERWISE NOTED
VERT	VERTICAL
W	WIDE FLANGE BEAM
W/	WITH
W/O	WITHOUT
WD	WOOD
WP	WORKING POINT
WS	WATERSTOP, WATER SURFACE
WT	WEIGHT
WWF	WELDED WIRE FABRIC

NOTES:
FOR ABBREVIATIONS NOT LISTED, SEE GENERAL ABBREVIATIONS AND ASME Y14.38 - "ABBREVIATIONS AND ACRONYMS FOR USE ON DRAWINGS AND RELATED DOCUMENTS" AS DISTRIBUTED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME).

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CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL
STRUCTURAL NOTES
SHEET 2 OF 2

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	01-G-0005
SHEET	05 of 76

BID DOCUMENTS

PIPE AND FITTING SYMBOLS

DOUBLE LINE	SINGLE LINE	
		EXISTING PIPE
		NEW PIPE
		ABANDONED PIPE
		EXISTING PIPE TO BE REMOVED
		WELDED JOINT
		FLANGED JOINT (OR GROOVED WHERE SPECIFICALLY NOTED)
		MECHANICAL JOINT & PROPRIETARY RESTRAINED JOINT
		BELL & SPIGOT JOINT (LEADED)
		HUB & SPIGOT JOINT (RUBBER GASKET)
		BALL JOINT
		FLANGED COUPLING ADAPTER
		FLEXIBLE COUPLING
		METAL BELLOWS EXP JOINT
		ELASTOMER BELLOWS EXP JOINT
		ELBOW UP
		ELBOW DOWN
		TEE UP
		TEE DOWN

DOUBLE LINE	SINGLE LINE	
		LATERAL UP
		LATERAL DOWN
		CONCENTRIC REDUCER
		ECCENTRIC REDUCER
		REDUCING BUSHING
		UNION
		CAP
		ANCHOR
		ELBOW, 90 DEGREE
		CROSS
		TEE
		ELBOW, 45 DEGREE
		LATERAL

NOTES:

1. ONLY FLANGED END CONNECTIONS ARE SHOWN HERE FOR DOUBLE LINE FITTINGS. FITTINGS WITH OTHER END PATTERNS ARE SHOWN SIMILARLY ON THE CONSTRUCTION DRAWINGS. ALSO SEE SECTION 40 27 00.
2. SYMBOLS SHOWN HERE FOR SINGLE LINE FITTINGS ARE GENERIC ONLY. REFER TO PIPING SPECIFICATIONS FOR SPECIFIC END CONNECTIONS FOR SINGLE LINE PIPE AND FITTINGS.
3. EXISTING PIPE AND EQUIPMENT IS SHOWN LIGHT-LINED AND/OR SCREENED AND IS NOTED AS EXISTING. NEW PIPING AND EQUIPMENT IS SHOWN HEAVY-LINED.

VALVE SYMBOLS

SINGLE LINE	DOUBLE LINE
GATE	
BUTTERFLY	OR
GLOBE	
BALL	
PLUG	OR
NEEDLE	
DIAPHRAGM	
SWING CHECK	

HOSE VALVE (HV- X) OR (V-X)
X = NO. IN SPECS

SAMPLE

MUD

PRESSURE RELIEF

AIR AND/OR VACUUM RELEASE

REGULATED SIDE

PRESSURE CONTROL (INTERNAL PILOT)

REGULATED SIDE

PRESSURE CONTROL (EXTERNAL PILOT)

MULTI-PORT VALVE,
ARROWS INDICATE FLOW PATTERN.
SEATING PORTS ARE IMPLIED BY
INDICATED FLOW PATTERN.

TELESCOPING SCUM VALVE

VALVE DESIGNATIONS

MANUAL VALVES AND CHECK VALVES

16"-V405

VALVE SIZE

VALVE TYPE, SEE
SECTION 40 27 02 FOR TYPE DEFINITION

CONTROL VALVES

NOTE: SEE I&C LEGEND SHEETS FOR TAGGING REQUIREMENTS.
SEE VALVE SCHEDULE.

SELF-CONTAINED REGULATING VALVES

NOTE: SEE I&C LEGEND SHEETS FOR TAGGING REQUIREMENTS.
SEE VALVE SCHEDULE.

PIPING SERVICE DESIGNATION

EXAMPLE:

16" WAS

16" WAS

SERVICE- SEE I&C LEGEND SHEETS OR PIPING SCHEDULE FOR ABBREVIATION MEANING

NOMINAL PIPE DIAMETER

OTHER SYMBOLS

PIPE TERMINATION

APPROXIMATE GRADE ELEVATION

MECHANICAL LEGEND AND NOTES

1. LAY PIPE TO UNIFORM GRADE BETWEEN INDICATED ELEVATION POINTS.
2. SIZE OF FITTINGS SHOWN ON DRAWINGS SHALL CORRESPOND TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE INDICATED. TYPE OF JOINT AND FITTING MATERIAL SHALL BE THE SAME AS SHOWN FOR ADJACENT STRAIGHT RUN OF PIPE.
3. LOCATION AND NUMBER OF PIPE HANGERS AND PIPE SUPPORTS SHOWN IS ONLY APPROXIMATE. CONTRACTOR SHALL DESIGN SUPPORTS AS SPECIFIED.
4. ALL JOINTS SHALL BE WATERTIGHT. WALL PIPES SHALL BE USED WHEREVER PIPING PASSES FROM A STRUCTURE TO BACKFILL.
5. ALL FLEXIBLE CONNECTORS AND COUPLING ADAPTERS SHALL BE PROVIDED WITH THRUST PROTECTION AS SPECIFIED, UNLESS OTHERWISE NOTED. THRUST PROTECTION SHALL BE ADEQUATE FOR TEST PRESSURES SPECIFIED.
6. SYMBOLS, LEGENDS, AND PIPE USE IDENTIFICATIONS SHOWN SHALL BE FOLLOWED THROUGHOUT THE DRAWINGS, WHEREVER APPLICABLE. NOT ALL OF THE VARIOUS PIPING COMPONENTS ARE NECESSARILY USED IN THE PROJECT.
7. PRIOR TO LEAKAGE TESING, PIPE TO BE FULLY RESTRAINED.
8. NUMBER AND LOCATION OF UNIONS SHOWN ON DRAWINGS IS ONLY APPROXIMATE. PROVIDE ALL UNIONS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT.
9. WHERE A GROOVED END COUPLING IS SHOWN, IT SHALL BE THE RIGID JOINT TYPE, UNLESS OTHERWISE SPECIFIED. WHERE A FLANGED COUPLING ADAPTER IS SHOWN, A STANDARD FLANGE SHALL BE JOINED TO THE COUPLING ADAPTER.
10. ALL PIPES PASSING THROUGH FIRE RATED WALLS SHALL BE INSTALLED TO MEET APPLICABLE UL SYSTEM REQUIREMENTS PERTAINING TO THE TYPE OF CONSTRUCTION. REFER TO ACHRITECTURAL DRAWINGS FOR WALLS WHICH ARE FIRE RATED.
11. AT TERMINATION OF PIPE ENCASEMENT AND AT BURIED CONNECTIONS WITH FACILITIES, PROVIDE FLEXIBILITY PROVISIONS IN ACCORDANCE WITH SECTION 40 27 01, PROCESS PIPING SPECIALTIES.

NO.	DATE	REVISION	DR	CHK	APVD
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CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL
PROCESS MECHANICAL LEGEND

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
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DWG	01-G-0006
SHEET	06 of 76

BID DOCUMENTS

HEATING, VENTILATING, AND AIR CONDITIONING PIPE AND FITTING SYMBOLS

DOUBLE LINE	SINGLE LINE	
		EXISTING PIPE (SCREENED)
		NEW PIPE
		EXISTING PIPE TO BE ABANDONED
		EXISTING PIPE TO BE REMOVED
		WELDED JOINT
		GROOVED END JOINT
		FLANGED JOINT
		FLEXIBLE COUPLING
		GROOVED END
		GROOVED END ADAPTER FLANGE
		STEEL BELLOWS EXP JOINT
		ELBOW UP
		ELBOW DOWN
		TEE UP
		TEE DOWN
		LATERAL UP
		LATERAL DOWN
		CONCENTRIC REDUCER
		ECCENTRIC REDUCER
		UNION
		ANCHOR
		PIPE ALIGNMENT GUIDE
		FLEXIBLE (ELASTOMER) PIPE CONNECTION

NOTES:

1. ONLY FLANGED FITTINGS ARE SHOWN FOR DOUBLE LINE PIPING. FITTINGS WITH OTER END PATTERNS ARE SIMILAR.
2. EXISTING PIPING AND EQUIPMENT IS SHOWN LIGHT LINED AND/OR SCREENED AND IS NOTED AS EXISTING. NEW PIPING AND EQUIPMENT IS SHOWN HEAVY-LINED.-

ON MULI-DICIPLINE PROJECTS, WHERE PIPE, FITTING, VALVE, AND FLOW STREAM IDENTIFICATION LEGENDS ARE PROVIDED IN MECHANICAL OR I & C, DO NOT REPEAT THEM ON THE HVAC LEGEND SHEET.

VALVE SYMBOLS

SINGLE LINE	DOUBLE LINE
GATE	
BUTTERFLY	OR
GLOBE	OR
BALL	OR
SEATING PORT	
ECCENTRIC PLUG	OR
PLUG OR COCK	OR
NEEDLE	OR
SWING CHECK	OR
BALL CHECK	OR

- BALANCING FITTING
- COMBINATION FLOWMETER AND BALANCING FITTING
- COMBINATION FLOWMETER, BALANCING FITTING AND SHUT-OFF VALVE (S.O.)
- PRESSURE RELIEF
- AIR VENT (AUTO)
- AIR VENT (MANUAL)
- REGULATED SIDE PRESSURE CONTROL
- MULTI-PORT VALVE (GLOBE VALVE SHOWN. FOR OTHER VALVE TYPES, APPROPRIATE VALVE SYMBOL SHOWN). ARROWS INDICATE FLOW PATTERN. SEATING PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- SOLENOID VALVE
- TO TEMPERATURE SENSOR
- TEMPERATURE SENSING VALVE

MISCELLANEOUS PIPING SYMBOLS

- STEAM TRAP X = NO. IN SPECS
- FLOW SWITCH
- FLOW METER X = NO. SHOWN IN SPECS
- PRESSURE SWITCH
- STRAINER
- GAUGE WITH COCK
- THERMOMETER
- GAUGE GLASS WITH COCKS

VALVE DESIGNATIONS

MANUAL VALVES AND CHECK VALVES

V 400
- VALVE TYPE, SEE SPECIFICATIONS
- VALVE DESIGNATION

CONTROL VALVES

- ACTUATOR SYMBOL
- FLOW DIRECTION
- VALVE SYMBOL
- FLOW DIRECTION

HVAC EQUIPMENT IDENTIFICATION

ACC	AIR-COOLED CONDENSER
ACCU	AIR-COOLED CONDENSING UNIT
ACU	AIR CONDITIONING UNIT
AHU	AIR HANDLING UNIT
AWC	ABSORPTION WATER CHILLER
BC	BOOSTER HEATING COIL
BD	BUTTERFLY DAMPER
CD	CEILING DIFFUSER
CG	CEILING GRILLE
CR	CEILING REGISTER
CHWP	CHILLED WATER PUMP
CR	CEILING REGISTER
CRP	CONDENSATE RETURN PUMP
CRU	CONDENSATE RETURN UNIT
CT	COOLING TOWER
CTP	COOLING TOWER PUMP
CUH	CABINET UNIT HEATER
CWP	CONDENSER WATER PUMP
DA	DEARATOR
DG	DOOR GRILLE
ECP	ENVIRONMENTAL CONTROL PANEL
EDH	ELECTRIC DUCT HEATER
EF	EXHAUST FAN
EUH	ELECTRIC UNIT HEATER
FG	FLOOR GRILLE
FD	FIRE DAMPER
HRU	HEAT RECOVERY UNIT
HCG	HIGH-CAPACITY GRILLE
HCSG	HIGH-CAPACITY SUPPLY GRILLE
HTP	HEAT PUMP
HU	HUMIDIFIER
HTR	HIGH THROW REGISTER
HWP	HEATING WATER PUMP
HX	HEAT EXCHANGER
LD	LINEAR DIFFUSER
MD	MOTORIZED DAMPER
ML	MOTORIZED LOUVER
OBD	OPPOSED BLADE DAMPER
PCG	PERFORATED CEILING GRILLE
PCD	PERFORATED CEILING DIFFUSER
PEF	PORTABLE EXHAUST FAN
RAC	ROOM AIR CONDITIONER
SF	SUPPLY FAN
SD	SLOT DIFFUSER
TAC	TERMINAL AIR CONDITIONER
TCU	TERMINAL CONTROL UNIT
UH	UNIT HEATER
WC	WATER CHILLER
WCC	WATER-COOLED CONDENSER
WCCU	WATER-COOLED CONDENSING UNIT
WG	WALL GRILLE
WR	WALL REGISTER
WSG	WATER SUPPLY GRILLE
WSHP	WATER SOURCE HEAT PUMP
WSR	WALL SUPPLY REGISTER

NOTE:
ABBREVIATIONS ARE SHOWN ON GENERAL LEGENDS.

FLOW STREAM IDENTIFICATION

IDENTIFICATION	SERVICE
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CO	CONDENSATE DRAIN
CTR	COOLING TOWER RETURN
CTS	COOLING TOWER SUPPLY
HPR	HIGH PRESSURE RETURN (CONDENSATE)
HPS	HIGH PRESSURE STEAM
HWR	HEATING WATER RETURN
HWS	HEATING WATER SUPPLY
LPR	LOW PRESSURE RETURN (CONDENSATE)
LPS	LOW PRESSURE STEAM
MPR	MEDIUM PRESSURE RETURN (CONDENSATE)
MPS	MEDIUM PRESSURE STEAM
RHG	REFRIGERANT HOT GAS
RL	REFRIGERANT LIQUID
RS	REFRIGERANT SUCTION

NOTE:
FLOW STREAM IDENTIFICATION ARE SHOWN ON INSTRUMENTATION & CONTROL LEGENDS.

HEATING, VENTILATING, AND AIR CONDITIONING SYMBOLS

- WALL REGISTER OR GRILLE (SUPPLY)
- CEILING DIFFUSER OR REGISTER (SUPPLY)
- CEILING REGISTER OR GRILLE (RETURN AND EXHAUST)
- WALL REGISTER OR GRILLE (RETURN AND EXHAUST)
- TURNING VANES
- 45 DEGREE ENTRY
- CONICAL TEE
- BELLMOUTH
- SD — SMOKE DAMPER
- FD — FIRE DAMPER
- MANUAL OPPOSED-BLADE DAMPER
- MANUAL BUTTERFLY DAMPER
- M — MOTORIZED DAMPER
- SOUND ATTENUATED DUCT
- FLEXIBLE CONNECTION
- FLEXIBLE DUCTWORK
- R — INCLINED RISE IN DUCT
- D — INCLINED DROP IN DUCT
- SUPPLY DUCT (SECTION)
- INTAKE, RETURN, OR EXHAUST DUCT (SECTION)
- T — ROOM TEMPERATURE SENSOR
- P — ROOM PRESSURE SENSOR
- H — ROOM HUMIDITY SENSOR
- ECP — ENVIRONMENTAL CONTROL PANEL
- (200) — 200 SCFM
- M — MOTORIZED VALVE - 3 WAY
- M — MOTORIZED VALVE - 2 WAY

NO.	DATE	DSGN
	REVISION	BY
DR	J BIEDA	APVD
CHK	KL DIAZ	APVD
	A VALIENTE	APVD
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SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL
HVAC LEGEND

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

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ONE-LINE DIAGRAM

SYMBOL	DESCRIPTION
	DRAWOUT AIR CIRCUIT BREAKER, LOW VOLTAGE
400	CIRCUIT BREAKER, THERMAL MAGNETIC TRIP SHOWN, 3 POLE, UNO
AF / AT	CIRCUIT BREAKER, STATIC TRIP UNIT, SENSOR AMP TRIP AND FRAME RATINGS SHOWN, 3 POLE, UNO
100/M	CIRCUIT BREAKER, MAGNETIC TRIP ONLY, TRIP RATING SHOWN, 3 POLE, UNO
400 400	CIRCUIT BREAKER WITH CURRENT LIMITING FUSES, TRIP AND FUSE RATING INDICATED, 3 POLE, UNO
400 225	FUSED SWITCH, SWITCH AND FUSE CURRENT RATING INDICATED, 3 POLE, UNO
100	SWITCH, CURRENT RATING INDICATED, 3 POLE, UNO
60 (3)	FUSE, CURRENT RATING AND QUANTITY INDICATED
1	MAGNETIC STARTER WITH OVERLOAD, NEMA SIZE INDICATED, FVNR UNO
AFD	ELECTRONIC STARTER/SPEED CONTROL RVSS = REDUCED VOLTAGE SOFT STARTER AFD = AC ADJUSTABLE FREQUENCY DRIVE DC = DC ADJUSTABLE SPEED DRIVE RVAT = REDUCED VOLTAGE AUTO TRANSFORMER TYPE RVRT = REDUCED VOLTAGE REACTOR TYPE
	CABLE OR BUS CONNECTION POINT
K	KEY INTERLOCK
3	AC MOTOR, SQUIRREL CAGE INDUCTION - HORSEPOWER INDICATED
G 500/625	GENERATOR, KW/KVA RATING SHOWN
VS V 0-600V	ANALOG METER WITH SWITCH - SCALE RANGE SHOWN V = VOLTAGE KW = KILOWATTS A = AMPERAGE KVAR = KILOVARS PF = POWER FACTOR
DPM	DIGITAL POWER METER (MULTIFUNCTION)
	UTILITY REVENUE METER
	GROUND
15 KVA 480-120/240V 1 PH	TRANSFORMER, SIZE, VOLTAGE RATINGS, AND PHASE INDICATED
480-120V (3)	POTENTIAL TRANSFORMER, VOLTAGE RATING AND QUANTITY INDICATED
100:5 (3)	CURRENT TRANSFORMER, RATIO(100:5) AND QUANTITY INDICATED (3)
	CONNECTION POINT TO EQUIPMENT SPECIFIED IN OTHER DIVISIONS. RACEWAY, CONDUCTOR AND CONNECTION IN THIS DIVISION
SPD	SURGE PROTECTIVE DEVICE

POWER SYSTEM PLAN

SYMBOL	DESCRIPTION
	CONNECTION POINT TO EQUIPMENT SPECIFIED. RACEWAY, CONDUCTOR,TERMINATION AND CONNECTION IN THIS DIVISION.
MCC-A	MAJOR ELECTRICAL COMPONENT OR DEVICE - NAME OR IDENTIFYING SYMBOL AS SHOWN.
LPXXA	PANELBOARD - SURFACE MOUNTED PANELBOARD LETTER OR NUMBER FACILITY NUMBER LP - LOW VOLTAGE PANEL DP - DISTRIBUTION PANEL
	PANELBOARD - FLUSH MOUNTED
	TERMINAL JUNCTION BOX
M	MOTOR, SQUIRREL CAGE INDUCTION
G	GENERATOR, VOLTAGE AND SIZE AS INDICATED.
LPXXA	HOME RUN - DESTINATION SHOWN
or /G	EXPOSED CONDUIT AND CONDUCTORS*
or /G	CONCEALED CONDUIT AND CONDUCTORS*

NOTE:
ALL UNMARKED CONDUIT RUNS CONSIST OF TWO NO. 12, ONE NO. 12 GROUND CONDUCTORS IN 3/4" CONDUIT. RUNS MARKED WITH CROSSHATCHES INDICATE NUMBER OF NO. 12 CONDUCTORS. CROSSHATCH WITH SUBSCRIPT "G" INDICATES GREEN GROUND WIRE.

/G	CROSSHATCHES WITH BAR INDICATE NO.10 CONDUCTOR. SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
[A1]	CONDUIT AND CONDUCTOR CALLOUT, SEE LEGEND.
	CONDUIT DOWN
	CONDUIT UP
	CONDUIT, STUBBED AND CAPPED
	CONDUIT TERMINATION AT CABLE TRAY
EX	EXISTING CONDUIT/ DUCT BANK
BD	BUS DUCT - SEE SPECIFICATIONS
CE	CONCRETE ENCASED CONDUIT
DB	DIRECT BURIED CONDUIT
FO	FIBER OPTIC CONDUIT
XXXX	CONCRETE ENCASED DUCT BANK WHERE XXXX IS THE DUCT BANK NAME. SEE CIRCUIT AND RACEWAY CODING DEFINITION
T	TRANSFORMER
J or HH	GENERAL CONTROL OR WIRING DEVICE. LETTER SYMBOLS OR ABBREVIATIONS INDICATE TYPE OF DEVICE
CS	CONTROL STATION, SEE CONTROL DIAGRAMS FOR CONTROL DEVICE(S) REQUIRED.
30	NONFUSED DISCONNECT SWITCH, CURRENT RATING INDICATED, 3 POLE
60/40	FUSED DISCONNECT SWITCH, CURRENT RATING INDICATED (60/40, 60=SWITCH RATING / 40=FUSE RATING) 3 POLE
2	COMBINATION CIRCUIT BREAKER AND MAGNETIC STARTER, NEMA SIZE INDICATED

POWER SYSTEM PLAN

SYMBOL	DESCRIPTION
100/40	BREAKER, SEPARATELY MOUNTED, CURRENT RATING INDICATED (100/40, 100 = FRAME SIZE; 40 = TRIP RATING) 3 POLE
C 2	CONTACTOR, MAGNETIC, NEMA SIZE INDICATED
L 30	LIGHTING CONTACTOR, CURRENT RATING INDICATED
2	STARTER, MAGNETIC NEMA SIZE INDICATED
XX 2	CONVENIENCE RECEPTACLE - DUPLEX UNLESS NOTED OTHERWISE WP - WEATHERPROOF C - CLOCK HANGER TL - TWIST LOCK CRE - CORROSION RESISTANT GFCI - GROUND FAULT CIRCUIT INTERRUPTER SUBSCRIPT NUMBER AT RECEPTACLE INDICATES CIRCUIT

GROUND SYSTEM PLAN

	GROUND ROD
	GROUND ROD IN TEST WELL
G	GROUNDING CONDUCTOR, SIZE AS INDICATED
	PIGTAIL FOR CONNECTION TO EQUIPMENT CABINET OR FRAME
G	EQUIPMENT GROUND BUS
N	EQUIPMENT NEUTRAL BUS

LIGHTING SYSTEM PLAN

	LUMINAIRE
	LUMINAIRE WITH INTERNAL BATTERY BACKUP
4 or 4	LUMINAIRE AND POLE, SEE SCHEDULE
5 or 5	WALL MOUNTED LUMINAIRE, SEE SCHEDULE
1	FLOOD LIGHTS - AIM IN THE DIRECTION SHOWN
	STANDBY LIGHTING UNIT, SURFACE MOUNTED, SEE SCHEDULE
XX or	EXIT LIGHTS - FILLED SECTION INDICATES LIGHTED FACE, ARROW INDICATES EGRESS DIRECTIONAL INDICATORS, XX = FIXTURE NUMBER, SEE SCHEDULE
$ a or 2a	SMALL LETTER SUBSCRIPT AT SWITCH AND LUMINAIRE INDICATES SWITCHING. SUBSCRIPT NUMBER AT LUMINAIRE INDICATES CIRCUIT
$3	WALL SWITCH: 2- DOUBLE POLE P- PILOT LIGHT 3- THREE WAY K- KEY OPERATED 4- FOUR WAY D- DIMMER WP- WEATHERPROOF CRE- CORROSION RESISTANT EX- EXPLOSIONPROOF L- MOMENTARY 3-WAY M- MOTOR RATED MS- MANUAL STARTER WITH OVERLOADS
OS	OCCUPANCY SENSOR
LC	LIGHTING CONTACTOR
MD	MOTION DETECTOR
PC	PHOTOCELL

COMBINED TELEPHONE/COMPUTER SYSTEM PLAN AND RISER

SYMBOL	DESCRIPTION
4	COMBINATION TELEPHONE/DATA RECEPTACLE, WALL MOUNTED, NUMBER OF PORTS INDICATED
4	COMBINATION TELEPHONE/DATA RECEPTACLE, FLOOR BOX, NUMBER OR PORTS INDICATED

TELEPHONE SYSTEM PLAN AND RISER

TTC	TELEPHONE TERMINAL CABINET
	TELEPHONE RECEPTACLE FLOOR BOX
	TELEPHONE RECEPTACLE

NOTES:

1. THESE ARE STANDARD LEGEND SHEETS. SOME SYMBOLS AND ABBREVIATIONS MAY APPEAR ON THE LEGEND AND NOT ON THE DRAWINGS.
2. FOR ADDITIONAL ABBREVIATIONS OF OTHER DIVISIONS (HVAC, MECHANICAL, AND STRUCTURAL/ARCHITECTURAL) SEE OTHER LEGENDS.

NO.	DATE	DSGN	REVISION	CHK	DR
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GENERAL
ELECTRICAL LEGEND
SHEET 1 OF 2

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CIRCUIT AND RACEWAY

GENERAL CIRCUIT CONDUCTOR AND CONDUIT IDENTIFICATION

POWER CIRCUIT CALLOUTS			
[P1]	[1/2"FLEX, 2#12, #12G]	[P27]	[1"C, 2#6, 1#10G]
[P2]	[3/4"C, 2#12, 1#12G]	[P28]	[1"C, 3#6, 1#8G]
[P3]	[3/4"C, 3#12, 1#12G]	[P29]	[1"C, 3#6, 2#14, 1#8G]
[P4]	[3/4"C, 4#12, 1#12G]	[P30]	[1"C, 3#6, 3#14, 1#8G]
[P5]	[3/4"C, 5#12, 1#12G]	[P31]	[1"C, 3#6, 4#14, 1#8G]
[P6]	[3/4"C, 6#12, 1#12G]	[P32]	[1"C, 3#6, 5#14, 1#8G]
[P7]	[3/4"C, 7#12, 1#12G]	[P33]	[1"C, 4#6, 1#8G]
[P8]	[3/4"C, 8#12, 1#12G]	[P34]	[1-1/4"C, 3#4, 1#8G]
[P9]	[3/4"C, 3#12, 2#14, 1#12G]	[P35]	[1-1/4"C, 3#4, 5#14, 1#8G]
[P10]	[3/4"C, 3#12, 3#14, 1#12G]	[P36]	[1-1/4"C, 3#3, 1#6G]
[P11]	[3/4"C, 3#12, 4#14, 1#12G]	[P37]	[1-1/4"C, 3#3, 3#14, 1#6G]
[P12]	[3/4"C, 4#12, 2#14, 1#14G]	[P38]	[1-1/4"C, 3#2, 1#6G]
[P13]	[3/4"C, 4#12, 4#14, 1#14G]	[P39]	[1-1/4"C, 3#1, 1#6G]
[P14]	[3/4"C, 4#12, 12#14, 1#14G]	[P40]	[1-1/2"C, 4#1, 1#6G]
[P15]	[3/4"C, 2#10, 1#10G]	[P41]	[1-1/2"C, 3#2/0, 1#4G]
[P16]	[3/4"C, 3#10, 1#10G]	[P42]	[2"C, 3#3/0, 1#4G]
[P17]	[3/4"C, 4#10, 1#10G]	[P43]	[2"C, 3#4/0, 1#4G]
[P18]	[3/4"C, 3#10, 3#14, 1#10G]	[P44]	[2-1/2"C, 3-350KCMIL, 1#3G]
[P19]	[3/4"C, 3#10, 6#14, 1#10G]		
[P20]	[3/4"C, 3#10, 10#14, 1#10G]		
[P21]	[1"C, 2#8, 1#10G]		
[P22]	[1"C, 3#8, 1#10G]		
[P23]	[1"C, 3#8, 2#14, 1#10G]		
[P24]	[1"C, 3#8, 3#14, 1#10G]		
[P25]	[1"C, 3#8, 4#14, 1#10G]		
[P26]	[1"C, 3#8, 14#14, 1#10G]		

MULTICONDUCTOR POWER CABLE CIRCUIT CALLOUTS	
[PV12]	[1"C, 1 (3C#12, 1#12G/S) TYPE 8]
[PV10]	[1-1/4"C, 1 (3C#10, 1#10G/S) TYPE 8]
[PV8]	[1-1/2"C, 1 (3C#8, 1#8G/S) TYPE 8]

EMPTY CONDUIT	
[EC-1]	[3/4"C, WITH PULL STRING]
[EC-2]	[1"C, WITH PULL STRING]
[EC-3]	[1-1/4"C, WITH PULL STRING]
[EC-4]	[1-1/2"C, WITH PULL STRING]
[EC-5]	[2"C, WITH PULL STRING]
[EC-6]	[3"C, WITH PULL STRING]
[EC-7]	[4"C, WITH PULL STRING]
[EC-8]	[5"C, WITH PULL STRING]

ANALOG CIRCUIT CALLOUTS	
[A1]	[3/4"C, 1 TYPE 3]
[A2]	[1"C, 2 TYPE 3]
[A3]	[1"C, 3 TYPE 3]
[A4]	[1"C, 4 TYPE 3]
[A5]	[1-1/4"C, 5 TYPE 3]
[A6]	[1-1/4"C, 6 TYPE 3]
[A7]	[1-1/2"C, 7 TYPE 3]
[A8]	[1-1/2"C, 8 TYPE 3]
[A9]	[1-1/2"C, 9 TYPE 3]
[A10]	[2"C, 10 TYPE 3]
[A11]	[2"C, 11 TYPE 3]
[A12]	[2"C, 12 TYPE 3]
[A13]	[2"C, 13 TYPE 3]
[A14]	[2"C, 14 TYPE 3]
[A15]	[3/4"C, 1 TYPE 4]
[A16]	[3/4"C, 2 TYPE 4]
[A17]	[1"C, 3 TYPE 4]
[A18]	[1-1/4"C, 4 TYPE 4]
[A19]	[1-1/4"C, 5 TYPE 4]
[A20]	[1-1/4"C, 6 TYPE 4]
[A21]	[1-1/2"C, 7 TYPE 4]
[A22]	[1-1/2"C, 8 TYPE 4]
[A23]	[2"C, 9 TYPE 4]
[A24]	[3/4"C, 1-4 pr. TYPE 5]
[A25]	[1"C, 2-4 pr. TYPE 5]
[A26]	[1"C, CAT 6e]

CONTROL CIRCUIT CALLOUTS	
[C1]	[3/4"C, MSC]
[C2]	[3/4"C, 2#14, 1#14G]
[C3]	[3/4"C, 3#14, 1#14G]
[C4]	[3/4"C, 4#14, 1#14G]
[C5]	[3/4"C, 5#14, 1#14G]
[C6]	[3/4"C, 6#14, 1#14G]
[C7]	[3/4"C, 7#14, 1#14G]
[C8]	[3/4"C, 8#14, 1#14G]
[C9]	[3/4"C, 9#14, 1#14G]
[C10]	[3/4"C, 10#14, 1#14G]
[C11]	[3/4"C, 11#14, 1#14G]
[C12]	[3/4"C, 12#14, 1#14G]
[C13]	[3/4"C, 13#14, 1#14G]
[C14]	[3/4"C, 14#14, 1#14G]
[C15]	[3/4"C, 15#14, 1#14G]
[C16]	[3/4"C, 16#14, 1#14G]
[C17]	[3/4"C, 17#14, 1#14G]
[C18]	[3/4"C, 18#14, 1#14G]
[C19]	[3/4"C, 19#14, 1#14G]
[C20]	[1"C, 20#14, 1#14G]
[C21]	[1"C, 21#14, 1#14G]
[C22]	[1"C, 22#14, 1#14G]
[C23]	[1"C, 23#14, 1#14G]
[C24]	[1"C, 24#14, 1#14G]
[C25]	[1"C, 25#14, 1#14G]
[C36]	[1 1/2"C, 36#14, 1#14G]
[C40]	[1 1/2"C, 40#14, 1#14G]

MULTICONDUCTOR CONTROL CABLE CIRCUIT CALLOUTS	
[CC5]	[3/4"C,1-5C TYPE 1]
[CC7]	[3/4"C,1-7C TYPE 1]
[CC9]	[1"C,1-9C TYPE 1]
[CC12]	[1"C,1-12C TYPE 1]
[CC19]	[1-1/2"C, 1-19C TYPE 1]
[CC25]	[1-1/2"C,1-25C TYPE 1]
[CC37]	[2"C,1-37C TYPE 1]
[CCC1]	[1-7C #12 TYPE 1]

NOTES:

1. FOR CABLE TYPES, SEE SPECIFICATIONS.
2. CONDUIT SIZES ARE BASE ON THE AREA OF THW CONDUCTORS.
3. SIZING OF CONDUCTORS #1AWG AND SMALLER BASED ON AMPACITIES AT 60 DEGREES C, SIZING OF CONDUCTORS #1/0AWG AND LARGER BASED ON AMPACITIES AT 75 DEGREES C.
4. WHERE CIRCUITS ARE UNDERGROUND, DIRECT BURIED OR CONCRETE ENCASED, MINIMUM CONDUIT SIZE SHALL BE 1".
5. FOR METRIC CONDUIT SIZES USE THE FOLLOWING CONVERSION:
   1/2" = 16 mm 1/4" = 35 mm
   3/4" = 21 mm 1 1/2" = 41 mm
   1" = 27 mm 2" = 53 mm

ABBREVIATION DESCRIPTION ABBREVIATION DESCRIPTION

ABBREVIATIONS

A	AMPERE, AUTOMATIC	KA	KILOAMPERES
AC	ALTERNATING CURRENT	KV	KILOVOLT
AFD	ADJUSTABLE FREQUENCY DRIVE	KVA	KILOVOLT AMPERES
AFF	ABOVE FINISHED FLOOR	KW	KILOWATTS
ATS	AUTOMATIC TRANSFER SWITCH	M	MAGNETIC CONTACTOR COIL, MOTOR, MANUAL
BKR	BREAKER	MCC	MOTOR CONTROL CENTER
C	CONDUIT, CONTACTOR, CONDUCTOR, CLOSE	MH	MANHOLE, METAL HALIDE, MOUNTING HEIGHT
CPT	CONTROL POWER TRANSFORMER	NC	NORMALLY CLOSED
CR	CONTROL RELAY	N.O.	NORMALLY OPEN
CT	CURRENT TRANSFORMER, CABLE TRAY	NTS	NOT TO SCALE
DC	DIRECT CURRENT	OL	OVERLOAD RELAY
DP	DISTRIBUTION PANEL	PB	PULL BOX
E	EMPTY	RGS	RIGID GALVANIZED STEEL CONDUIT
F, FU	FUSE	SS	START STOP
FREQ	FREQUENCY	SST	STAINLESS STEEL
G	GROUND	SV	SOLENOID VALVE
GEN	GENERATOR	SWBD	SWITCHBOARD
GFCI	GROUND FAULT CIRCUIT INTERRUPTER	TYP	TYPICAL
GND	GROUND	V	VOLTAGE, VOLTS
HH	HANDHOLE	W	WATTS
HOA	HAND-OFF-AUTO	WP	WEATHERPROOF
HP	HORSEPOWER	XFMR	TRANSFORMER
HS	HAND SWITCH		
HZ	HERTZ		
IC	INTERRUPTING CAPACITY		
J, JB	JUNCTION BOX		

LUMINAIRE SCHEDULE

LUMINAIRE SCHEDULE

FIXTURE TYPE	VOLTAGE	LAMP TYPE	TOTAL INPUT WATTS	TOTAL OUTPUT LUMENS	MOUNT	DESCRIPTION	MAKE/MODEL
A	120/277V UNIVERSAL DRIVER	LED	131	18000	PENDANT	LED HIGH BAY LUMINAIRE, METAL FORMED STEEL OR ALUMINUM CONSTRUCTION, -40°C TO 65°C OPERATING TEMPERATURE, 5000K COLOR TEMPERATURE, 80CRI, CLEAR GLASS LENS, MEDIUM LIGHT DISTRIBUTION, WET LOCATION LISTED, 5 YEAR WARRANTY.	LITHONIA JHBL SERIES JHBL-18000LM-GL-MD-MVOLT-50K-80CRI
B	120/277V UNIVERSAL DRIVER	LED	92	12000	PENDANT	LED HIGH BAY LUMINAIRE, METAL FORMED STEEL OR ALUMINUM CONSTRUCTION, -40°C TO 55°C OPERATING TEMPERATURE, 5000K COLOR TEMPERATURE, 80CRI, CLEAR GLASS LENS, MEDIUM LIGHT DISTRIBUTION, WET LOCATION LISTED, 5 YEAR WARRANTY.	LITHONIA JEBL SERIES JEBL-12000LM-GL-MVOLT-50K-80CRI
C	120/277V UNIVERSAL DRIVER	LED	17	2000	WALL	LED WALL-MOUNTED LUMINAIRE, DIE-CAST ALUMINUM HOUSING, POWDER COAT FINISH, -30°C TO 40°C OPERATING TEMPERATURE, 3000K COLOR TEMPERATURE, 80CRI, RECESSED LENS, DOWNWARD AND FORWARD DISTRIBUTION, IP65 RATED, 5 YEAR WARRANTY. FURNISH WITH INTEGRAL PHOTOCELL CONTROL.	LITHONIA ARC LED SERIES ARC1 LED-P-30K-MVOLT-PE
D	120/277V UNIVERSAL DRIVER	LED	138	15000	POLE	LED AREA LUMINAIRE, POWDER COATED DIE-CAST ALUMINUM HOUSING, NATURAL ALUMINUM FINISH, -29°C TO 40°C OPERATING TEMPERATURE, 3000K COLOR TEMPERATURE, 70CRI, PRECISION-MOLDED CLEAR ACRYLIC LENS, TYPE 3 SHORT DISTRIBUTION, UL 1598 WET LOCATION LISTED, 5 YEAR WARRANTY.	LITHONIA DSX SERIES DSX1 LED-P5-30K-T3S-MVOLT-RPA AND RSA-20-SC POLE
E	120/277V UNIVERSAL DRIVER WITH EMERGENCY BATTERY PACK	LED	1.2	536	WALL OR CLOUMN	LED STANDBY EMERGENCY LUMINAIRE, WHITE ENGINEERING GRADE THERMOPLASTIC HOUSING, -18°C TO 32°C OPERATING TEMPERATURE, IMPACT RESISTANT, CORROSION-PROOF, DAMP LOCATION RATED, 3 YEAR WARRANTY. EMERGENCY BATTERY PACK INCLUDED	LITHONIA ELM6 LED SERIES ELM6 LED W LP03VS-DL
F	120/277V UNIVERSAL DRIVER	LED	183	20000	POLE	LED AREA LUMINAIRE, POWDER COATED DIE-CAST ALUMINUM HOUSING, NATURAL ALUMINUM FINISH, -29°C TO 40°C OPERATING TEMPERATURE, 3000K COLOR TEMPERATURE, 70CRI, PRECISION-MOLDED CLEAR ACRYLIC LENS, FORWARD THROW DISTRIBUTION, UL 1598 WET LOCATION LISTED, 5 YEAR WARRANTY.	LITHONIA DSX SERIES DSX1 LED-P7-30K-TFTM-MVOLT-RPA WITH AST35-390 TENON AND RSA-30-6G POLE
G	120/277V UNIVERSAL DRIVER	LED	102	13500	WALL	LED AREA LUMINAIRE, POWDER COATED DIE-CAST ALUMINUM HOUSING, NATURAL ALUMINUM FINISH, -29°C TO 40°C OPERATING TEMPERATURE, 3000K COLOR TEMPERATURE, 70CRI, PRECISION-MOLDED CLEAR ACRYLIC LENS, FORWARD THROW MEDIUM DISTRIBUTION, UL 1598 WET LOCATION LISTED, 5 YEAR WARRANTY.	LITHONIA DSX SERIES DSX1 LED-P3-30K-TFTM-MVOLT-WBA
X	120/277V WITH EMERGENCY BATTERY PACK	LED	4	N/A	UNIVERSAL	LED EMERGENCY EXIT SIGN, CAST-ALUMINUM HOUSING, SINGLE WHITE ALUMINUM FACEPLATE WITH DIRECTIONAL CHEVRON KNOCKOUTS, UNIVERSAL MOUNT, -30°C TO 50°C OPERATING TEMPERATURE, NEMA 4X, NEMA 4X, WET LOCATION RATED, RATED FOR CLASS I DIV II ENVIRONMENT, 5 YEAR WARRANTY. FURNISH WITH EMERGENCY BATTERY PACK RATED FOR 90 MINUTES OPERATION, AND SELF-DIAGNOSTIC FUNCTIONALITY.	CROUSE-HINDS UX LED UX-7-1-SD-HAZ

NO.	DATE	REVISION	CHK	DR
DSGN	KB HORTON	G MESSER	D NICHOLSON	KB HORTON
		BY	APVD	

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GENERAL
ELECTRICAL LEGEND
SHEET 2 OF 2

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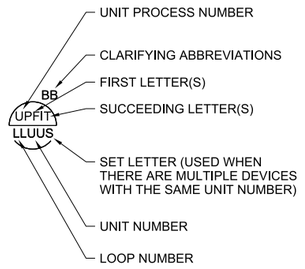
INSTRUMENT IDENTIFICATION

EXAMPLE SYMBOLS



DIGITAL SYSTEM INTERFACES

- ▲ ANALOG INPUT
- ▼ ANALOG OUTPUT
- $\triangle_X$ DISCRETE INPUT
- ∇_X DISCRETE OUTPUT

INSTRUMENT IDENTIFICATION LETTERS TABLE

LETTER	FIRST-LETTER		SUCCEEDING-LETTERS		
	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	READOUT OR PASSIVE FUNCTION	READOUT OR PASSIVE FUNCTION
A	ANALYSIS (+)		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
C	USER'S CHOICE (*)			CONTROL	
D	DENSITY (S.G.)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT, SENSOR		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE (*)		GLASS, GAUGE VIEWING DEVICE	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
O	USER'S CHOICE (*)		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD OR PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTI VARIABLE		MULTI FUNCTION	MULTI FUNCTION	MULTI FUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	ALARM	X AXIS	UNCLASSIFIED (*)	UNCLASSIFIED (*)	UNCLASSIFIED (*)
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

TABLE BASED ON THE INTERNATIONAL SOCIETY OF AUTOMATION (ISA) STANDARD.

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.
(*) WHEN USED, DEFINE THE MEANING HERE FOR THE PROJECT.

GENERAL INSTRUMENT OR FUNCTIONAL SYMBOLS

- FIELD MOUNTED
- REAR-OF-PANEL MOUNTED (OPERATOR INACCESSIBLE)
- PANEL MOUNTED (OPERATOR ACCESSIBLE)
- MCC MOUNTED
- COMPUTER FUNCTION
- PLC FUNCTION
- SHARED DISPLAY, SHARED CONTROL

TRANSDUCERS

A	ANALOG	I	CURRENT
D	DIGITAL	P	PNEUMATIC
E	VOLTAGE	PF	PULSE FREQUENCY
F	FREQUENCY	PD	PULSE DURATION
H	HYDRAULIC	R	RESISTANCE

EXAMPLE

CURRENT TO PNEUMATIC TRANSDUCER (BACK OF PANEL, IN A FLOW LOOP)

ACCESSORY DEVICES

A	ALARM
C	CONTROLLER
I	INDICATOR
R	RECORDER
S	SWITCH
T	TRANSMITTER
X	UNCLASSIFIED

EXAMPLE

TRANSMITTER AS AN ACCESSORY TO A FLOW ELEMENT

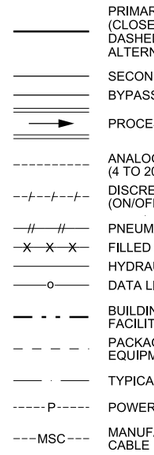
SPECIAL CASES

ON AND OFF EVENT LIGHTS

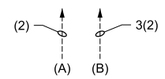
ON-OFF HAND SWITCH, MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).

STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).

LINE LEGEND



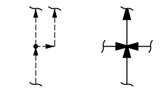
PARALLELING LINES



(A) TOTAL OF 2 SIGNALS

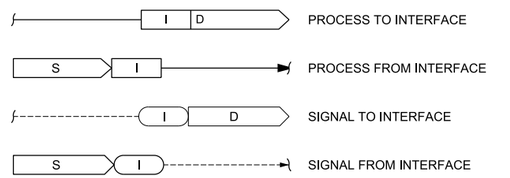
(B) 3 TYPICAL SETS OF 2 SIGNALS EACH. TOTAL OF 6 SIGNALS.

CONNECTING LINES

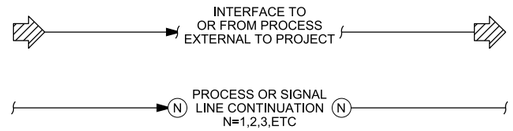


NON-CONNECTING LINES

INTERFACE SYMBOLS



- I INTERFACE IDENTIFIER
- D DESTINATION DRAWING NO.
- S SOURCE DRAWING NO.



SELF CONTAINED VALVE & EQUIPMENT TAG NUMBERS

W-D-X-Y

W		UNIT PROCESS NUMBER
D	ARV	AIR RELEASE VALVE
	AVRV	AIR AND VACUUM RELEASE VALVE
	CONV	CONVEYOR
	E	EJECTOR
	G	GATE
	M	MECHANICAL EQUIPMENT
	MIX	MIXER
	P	PUMP
	SSH	SAFETY SHOWER
	T	TANK
X		LOOP NUMBER
Y		UNIT NUMBER

ABBREVIATIONS & LETTER SYMBOLS

AC	ALTERNATING CURRENT
AM	AUTO-MANUAL
CAM	COMPUTER-AUTO-MANUAL
CCS	CENTRAL CONTROL SYSTEM
CL_2 etc.	CHLORINE (TYPICAL: USE STANDARD CHEMICAL ELEMENT ABBREVIATIONS)
CM	COMPUTER-MANUAL
COD	CHEMICAL OXYGEN DEMAND
CP-X	CONTROL PANEL NO. X
DC	DIRECT CURRENT
DCS	DISTRIBUTED CONTROL SYSTEM
DCU	DISTRIBUTED CONTROL UNIT
DO	DISSOLVED OXYGEN
FCL_2	FREE CHLORINE RESIDUAL
FOS	FAST-OFF-SLOW
FOSA	FAST-OFF-SLOW-AUTO
FOSR	FAST-OFF-SLOW-REMOTE
FP-W-X	FIELD PANEL NO. WX (W=UNIT PROCESS NUMBER X=PANEL NUMBER)
FR	FORWARD-REVERSE
FTR	FILTRATE
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
ISR	INTRINSICALLY SAFE RELAY
LEL	LOWER EXPLOSIVE LIMIT
LOS	LOCKOUT STOP
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MC	MODULATE-CLOSE
MCC-X	MOTOR CONTROL CENTER NO. X
MSC	MANUFACTURER SUPPLIED CABLE
OC	OPEN-CLOSE(D)
OCA	OPEN-CLOSE-AUTO
OCR	OPEN-CLOSE-REMOTE
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN-STOP-CLOSE
pH	HYDROGEN ION CONCENTRATION
PLC	PROGRAMMABLE LOGIC CONTROLLER
RIO	REMOTE I/O UNIT
RM-X	REMOTE MULTIPLEXING MODULE NO. X
RTU-X	REMOTE TELEMETRY UNIT NO. X
SF	SLOWER-FASTER
SS	START-STOP
SSC	SUPERVISORY SET POINT CONTROL
TCL_2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANIC CARBON
TOD	TOTAL OXYGEN DEMAND
TURB	TURBIDITY
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
Δ	DIFFERENCE
Σ	SUM
×	MULTIPLY
÷	DIVIDE
F(X)	CHARACTERIZED
X^n	RAISED TO THE Nth POWER
$\sqrt{\ }$	SQUARE ROOT
AVG	AVERAGE
1:1	REPEAT OR BOOST
>	SELECT HIGHEST SIGNAL
<	SELECT LOWEST SIGNAL
}	BIAS
%	GAIN OR ATTENUATE

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A SINGLE ASTERISK (∗) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (∗∗) ARE TO BE PROVIDED UNDER DIVISION 26, ELECTRICAL.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THE PROJECT.

NO.	DATE	REVISION	DSGN
DR	C HARRIS	A PASTRANA	C SAHARKHIZ
CHK	C SAHARKHIZ	APVD	C SAHARKHIZ
BY	APVD		

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CRESTVIEW, FL

GENERAL
INSTRUMENTATION AND CONTROL
LEGEND SHEET 1

BID DOCUMENTS

NTS	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
PROJ	D3403200
DWG	01-G-0010
SHEET	10 of 76

VALVE SYMBOLS

- GATE
- KNIFE GATE
- BUTTERFLY
- GLOBE
- BALL
- V VEE-BALL
- PLUG
- SEAT PORT ECCENTRIC PLUG
- DIAPHRAGM
- PINCH
- NEEDLE
- SWING CHECK
- BALL CHECK
- BACKFLOW PREVENTER
- ROTARY
- TELESCOPE
- S SAMPLE
- MUD
- PRESSURE RELIEF
- AIR AND/OR VACUUM RELEASE
- REGULATED SIDE PRESSURE CONTROL
- PRESSURE REGULATION (CLAY-TYPE)
- MULTI-PORT VALVE (GATE VALVE SHOWN. FOR OTHER VALVE TYPES, APPROPRIATE VALVE SYMBOL SHOWN.) SEAT PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- ANGLE GATE

GATE SYMBOLS

- SLUICE
- BUTTERFLY
- FABRICATED SLIDE
- FLAP
- STOP LOG
- SHEAR

ACTUATOR SYMBOLS

- PNEUMATIC DIAPHRAGM SPRING-OPPOSED, SINGLE OR DOUBLE ACTING
- PNEUMATIC CYLINDER SINGLE OR DOUBLE ACTING ACTUATED BY ONE INPUT
- M ELECTRIC MOTOR
- S SOLENOID
- VALVE POSITIONER
- H HYDRAULIC
- DIAPHRAGM, DIFFERENTIAL PRESSURE
- E/H ELECTROHYDRAULIC
- MANUAL

NOTE:
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL, OR HYDRAULIC)

XX: FO FAIL OPEN
FC FAIL CLOSED
FLP FAIL TO LAST POSITION

PRIMARY ELEMENT SYMBOLS

- PARSHALL FLUME
- WEIR
- ORFICE PLATE
- FLOW TUBE
- PITOT-STATIC
- VORTEX METER
- ULTRASONIC FLOWMETER
- M ELECTROMAGNETIC FLOWMETER
- PROPELLER OR TURBINE METER
- THERMAL FLOWMETER
- LEVEL (BUBBLER TUBE)
- LS LEVEL (FLOAT)
- FI ROTAMETER
- DE DENSITY METER
- XX GENERIC
- LE LEVEL

MISCELLANEOUS SYMBOLS

- V VENT TO ATMOSPHERE
- AIR GAP
- T DRIP TRAP
- PIG INSERT POINT
- PIG CATCH POINT
- A SELF CONTAINED AIR SUPPLY
- AP AIR PURGE SET
- F FLUSHING CONNECTION
- S SEAL WATER SET
- WP WATER PURGE SET
- FLEXIBLE CONNECTION
- AERATOR
- DIAPHRAGM SEAL
- ANNULAR DIAPHRAGM SEAL
- SS COMPOSITE SAMPLER
- FLAME TRAP
- CALIBRATION COLUMN
- S INLINE SILENCER
- BLIND FLANGE
- PIPE CAP
- STRAINER
- BASKET STRAINER
- FILTER
- PULSATION DAMPENER
- EXPANSION CHAMBER

- FFLCPLLLX PANEL NAME; PANEL OUTLINE; PANEL CONTINUED ON SAME OR OTHER DRAWING
- 120V 120 VOLT, 60 HZ POWER
- 480V 480 VOLT, 60 HZ POWER
- XX AIR SET XX = SUPPLY PRESSURE IN PSIG.
- PLUG
- RECEPTACLE
- RUPTURE DISK (VACUUM)
- RUPTURE DISK (PRESSURE)
- TV TV MONITOR
- TV TV CAMERA
- A, B AND C LOGIC ELEMENT: IF A AND NOT B THEN C
- A, B OR C LOGIC ELEMENT: IF A OR B THEN C
- RADIO ANTENNA
- I OR I INTERLOCK, SEE CONTROL DIAGRAMS
- VOICE COMMUNICATION POINT
- SKIMMING MECHANISM
- SCREW CONVEYOR
- MIXER
- ELECTRIC MOTOR

PUMP AND COMPRESSOR SYMBOLS

- CENTRIFUGAL PUMP (DRY PIT) XX
- CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP XX
- RECIPROCATING OR METERING PUMP (POSITIVE DISPLACEMENT) XX
- DIAPHRAGM PUMP XX
- GEAR PUMP OR BLOWER (POSITIVE DISPLACEMENT) XX
- PROGESSING CAVITY PUMP XX
- COMPRESSOR (CENTRIFUGAL) XX
- COMPRESSOR (PISTON) XX
- BLOWER OR FAN (CENTRIFUGAL) XX
- EJECTOR
- PISTON PUMP XX
- SUBMERSIBLE SUMP PUMP XX
- ROTARY PUMP
- VACUUM PUMP
- SCREW PUMP

XX: AS ADJUSTABLE SPEED
CS-1 CONSTANT SPEED (SINGLE SPEED)
CS-2 CONSTANT SPEED (TWO SPEED)

LINE SIZE AND MATERIAL IDENTIFICATION

(FOR REFERENCE ONLY. SEE SITE AND MECHANICAL DRAWINGS)

6" DR
PIPE DIAMETER (INCHES)
FLOWSTEAM IDENTIFICATION

FLOW STREAM IDENTIFICATION

DR DRAIN
DSC DIGESTED SLUDGE CAKE
DS DIGESTED SLUDGE

FTR FILTRATE

OF OVERFLOW

POLY POLYMER
POS POLYMER SOLUTION

SA SAMPLE

V VENT

W1 NO. 1 (POTABLE) WATER
W2 NO. 2 (NON-POTABLE) WATER
W3 NO.3 (REUSE) WATER
WAS WASTE ACTIVATED SLUDGE

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
		C HARRIS	A PASTRANA	C SAHARKHIZ	APVD	C SAHARKHIZ	

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CITY OF CRESTVIEW
CRESTVIEW, FL

GENERAL
INSTRUMENTATION AND CONTROL
LEGEND SHEET 2

BID DOCUMENTS

NTS	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
PROJ	D3403200
DWG	01-G-0011
SHEET	11 of 76

PROPOSED STABILIZED ROAD TO NEW ARENA ROAD, BY OTHERS
CONCRETE PAVEMENT
CANTILEVER SLIDE GATE
PROPERTY LINE (TYP)
40 - DEWATERING BUILDING
20 - AEROBIC DIGESTER NO. 3
20 - AEROBIC DIGESTER NO. 4
DEMOLISH SLUDGE DRYING BEDS AND USE AREA AS CONTRACTOR STAGING AREA
30 - BIOSOLID FEED PUMP STATION
25 - INTERMEDIATE SLUDGE TRANSFER PUMP STATION
CONCRETE SIDEWALK
CHAIN LINK FENCE
ASPHALT PAVEMENT
CANTILEVER SLIDE GATE
CONTROL PT #50023 N 637 690.19 E 1 310 207.41
SURFACE RESTORATION
CONTROL PT #50116 N 637 681.53 E 1 310.577.69
PROPERTY LINE (TYP)
SECTION LINE
FUTURE SPLITTER BOX
FUTURE MASTER LIFT STATION FLOW METER
CONTROL PT #50069 N 637 492.60 E 1 310 571.53
FUTURE GRIT REMOVAL
FUTURE STATIC SCREEN
PLANT DRAIN PUMP STATION
CONTROL PT #50022 N 637 501.50 E 1 310 243.71
FUTURE RAS / WAS PUMP STATION
FUTURE SECONDARY CLARIFIER 3
FUTURE SECONDARY CLARIFIER 4
FUTURE SCUM PUMP STATION
FUTURE ANOXIC & AERATION BASIN
FUTURE ANOXIC & AERATION BASIN
FUTURE ROAD
STORMWATER CONTROL STRUCTURE
STORMWATER BASIN
STORMWATER INLET AND PIPE (TYP)
TERTIARY FILTER
W-3 PUMP STATION
TERTIARY PUMP STATION
DOG HOUSE MANHOLE OVER EXISTING 30" EFFLUENT MAIN TO SPRAY FIELDS
RIB PUMP STATION (16" PLE FORCEMAIN TO RIB SITE)
LIMEROCK STABILIZED EARTHEN DRIVE AND LINEAR POND TREATMENT TO RIB SITE
EXISTING ARENA ROAD TO BE VACATED PER ILA & PARCEL 109 PURCHASE AGREEMENT AFTER CONSTRUCTION OF NEW ARENA ROAD
6' CHAIN LINK FENCE W/ BARB WIRE (TYP)
STORMWATER SWALE (TYP)
EARTHEN ROAD
EFFLUENT METER VAULT
HYDRO-PNEUMATIC TANK
CHLORINE CONTACT BASIN

N
0 40 80 120
Scale In Feet

NO.	DATE	DSGN	DR	REVISION	CHK	APVD	BY	APVD
			C CHILDRESS		A MALONE			R MORRISON

25 W CEDAR STREET, SUITE 350
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CIVIL
OVERALL SITE PLAN

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
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GRAVEL CONSTRUCTION ENTRANCE
3125-130

PROPERTY LINE (TYP)

SILT FENCE, TYP
3125-165

DEMOLISH ABANDONED POWER POLE AND WIRE TO THE WEST

DEMOLISH CHAIN LINK FENCE AND GATES

DEMOLISH CURB AND GUTTER

DEMOLISH LIGHT POLE

CONTROL PT
#50023
N 637 690.19
E 1 310 207.41

DEMOLISH SIDEWALK FOR YARD PIPING

DEMOLISH EXISTING 2" WATERLINE AND REPLACE WITH NEW 4"

DEMOLISH EXISTING 4" DRAIN

DEMOLISH CURB AND GUTTER

DEMOLISH CURB AND ASPHALT FOR YARD PIPING

MATCH LINE - SEE DWG 05-C-1002

ARENA ROAD
GENERATOR
ELECTRIC BUILDING
ADMINISTRATIVE BUILDING
CHLORINE BUILDING
SLUDGE DIGESTER
ASPHALT PAVEMENT
SANITARY SEWER MANHOLE #7
PANEL STATION
LIFT STATION
SANITARY SEWER MANHOLE #6
AERATION BASIN
GATE POST
UE
SSFM

N

0 20 40 60
Scale In Feet

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN	R MORRISON		C CHILDRESS	A MALONE			R MORRISON

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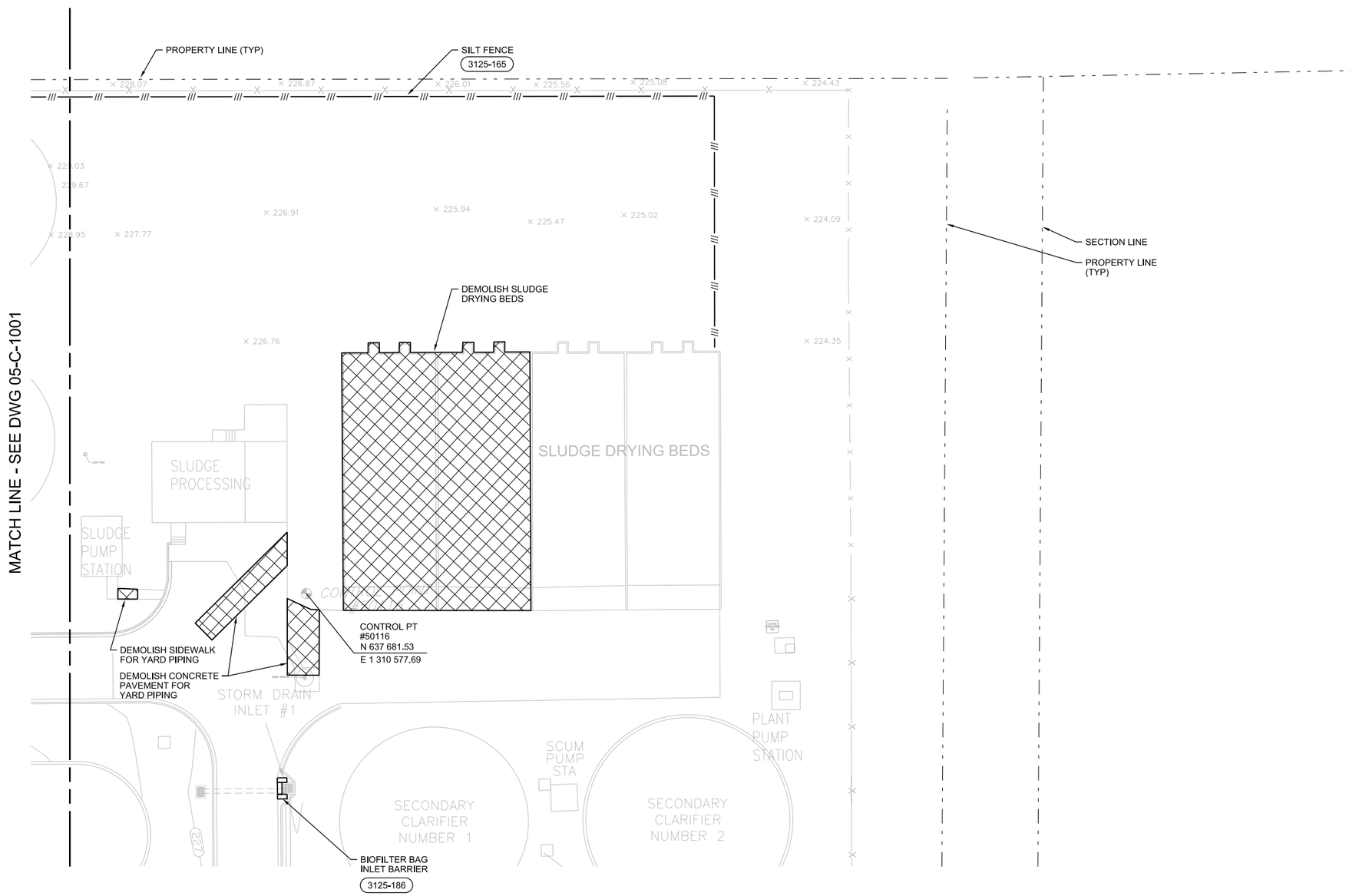
CRESTVIEW, FL

CIVIL
DEMOLITION AND EROSION CONTROL PLAN

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-C-1001
SHEET	13 of 76



N

0 20 40 60
Scale In Feet

NO.	DATE	DR	REVISION	CHK	BY
DSGN	R MORRISON	C CHILDRESS		A MALONE	R MORRISON
				APVD	APVD

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BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-C-1002
SHEET	14 of 76

CONCRETE STANDARD CURB (3216-315)
ROUTE NW DOWNSPOUT ONTO DRIVEWAY
APPROXIMATE NORTH FENCE LINE
40 - DEWATERING BUILDING TOC = 235.00 AT DOCK SLAB (SEE NOTE 1)
PROPERTY LINE (TYP)
ROUTE NE DOWNSPOUT INTO DITCH
SLOPE TO EXISTING DIRT ROAD. (SEE NOTE 2)
CONCRETE PAVEMENT (3213-240)
PRECAST CONCRETE WHEEL STOP (3217-350)
10' x 40' CONCRETE DOOR LANDING (3213-220)
CENTERLINE OF SODDED DITCH, 3:1 MAXIMUM SIDE SLOPES. (SEE NOTE 1)
CONNECT TO EXISTING DIRT ROAD. MATCH EXISTING ELEVATION 233.00± (SEE NOTE 2)
ELECTRICAL DUCT BANK, TYP SEE 05-E-SERIES DWGS
45' WIDE CANTILEVER SLIDE GATE (3231-415)
STANDARD CONCRETE CURB AND GUTTER (3216-310)
4' WIDE CONCRETE SIDEWALK (3213-220)
A 05-C-3001
CONNECT TO EXISTING ASPHALT. MATCH EXISTING ELEVATION 233.82± (SEE NOTE 2)
3' CURB ENDING TRANSITION
YARD PIPING, TYP. SEE 05-Y-SERIES DWGS
30 - BIOSOLID FEED PUMP STATION TOC = 231.00 (SEE NOTE 1)
CHAIN LINK FENCE (3231-410)
BOLLARD (3471-810)
ASPHALT PAVEMENT (3212-210)
SPILL-OUT CONCRETE CURB AND GUTTER (3216-310)
SLOPE CONSISTENT WITH EXISTING PAVEMENT. (SEE NOTE 2)
SLOPE 1% MIN TO EXISTING PAVEMENT (SEE NOTE 2)
45' WIDE CANTILEVER SLIDE GATE (3231-415)
CONTROL PT #50023 N 637 690.19 E 1 310 207.41
RESTORE EXISTING SIDEWALK (3213-220)
RESTORE EXISTING CONCRETE CURB AND GUTTER (3216-310)
DAYLIGHT DITCH AT TOP OF EXISTING CURB EL = 29.3± (SEE NOTE 1) (3216-340)
ASPHALT SURFACE RESTORATION (3123-115)
NEW 1' LONG SECTION OF DROP CURB WITH 1.5' LONG TRANSITIONS TO EXISTING CURB
FUTURE SPLITTER BOX
FUTURE MASTER LIFT STATION FLOW METER
SEE DWG 05-C-2002
MATCH LINE - SEE D

ARENA ROAD
ELECTRIC BUILDING
ADMINISTRATIVE BUILDING
CHLORINE BUILDING
SLUDGE DIGESTER
ASPHALT PAVEMENT
SANITARY SEWER MANHOLE #7
RANEY STATION
LIFT STATION
SANITARY SEWER MANHOLE #6
AERATION BASIN

NOTES:

1. THE FACILITY SLAB ELEVATIONS AND ASSOCIATED GRADING ARE BASED ON THE SPORATIC SPOT ELEVATIONS SHOWN. FIELD VERIFY THE EXISTING GROUND ELEVATION PRIOR TO CONSTRUCTION.
2. THE ROAD GRADING IS BASED ON PREVIOUS RECORD DRAWINGS WITH A DIFFERENT VERTICAL DATUM. EXISTING ELEVATIONS ARE ASSUMED BASED ON REVIEW OF THOSE DRAWINGS. FIELD VERIFY THE EXISTING GROUND ELEVATION PROIR TO CONSTRUCTION.

N
0 20 40 60
Scale In Feet

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
	R MORRISON		C CHILDRESS	A MALONE	APVD	R MORRISON	

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SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
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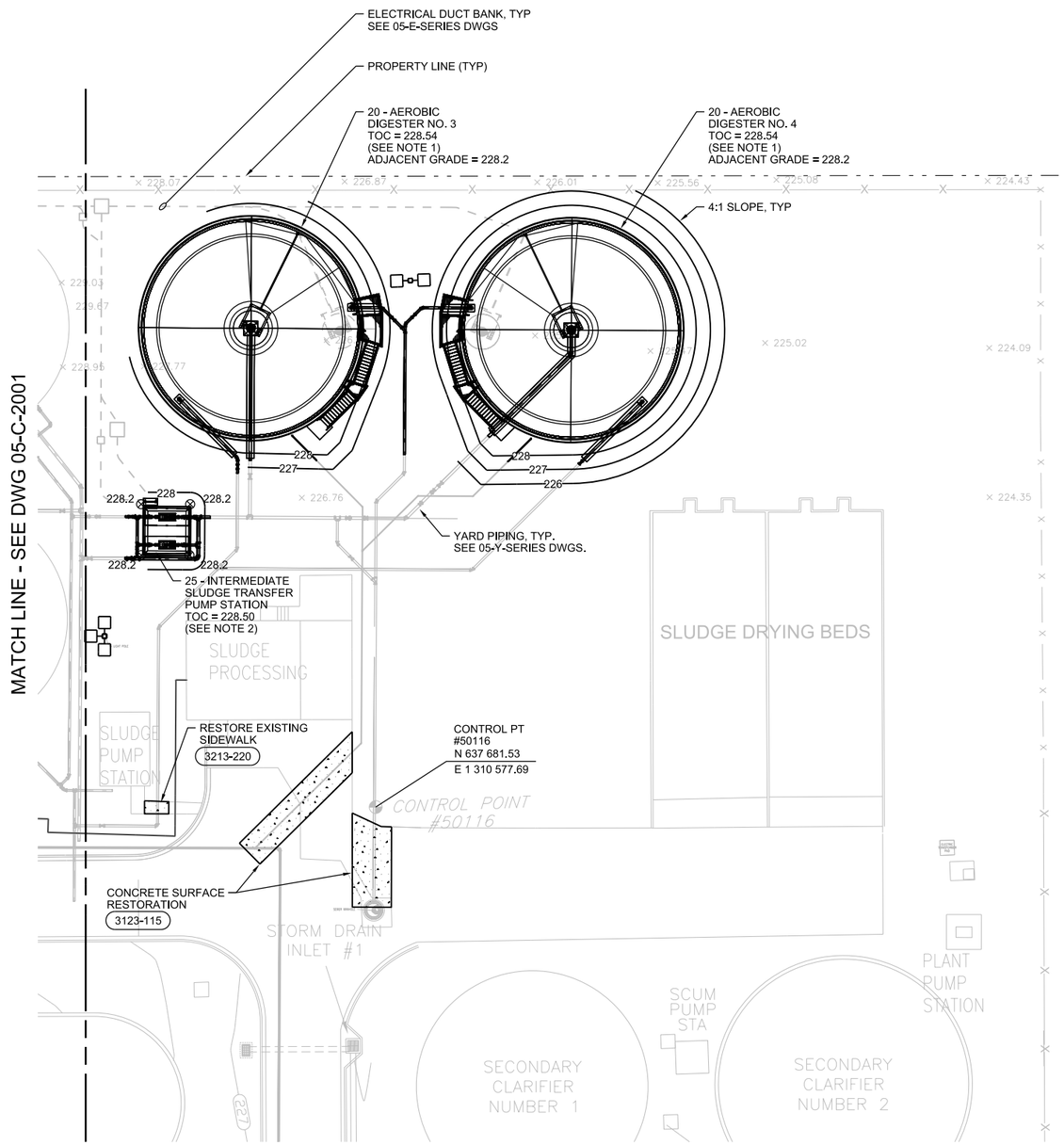
CIVIL
ENLARGED SITE PLAN

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-C-2001
SHEET	15 of 76



NOTES:

1. NEW DIGESTER TOC ELEVATION SHALL MATCH THE EXISTING NORTH DIGESTER TOC ELEVATION. THE ELEVATION SHOWN IS ASSUMED BASED ON AVAILABLE RECORD DWGS. FIELD VERIFY THE EXISTING DIGESTER TOC ELEVATION PRIOR TO CONSTRUCTION OF THE NEW DIGESTERS.
2. THE FACILITY SLAB ELEVATIONS AND ASSOCIATED GRADING ARE BASED ON THE SPORATIC SPOT ELEVATIONS SHOWN. FIELD VERIFY THE EXISTING GROUND ELEVATION PRIOR TO CONSTRUCTION.

N

0 20 40 60
Scale In Feet

NO.	DATE	REVISION	DR	CHK	BY
DSGN	R MORRISON		C CHILDRESS	A MALONE	APVD
					R MORRISON

Jacobs
25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

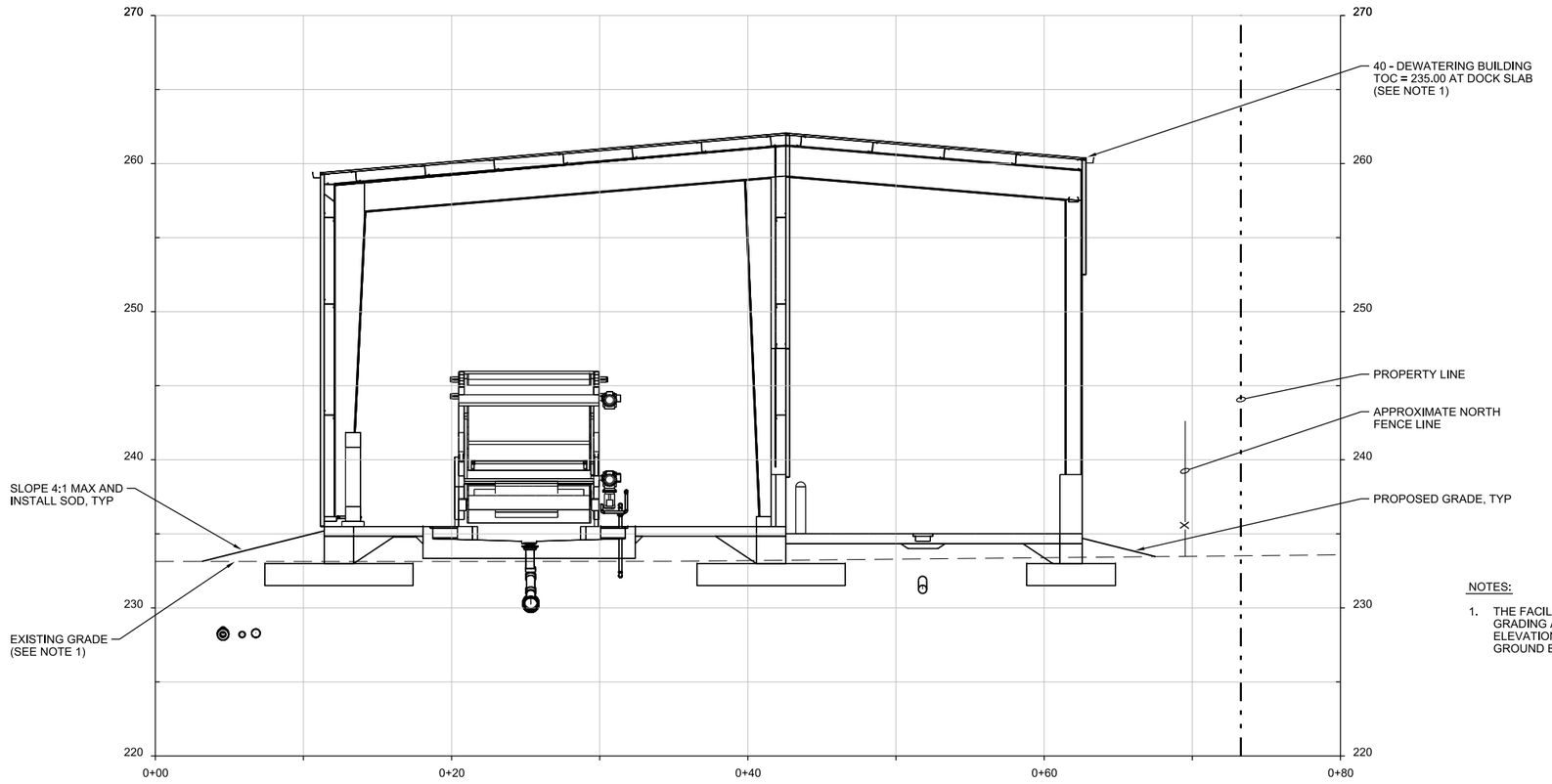
CREST VIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

CIVIL
ENLARGED
SITE PLAN

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-C-2002
SHEET	16 of 76



A SECTION
1"=5'
05-C-2001

NOTES:

1. THE FACILITY SLAB ELEVATIONS AND ASSOCIATED GRADING ARE BASED ON THE SPORATIC SPOT ELEVATIONS SHOWN. FIELD VERIFY THE EXISTING GROUND ELEVATION PRIOR TO CONSTRUCTION.

NO.	DATE	DR	REVISION	CHK	APVD	BY	APVD
DSGN	R MORRISON	C CHILDRESS		A MALONE		R MORRISON	

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PENSACOLA, FLORIDA 32502
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CRESTVIEW, FL

Jacobs

CIVIL
SECTIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-C-3001
SHEET	17 of 76

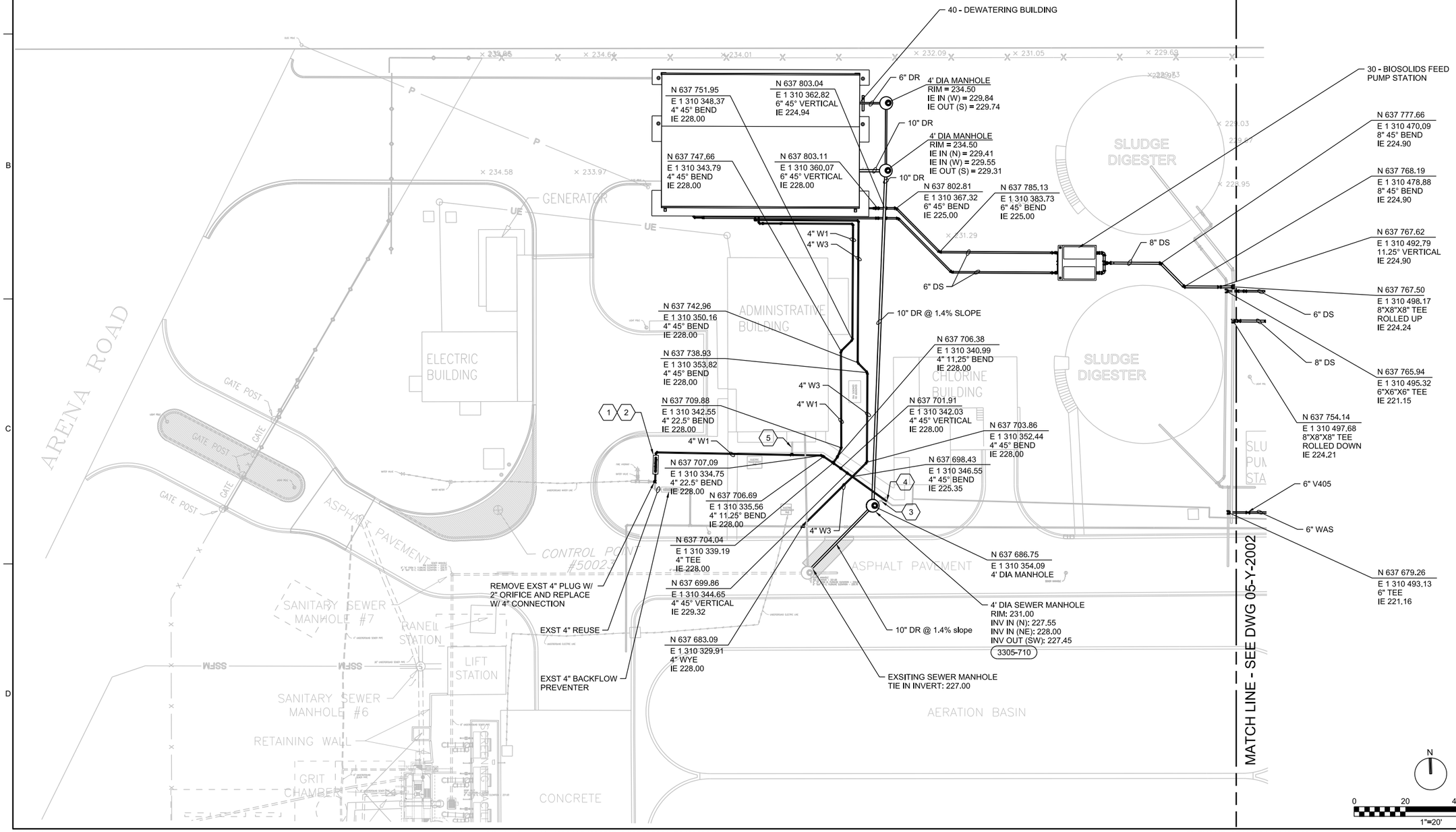
BID DOCUMENTS

GENERAL NOTES

1. UNLESS OTHERWISE NOTED, SEE PROCESS MECHANICAL FACILITY DRAWINGS FOR CONTINUATION OF PIPING.
2. EXISTING PIPES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION. FIELD VERIFY LOCATIONS AND DEPTHS OF THE EXISTING PIPES WHERE THE WORK OF THIS PROJECT TIES IN OR IS IMPACTED BY PRIOR TO ORDERING MATERIALS. ADJUST PIPING AND TIE-IN LOCATIONS AS NEEDED FOR PROPER INSTALLATION IN ACCORDANCE WITH THE SPECIFICATIONS.
3. CONTRACTOR TO COORDINATE MANHOLE RIM ELEVATIONS WITH FINISHED GRADE. SET MANHOLE RIM TO BE 6" ABOVE GRADE.

SHEET KEYNOTES

1. DEMOLISH EXISTING 2" W1 PIPING AND BACKFLOW AND REPLACE WITH A 4" W1 AND BACKFLOW ASSEMBLY.
2. 4" V640 BACKFLOW PREVENTER WITH 4" V500 VALVES ON EACH SIDE OF THE BACKFLOW. INSTALL THE BACKFLOW ASSEMBLY WITHIN AN ENVIRONMENTAL ENCLOSURE.
3. INTERCEPT THE EXISTING 4" DRAIN AND TIE INTO NEW MANHOLE. DEMOLISH THE REST OF THE 4" PIPE THAT EXTENDS TO THE EXISTING MANHOLE IN THE STREET.
4. CONNECT THE NEW 4" W1 TO THE EXISTING 2" W1.
5. RECONNECT THE EXISTING 2" WATERLINE FEEDING THE ADMINISTRATION BUILDING TO THE NEW 4" W1.



NO.	DATE	DSGN
DR	S TATMAN	KL DIAZ
CHK	KL DIAZ	R BOE
APVD	R BOE	K WADDELL
BY	APVD	K WADDELL

REVISION

Jacobs
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CRESTVIEW, FL

YARD PIPING
ENLARGED
YARD PIPING PLAN

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-Y-2001
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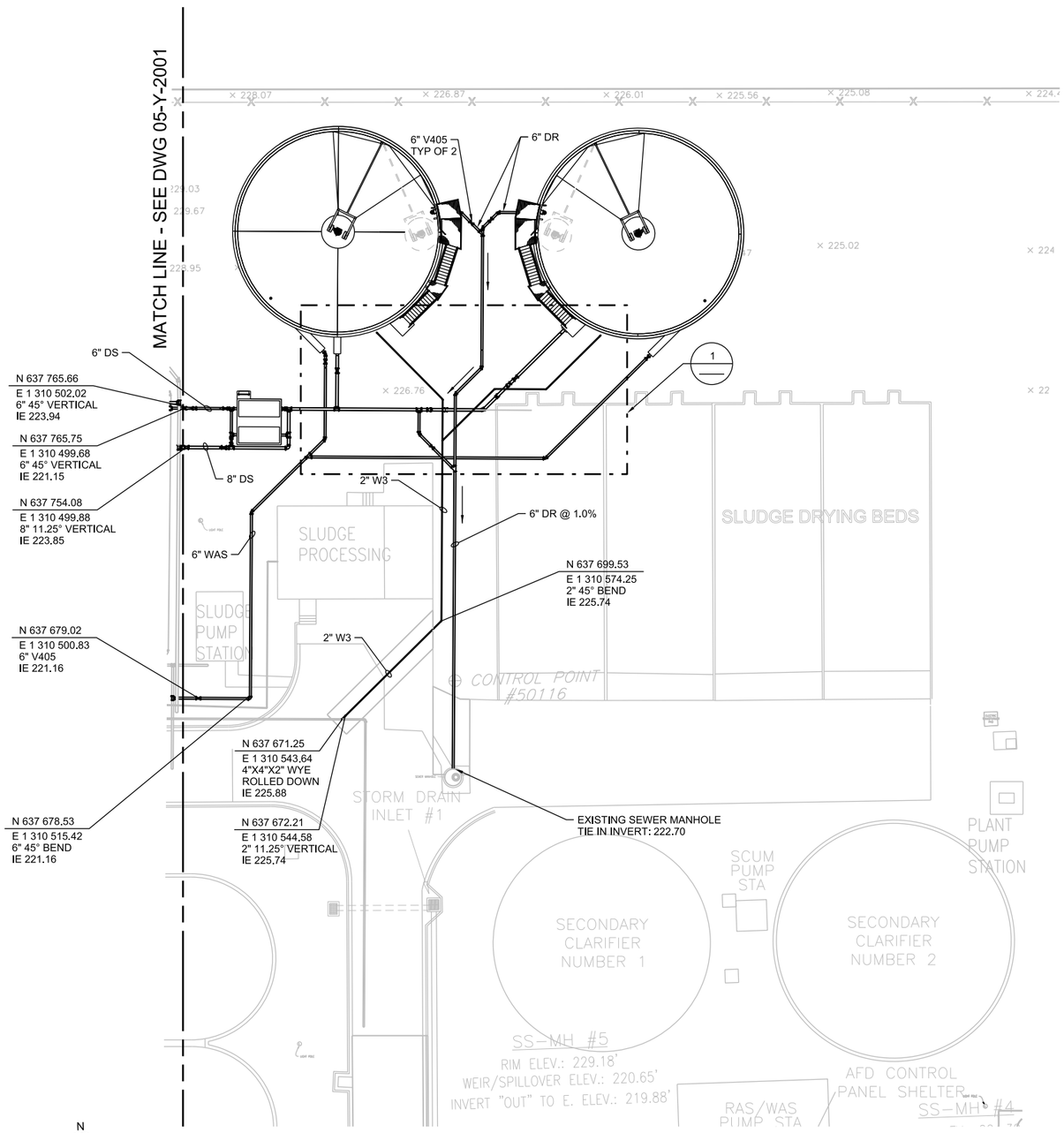

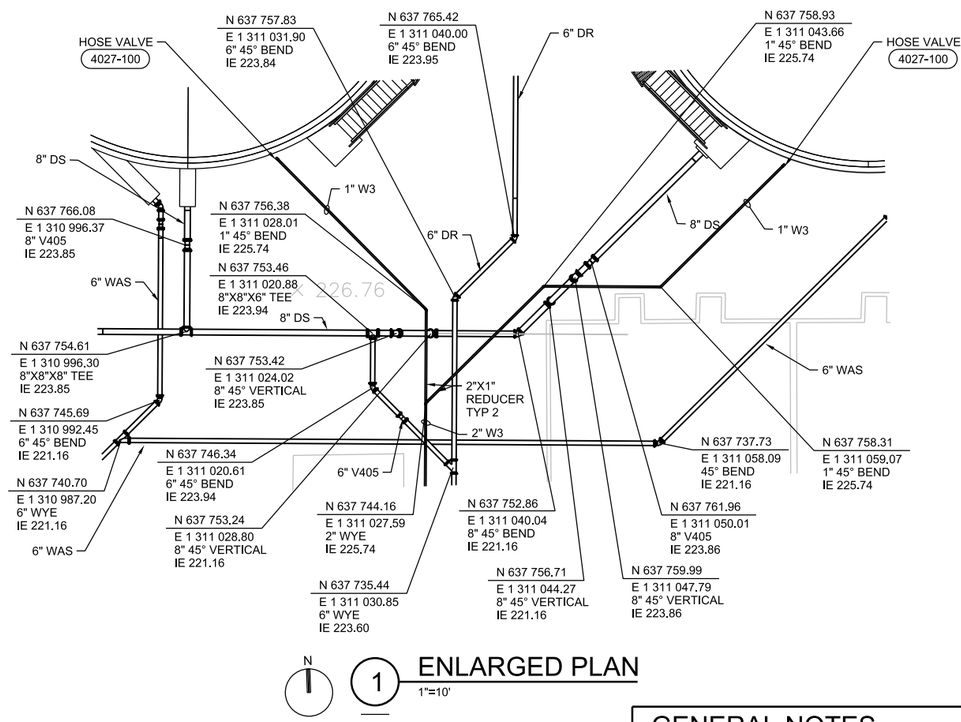

N

1 ENLARGED PLAN
1"=10'

GENERAL NOTES

1. UNLESS OTHERWISE NOTED, SEE PROCESS MECHANICAL FACILITY DRAWINGS FOR CONTINUATION OF PIPING.
2. EXISTING PIPES ARE SHOWN BASED ON BEST AVAILABLE INFORMATION. FIELD VERIFY LOCATIONS AND DEPTHS OF THE EXISTING PIPES WHERE THE WORK OF THIS PROJECT TIES IN OR IS IMPACTED BY PRIOR TO ORDERING MATERIALS. ADJUST PIPING AND TIE-IN LOCATIONS AS NEEDED FOR PROPER INSTALLATION IN ACCORDANCE WITH THE SPECIFICATIONS.

NO.	DATE	DR	REVISION	CHK	APVD	BY	APVD
DSGN		S TATMAN	KL DIAZ	R BOE		K WADDELL	

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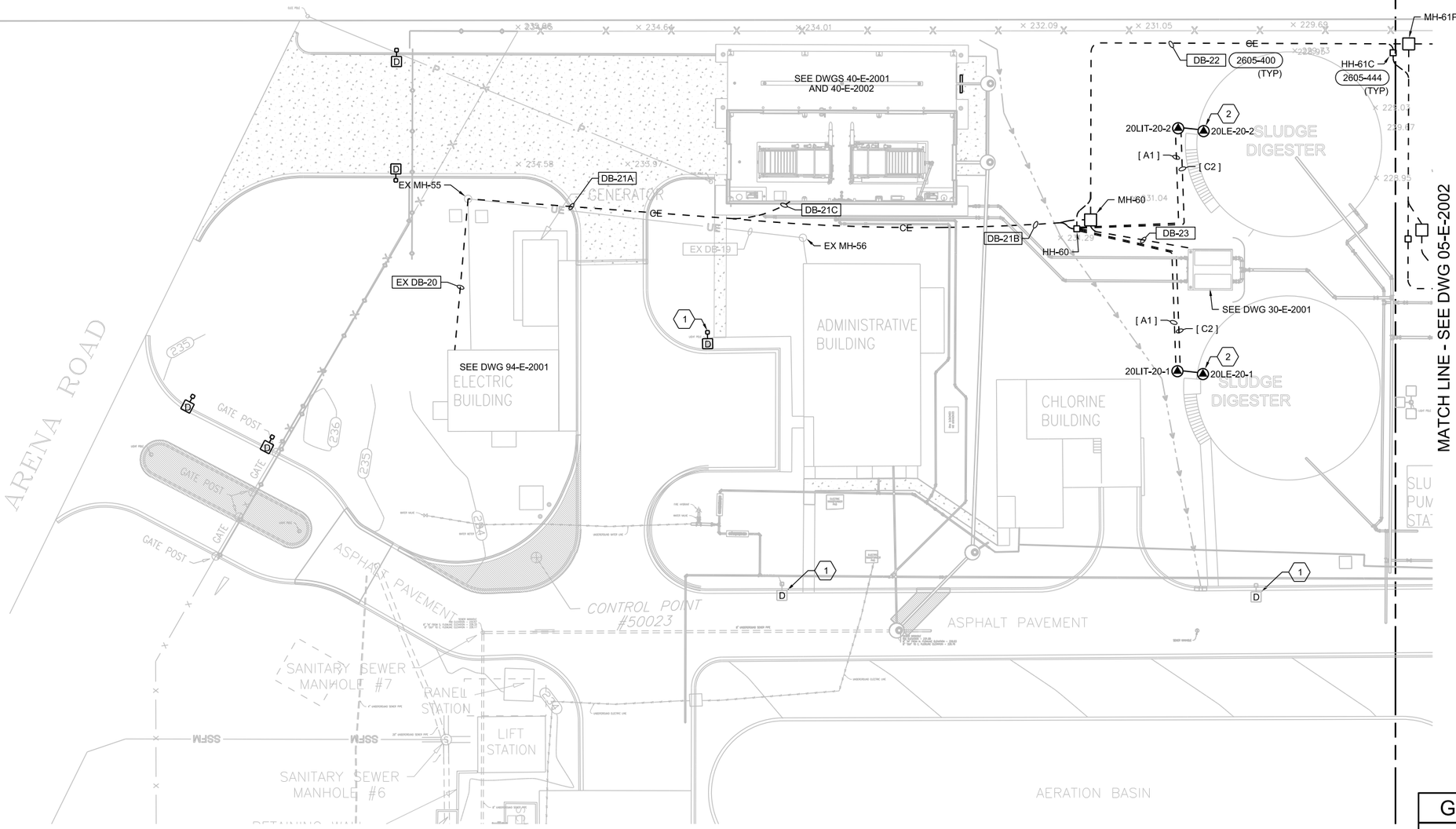
CIVIL
ENLARGED
YARD PIPING PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-Y-2001
SHEET	19 of 76

BID DOCUMENTS



N

0 20 40 60
Scale In Feet

GENERAL SHEET NOTES

1. SEE DRAWING DRAWING 05-E-6001 FOR DUCT BANK SECTIONS.

SHEET KEYNOTES

1. REPLACE EXISTING POLE LIGHT. USE EXISTING CONDUCTORS FOR NEW FIXTURE.
2. MOUNT LEVEL ELEMENT TO EXISTING DIGESTER WALL ACCESSIBLE FROM THE TOP PLATFORM PER THE MANUFACTURER'S RECOMMENDED INSTALLATION INSTRUCTIONS.

NO.	DATE	DSGN	DR	CHK	APVD
REVISION			G MESSER	D NICHOLSON	KB HORTON
BY	KB HORTON				
APVD					

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PENSACOLA, FLORIDA 32502
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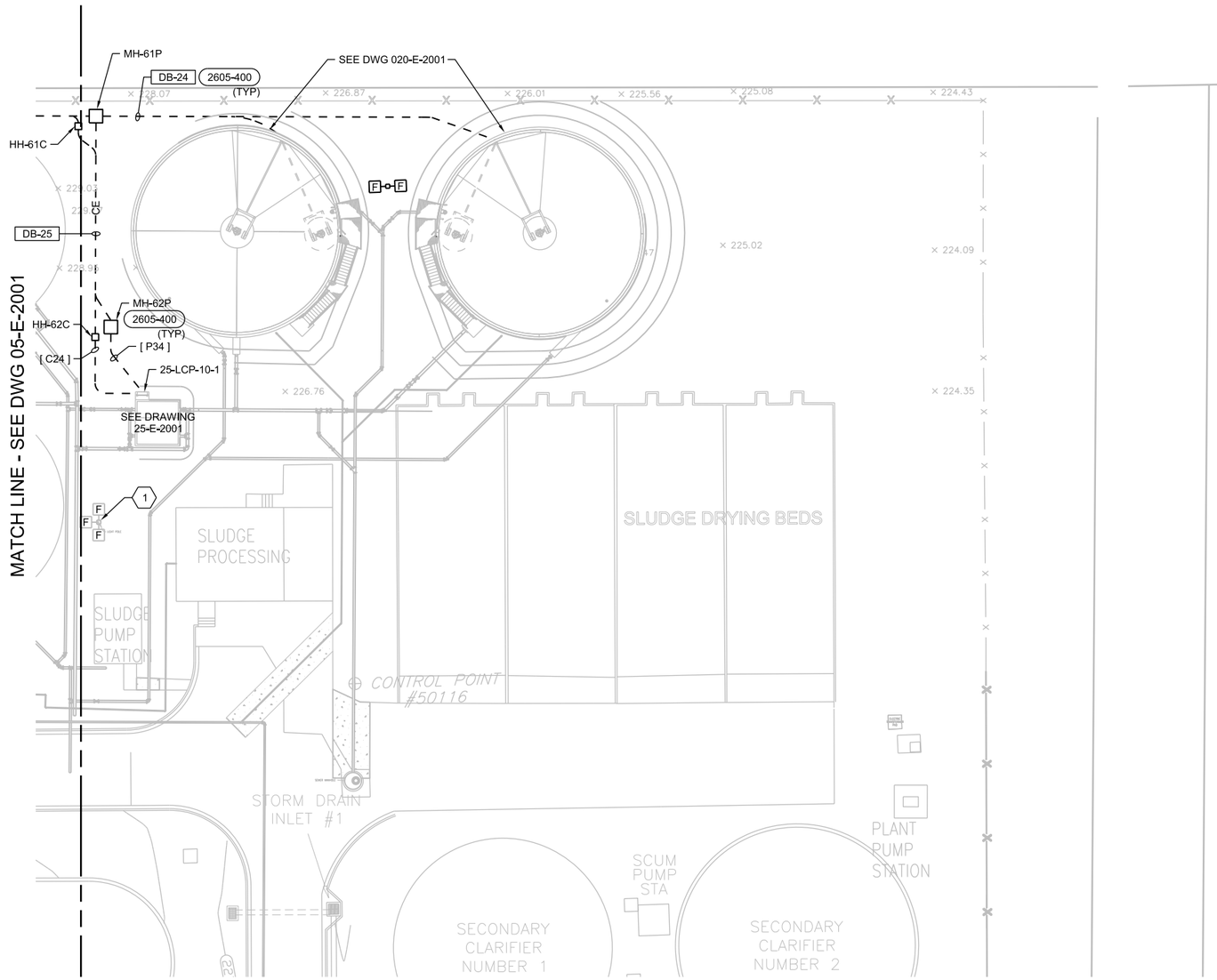
ELECTRICAL
ENLARGED
SITE PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-E-2001
SHEET	20 of 76

BID DOCUMENTS



N

0 20 40 60
Scale In Feet

GENERAL SHEET NOTES

1. SEE DRAWING DRAWING 05-E-6001 FOR DUCT BANK SECTIONS.

SHEET KEYNOTES

1. REPLACE EXISTING POLE LIGHTS. USE EXISTING POLE AND CONDUCTORS FOR NEW FIXTURES. FURNISH LIGHTS WITH MOUNTING HARDWARE APPROPRIATE FOR EXISTING POLE.

NO.	DATE	DR	REVISION	CHK	APVD	BY	APVD
DSGN	KB HORTON		G MESSER	D NICHOLSON			KB HORTON

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PENSACOLA, FLORIDA 32502
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CRESTVIEW, FL

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ELECTRICAL
ENLARGED SITE PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-E-2002
SHEET	21 of 76

BID DOCUMENTS

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
EX DB-20	1	EX 1"	SPARE		
	2	EX 1"	[C20]	25-LCP-10-1	CP-B
	3	EX 2 1/2"	[P41]	20-MIX-30-1	MCC-C4
	4	EX 1"	[P16]	40-VCP-40-1	MCC-C4
	5	EX 2 1/2"	[P41]	20-MIX-30-2	MCC-C4
	6	EX 1"	[P16]	40MPC-LP	MCC-C4
	7	EX 2 1/2"	[P34]	25LCP-10-1	MCC-C4
	8	EX 1"	[P3]	40-CONV-30-1	MCC-C4
	9	EX 2"	EX	EX	EX
	10	EX 2"	EX	EX	EX
	11	EX 2"	[C6]	30HS/PS-30-1	MCC-C4
			[C6]	30HS/PS-30-2	MCC-C4
			[C16]	40-VCP-20-1	MCC-C4
			[P14]	40HS	MCC-C4
	12	EX 2"	[P34]	40-VCP-20-1	MCC-C4
	13	EX 2 1/2"	[A4]	25-LCP-10-1	CP-B
			[A1]	20LIT-20-1	CP-B
			[A1]	20LIT-20-2	CP-B
			[A1]	20LIT-20-3	CP-B
			[A1]	20LIT-20-4	CP-B
	14	EX 2 1/2"	FO	40-VCP-20-1	CP-B
	15	NEW 1"	[P16]	EX FAN	MCC-C4
	16	NEW 1"	[P16]	SU[[LY FAN	MCC-C4
	18	NEW 1 1/2"	[PV8]	30-P-30-1	MCC-C4
	16	NEW 1 1/2"	[PV8]	30-P-30-2	MCC-C4

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
DB-21A	1	1 1/2"	[P41]	20-MIX-30-1	MCC-C4
	2	1 1/2"	[P41]	20-MIX-40-1	MCC-C4
	3	1"	[P28]	HTR	MCC-C4
	4	1"	[P16]	40MPC-LP	MCC-C4
	5	1 1/4"	[P34]	25-LPC-10-1	MCC-C4
	6	1"	[EC2]	MH-60	MH-55
	7	1"	[C20]	25-LCP-10-1	CP-B
	8	2"	[A4]	25-LCP-10-1	CP-B
			[A1]	20LIT-20-1	CP-B
			[A1]	20LIT-20-2	CP-B
			[A1]	20LIT-20-3	CP-B
			[A1]	20LIT-20-4	CP-B
	9	1 1/2"	[PV8]	30-P-30-1	MCC-C4
	10	1 1/2"	[PV8]	30-P-30-2	MCC-C4
	11	1"	[C6]	30HS/PS-30-1	MCC-C4
			[C6]	30HS/PS-30-2	MCC-C4
	12	1"	[P28]	HTR	MCC-C4
	13	1"	[P3]	40-CONV-30-1	MCC-C4
	14	1"	[P14]	40-HS	MCC-C4
	15	1"	[EC2]	FUTURE	MCC-C4
	16	1"	[EC2]	FUTURE	MCC-C4
	17	1 1/4"	[P34]	40-VCP-20-1	MCC-C4
	18	1"	[C16]	40-VCP-20-1	MCC-C4
	19	2"	FO	40-VCP-20-1	CP-B
	20	1 1/4"	[EC-3]	FUTURE	MCC-C4
	21	1"	[EC-2]	FUTURE	MCC-C4
	22	1"	[P16]	EX FAN	MCC-C4
	23	1"	[P16]	SUPPLY FAN	MCC-C4
	24	1"	[P16]	40-VCP-40-1	MCC-C4
	25	1"	[EC-2]	FUTURE	MCC-C4

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
DB-21B	1	1 1/2"	[P41]	20-MIX-30-1	MCC-C4
	2	1"			
	3	1 1/2"	[P41]	20-MIX-40-1	MCC-C4
	4	1"			
	5	1 1/4"	[P34]	25-LPC-10-1	MCC-C4
	6	1"	[EC2]	MH-60	MH-55
	7	1"	[C20]	25-LCP-10-1	CP-B
	8	2"	[A4]	25-LCP-10-1	CP-B
			[A1]	20LIT-20-1	CP-B
			[A1]	20LIT-20-2	CP-B
			[A1]	20LIT-20-3	CP-B
			[A1]	20LIT-20-4	CP-B
	9	1 1/2"	[PV8]	30-P-30-1	MCC-C4
	10	1 1/2"	[PV8]	30-P-30-2	MCC-C4
	11	1"	[C6]	30HS/PS-30-1	MCC-C4
	12	1"	[C6]	30HS/PS-30-2	MCC-C4

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
DB-21C	1	1"	[P3]	40-CONV-30-1	MCC-C4
	2	1"	[P14]	40-HS	MCC-C4
	3	1"	[EC2]	FUTURE	MCC-C4
	4	1"	[EC2]	FUTURE	MCC-C4
	5	1 1/4"	[P34]	40-VCP-20-1	MCC-C4
	6	1"	[C16]	40-VCP-20-1	MCC-C4
	7	2"	FO	40-VCP-20-1	CP-B
	8	1 1/4"	[EC-3]	FUTURE	MCC-C4
	9	1"	[EC-2]	FUTURE	MCC-C4
	10	1"	[P16]	40-VCP-40-1	MCC-C4
	11	1"	[EC-2]	FUTURE	MCC-C4
	12	1"	[P16]	40MPC-LP	MCC-C4
	13	1"	[P16]	EX FAN	MCC-C4
	14	1"	[P16]	SUPPLY FAN	MCC-C4
	15	1"	[P28]	HTR	MCC-C4
	16	1"	[P28]	HTR	MCC-C4

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
DB-22	1	1 1/2"	[P41]	20-MIX-30-1	MCC-C4
	2	1 1/2"	[P41]	20-MIX-40-1	MCC-C4
	3	1"	[A1]	20LIT-20-3	CP-B
			[A1]	20LIT-20-4	CP-B
	4	1"	[C2]	20LIT-20-3	25-LCP-10-1
			[C2]	20LIT-20-4	25-LCP-10-1
	5	1 1/4"	[P34]	25-LPC-10-1	MCC-C4
	6	1"	[EC2]	HH-61P	MH-60
	7	1"	[C20]	25-LCP-10-1	CP-B
	8	2"	[A4]	25-LCP-10-1	CP-B
			[A1]	20LIT-20-3	CP-B
			[A1]	20LIT-20-4	CP-B

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
DB-23	1	1 1/2"	[PV8]	30-P-30-1	MCC-C4
	2	1 1/2"	[PV8]	30-P-30-2	MCC-C4
	3	1"	[C6]	30HS/PS-30-1	MCC-C4
	4	1"	[C6]	30HS/PS-30-2	MCC-C4

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
DB-24	1	1 1/2"	[P41]	20-MIX-30-1	MCC-C4
	2	1 1/2"	[P41]	20-MIX-40-1	MCC-C4
	3	1"	[A1]	20LIT-20-3	CP-B
	4	1"	[A1]	20LIT-20-4	CP-B

DUCT BANK ID	#	CONDUIT SIZE	CIRCUIT	TO	FROM
DB-25	1	1 1/4"	[P34]	25-LPC-10-1	MCC-C4
	2	1"	[EC2]	HH-62P	HH-61P
	3	1"	[C20]	25-LCP-10-1	CP-B
			[C2]	20LIT-20-3	25-LCP-10-1
			[C2]	20LIT-20-4	25-LCP-10-1
	4	1"	[A4]	25-LCP-10-1	CP-B

NO.	DATE	REVISION	BY	APVD

DSGN KB HORTON
DR G MESSER
CHK D NICHOLSON
APVD KB HORTON

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

ELECTRICAL

DUCT BANK SECTIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	05-E-6001
SHEET	22 of 76

BID DOCUMENTS

CP-B

LEVEL (2) — SS1 — (2) — HOR 20HS 30-1 * — I @ MCC — 2 (3) — P

IN REMOTE (2) — RUNNING (2) — RUN CMD (2)

ALARM (2) — RUNNING (2) — IN REMOTE (2) — RUN CMD (2) — 2 (4) — (4)

LEVEL (2) — SS1 — (2) — SS3 — 20LIT 20-2 — MSC — 20LE 20-2

WAS FROM SECONDARY CLAIRIFIERS — 6" WAS

480V

25-LCP-10-1 *

SS3

HOR 25HS 10-1A	HOR 25HS 10-2A	FAIL 25XL 10-1	FAIL 25XL 10-2	25LI 20-X (4) (X=1-4)
RESET 25HS 10-1B	RESET 25HS 10-2B	RUN 25YL 10-1	RUN 25YL 10-2	

SS3 — 20LIT 20-3 — MSC — 20LE 20-3

CS — M — DIGESTER AERATOR NO. 3 — 20-MIX-30-1 — HP: 75

6" WAS — 6" DR — DIGESTER NO. 3 — 20-T-30-1

8" DS — DECANT TO PLANT DRAIN

HOR 20HS 40-1 * — I @ MCC — P

SS3 — 20LIT 20-4 — MSC — 20LE 20-4

CS — M — DIGESTER AERATOR NO. 4 — 20-MIX-40-1 — HP: 75

6" WAS — 6" DR — DIGESTER NO. 4 — 20-T-40-1

8" DS — DECANT TO PLANT DRAIN

(2) — (2)

25PI 10-1B — 25PSH 10-1 * — P

25PI 10-1A * — CS — INTERMEDIATE SLUDGE PUMP NO. 1 — 25-P-10-1 — HP: 10

25PI 10-2B — 25PSH 10-2 * — P

25PI 10-2A * — CS — INTERMEDIATE SLUDGE PUMP NO. 2 — 25-P-10-2 — HP: 10

6" DS — 6" DS — 6" DS — 6" DS — 6" DS

3" TWAS — RDT — 3" TWAS — FILTRATE TO PLANT DRAIN

SS3 — 20LIT 20-1 — MSC — 20LE 20-1

6" DR — DECANT TO PLANT DRAIN — DIGESTER NO. 1 — 8" DS

6" DR — DECANT TO PLANT DRAIN — DIGESTER NO. 2 — 8" DS

8" DS — TO SLUDGE DRYING BEDS

TO EXISTING BELT FILTER PRESS

8" DS — A — 08-N-6002 — TO BIOSOLIDS PUMP STATION (PROPOSED)

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
REVISION			G GRAY	A PASTRANA	C SAHARKHIZ		C SAHARKHIZ

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

INSTRUMENTATION AND CONTROL

P&ID
AEROBIC DIGESTERS NO 3 & 4

BID DOCUMENTS

NTS	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
PROJ	D3403200
DWG	08-N-6001
SHEET	23 of 76

CP-B

RUN CMD (2) | RUN STATUS (2) | IN REMOTE (2) | FAIL (2) | SPEED IND. (2) | SPEED CMD (2)

SS2 (2) | SS2 (2)

2 (4) | 2 (2)

480V

30-AFD-30-X *
LOCATED IN MCC-C4
(X=1, 2)

RUN: 30YL 10-X
FAIL: 30XL 10-X

(2)

(2) | (2)

30PI 30-1B * | 30PSH 30-1 *

30PI 30-1A * | ED | 30HS 30-1 **

AS

BIOSOLIDS FEED PUMP NO. 1
30-P-30-1
HP: 10

6" DS

08-N-6001 A
FROM AEROBIC DIGESTERS

8" DS

6" DS

30PI 30-2A * | ED | 30HS 30-2 **

AS

BIOSOLIDS FEED PUMP NO. 2
30-P-30-2
HP: 10

30PI 30-2B * | 30PSH 30-2 *

6" DS (BYPASS)

6" DS

A 08-N-6003
TO BELT FILTER PRESS 1

6" DS

B 08-N-6003
TO FUTURE BELT FILTER PRESS 2

NO.	DSGN	DATE	DR	CHK	APVD	BY	APVD
			G GRAY	A PASTRANA	C SAHARKHIZ		C SAHARKHIZ

REVISION

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

INSTRUMENTATION AND CONTROL

P&ID
BIOSOLIDS FEED PUMPS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	08-N-6002
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BID DOCUMENTS

CP-B

ETHERNET

480V

40-VCP-20-1 *

PLC | OIU

E-STOP
40HS 20-1B

E-STOP PULL CORD
40HS 20-1A

120V

08-N-6005 A
FROM POLYMER SYSTEM

1 1/2" POS

08-N-6002 A
FROM BIOSOLIDS FEED PUMP 1

6" DS

6" x 4"

40FIT 20-1

4" DS

POLYMER INJECTION RING
40-V-21-1A

POLYMER MIXING VALVE
40-V-21-1B

4" x 6"

40-ARV-22-1

6" DS

SLUDGE DISTRIBUTOR 1
40-M-20-1A
HP: 0.75

W2

GRAVITY BELT
40-M-20-1B
HP: 3

FTR

MSC

DR

40PSL 20-1

40PI 20-1

W3

2" W3

1 1/2" W2

40FV 20-1

WASHWATER BOOSTER PUMP NO. 1
40-P-20-1
HP: 15

CS

BELT DRIVES
40-M-20-1C
40-M-20-1D
HP: 3

AS

HYDRAULIC TENSIONING SYSTEM 1
40-M-20-1E
HP: 1

40PI 20-1C

40PSL 20-1C

PRESSURE SECTION

DSC CHUTE

A 08-N-6004
TO CONVEYOR 1

LOW VOLTAGE TJB *

(10) (4)

BELT FILTER PRESS 1
40-M-20-1

8" DR

TO PLANT DRAIN PUMP STATION

FROM FUTURE POLYMER SYSTEM

1 1/2" POS

40FIT 20-2

08-N-6002 B
FROM BIOSOLIDS FEED PUMP 2

6" DS

FROM W3

TO CONVEYOR 2 (FUTURE)

FUTURE BELT FILTER PRESS 2

8" DR

TO PLANT DRAIN PUMP STATION

SHEET KEYNOTES

1. ALL EQUIPMENT INSIDE BOUNDARY IS PROVIDED BY BELT FILTER PRESS VENDOR UNLESS OTHERWISE NOTED.
2. TO SWITCH IN PANEL CP-B. SEE 08-N-7001 FOR CONNECTION INFORMATION. CONTROL SIGNALS MANAGED VIA ETHERNET DATA NETWORK. SEE SPECIFICATION FOR I/O LIST.
3. WHERE NOTED, ANALOG CABLES SHALL BE SHIELDED, 3-WIRE CIRCUITS.

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
			G GRAY	A PASTRANA	C SAHARKHIZ		C SAHARKHIZ

REVISION

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SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

INSTRUMENTATION AND CONTROL
P&ID
BELT FILTER PRESS

BID DOCUMENTS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
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SHEET	25 of 76

40-VCP-20-1

RUN FWD
ALARM
RUN FWD CMD
IN REMOTE
RUN REV
E-STOP

480V

(6)

@ MCC

P

120V

08-N-6003 a
DSC
FROM BELT FILTER PRESS 1

40SSL 30-1 *

HOR 40HS 30-1A **
FR 40HS 30-1B **
E-STOP 40HS 30-1D **
E-STOP 40HS 30-1C *

CS

CONVEYOR 1
40-CONV-30-1 *
HP: 3

DR

FROM FUTURE BELT FILTER PRESS 2
DSC

CONVEYOR 2
(FUTURE)

DSC
DSC

TRUCK LOADING 1

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN		G GRAY	A PASTRANA	C SAHARKHIZ	APVD	C SAHARKHIZ	

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INSTRUMENTATION AND CONTROL
P&ID
DIGESTED SLUDGE CAKE CONVEYOR

BID DOCUMENTS

NTS	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
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40-VCP-20-1

ON

RUN CMD | LOW PRESSURE | LOSS OF FLOW ALARM | RUNNING | SPEED CMD

(4)

40FSH 40-2 *

W1

EYEWASH AND SAFETY SHOWER
40-SSH-40-1 *

480V

40-LCP-40-1 *

POLYMER MAKEUP UNIT 1

P

40PSL 40-1C | 40PI 40-1C *

S

FC

W2

40PCV 40-1 *

40SV 40-1 *

40FI 40-1B *

40FSL 40-1 *

CALIBRATION COLUMN *

M

CS

40PSH 40-1A | 40PI 40-1A *

40FI 40-1A *

40PI 40-1B *

W2

POLYMER WATER BOOSTER PUMP 1
40-P-4-1
HP: 3

1 1/2" POLY

POLYMER BARREL

M

AS

POLYMER PUMP 1
40-P-40-1A *
HP: 0,5

NEAT POLYMER REACTOR 1
40-T-40-1 *
HP: 1

1 1/2" POS

A | 08-N-6003

TO BELT FILTER PRESS NO. 1

4" DR

TO PLANT DRAIN

POLYMER MAKEUP UNIT 2 (FUTURE)

W2

1 1/2" POLY

FUTURE POLYMER BARREL

1 1/2" POS

TO FUTURE BELT FILTER PRESS NO. 2

4" DR

TO PLANT DRAIN

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
			G GRAY	A PASTRANA	C SAHARKHIZ	C SAHARKHIZ	C.SAHARKHIZ

REVISION

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INSTRUMENTATION AND CONTROL

P&ID
BFP POLYMER SYSTEM

BID DOCUMENTS

NTS

VERIFY SCALE

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0 1"

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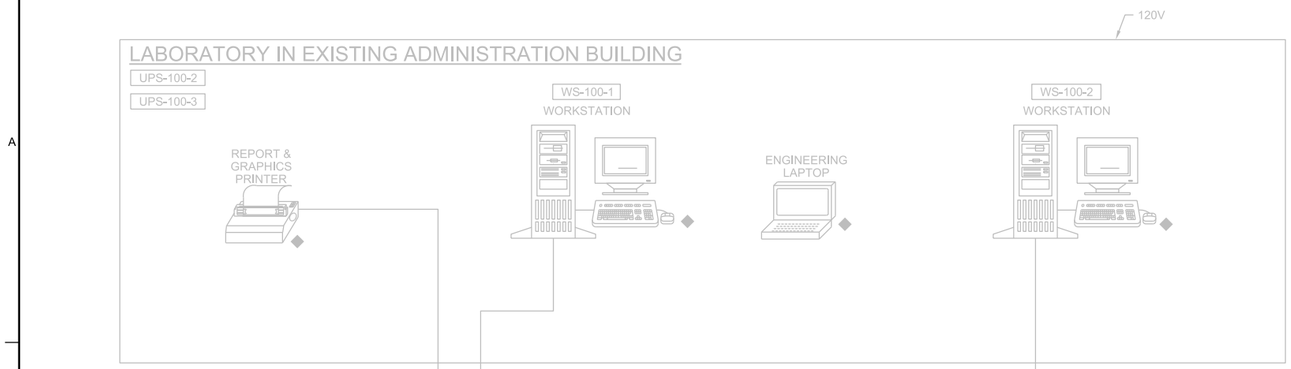
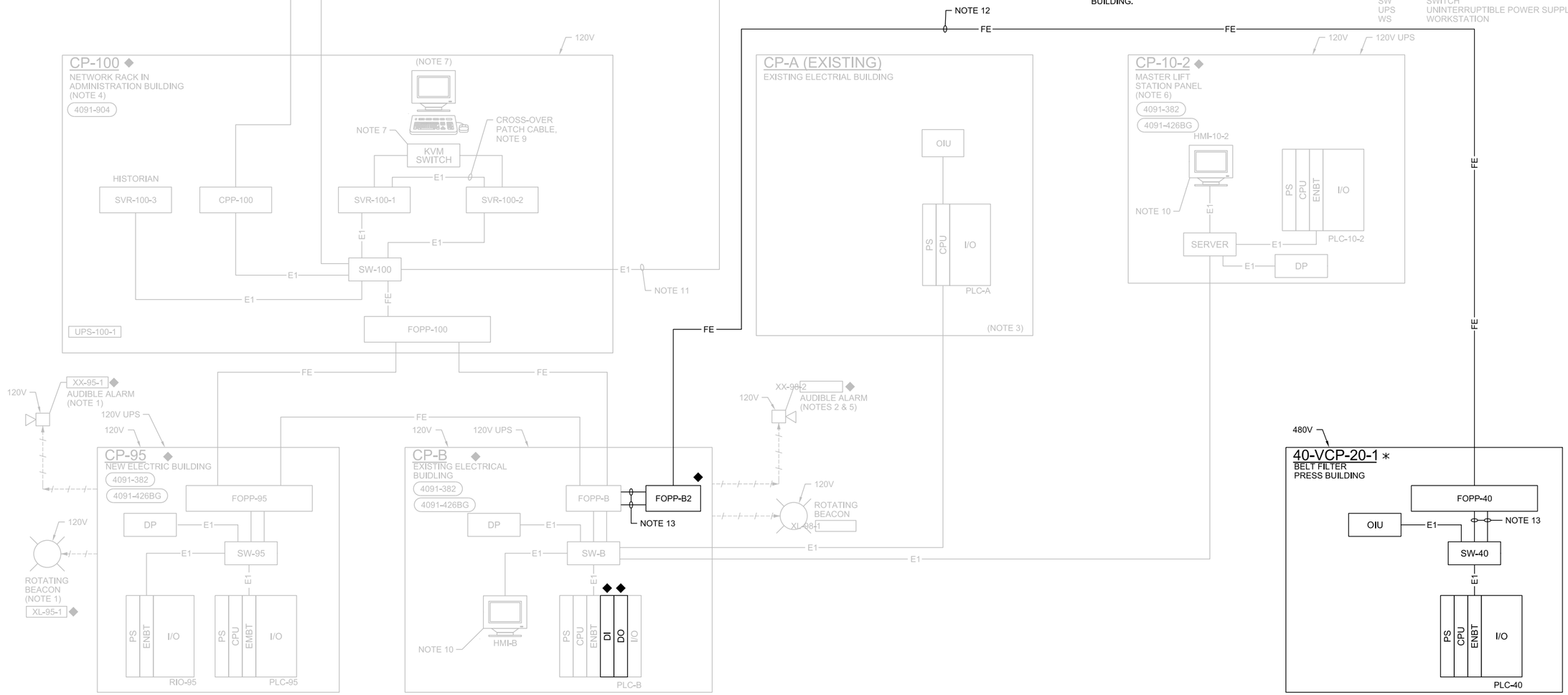


NOTES:

1. LOCATED ON EXTERNAL EAST WALL OF NEW ELECTRICAL BUILDING.
2. REPLACE EXISTING HORN LOCATED ON EXISTING BUILDING.
3. FIELD VERIFY NETWORK CONNECTION FROM EXISTING OIU TO PLC-A. IF ETHERNET PORT OF CPU IS USED, PROVIDE A NEW ETHERNET SWITCH FOR CONNECTION OF PLC-B TO SW-B AND EXISTING OIUT.
4. LOCATE NETWORK RACK IN THE SHOP IN THE EXISTING ADMINISTRATION BUILDING. COORDINATE LOCATION WITH THE OWNER. SEE DWG 05-E-5001.
5. LOCATED ON EXTERNAL SOUTH WALL OF EXISTING ELECTRICAL BUILDING.
6. LOCATE THIS PANEL IN THE EXISTING ELECTRICAL BUILDING. IT REPLACES THE EXISTING MASTER LIFT STATION PANEL, WHICH IS LOCATED IN THE FIELD.
7. THIS IS A RACK CONSOLE. IT CONSISTS OF THE KVM SWITCH, A MONITOR, A KEY PAD AND A TOUCH PAD.
8. UNLESS OTHERWISE NOTED, ALL E1 CABLE SHOWN ON THIS DWG SHALL BE CAT 6E.
9. CROSS-OVER PATCH CABLE SHALL BE AT LEAST CAT 5E.
10. HMI ALSO INCLUDES THE CPU.
11. METALLIC ETHERNET CABLE SHALL BE CAT6.
12. NEW FIBER OPTIC CABLE BETWEEN BUILDINGS SHALL BE 12-CONDUCTORS MINIMUM WITH AT LEAST 50% AS SPARE.
13. CONNECT NEW FIBER PATCH CABLES TO EXTEND THE EXISTING NETWORK RING TO THE BELT FILTER PRESS BUILDING.

ABBREVIATIONS:

CPP	CATEGORY 6 PATCH PANEL
CPU	CENTRAL PROCESSING UNIT
DP	DATAPORT
E1	10/100 BASE-TX
ENBT	PLC ETHERNET MODULE
FE	MULTIMODE FO-100 BASE-FX
FO	FIBER OPTICS
FOPP	FIBER OPTIC PATCH PANEL
HMI	HUMAN MACHINE INTERFACE
IOM	INPUT/OUTPUT MODULES
KVM	KEYBOARD, VIDEO, MOUSE EXTENDER
OIT	OPERATOR INTERFACE UNIT
PS	POWER SUPPLY
RIO	REMOTE INPUT/OUTPUT
S	SERIAL
SVR	SERVER
SW	SWITCH
UPS	UNINTERRUPTIBLE POWER SUPPLY
WS	WORKSTATION



NO.	DATE	DSGN	REVISION	CHK	DR	BY	APVD
	C HARRIS		A PASTRANA	C SAHARKHIZ		C SAHARKHIZ	APVD

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CRESTVIEW, FL

INSTRUMENTATION AND CONTROL

BLOCK DIAGRAM

BID DOCUMENTS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

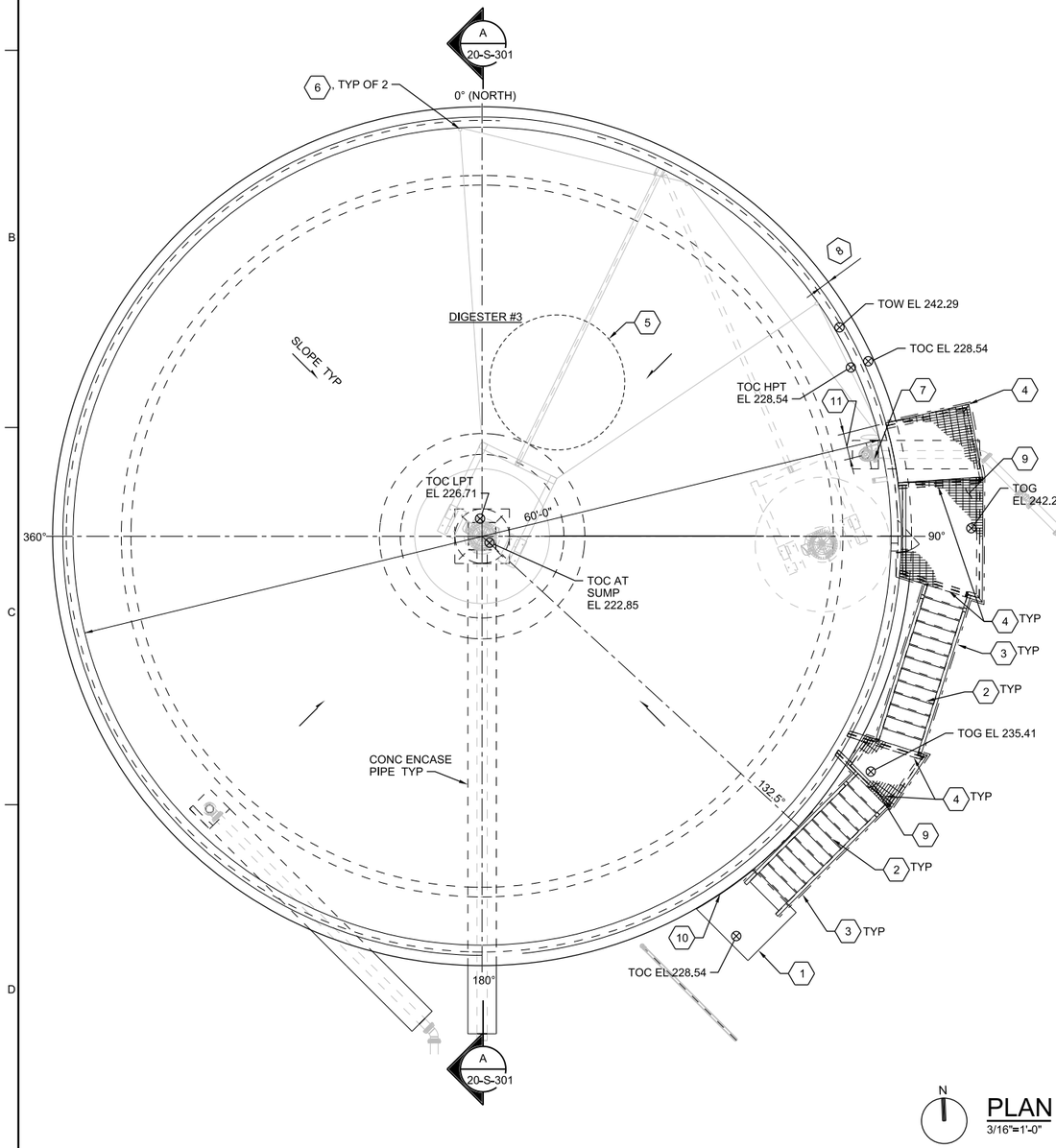
DATE	MARCH 2021
PROJ	D3403200
DWG	08-N-7001
SHEET	28 of 76

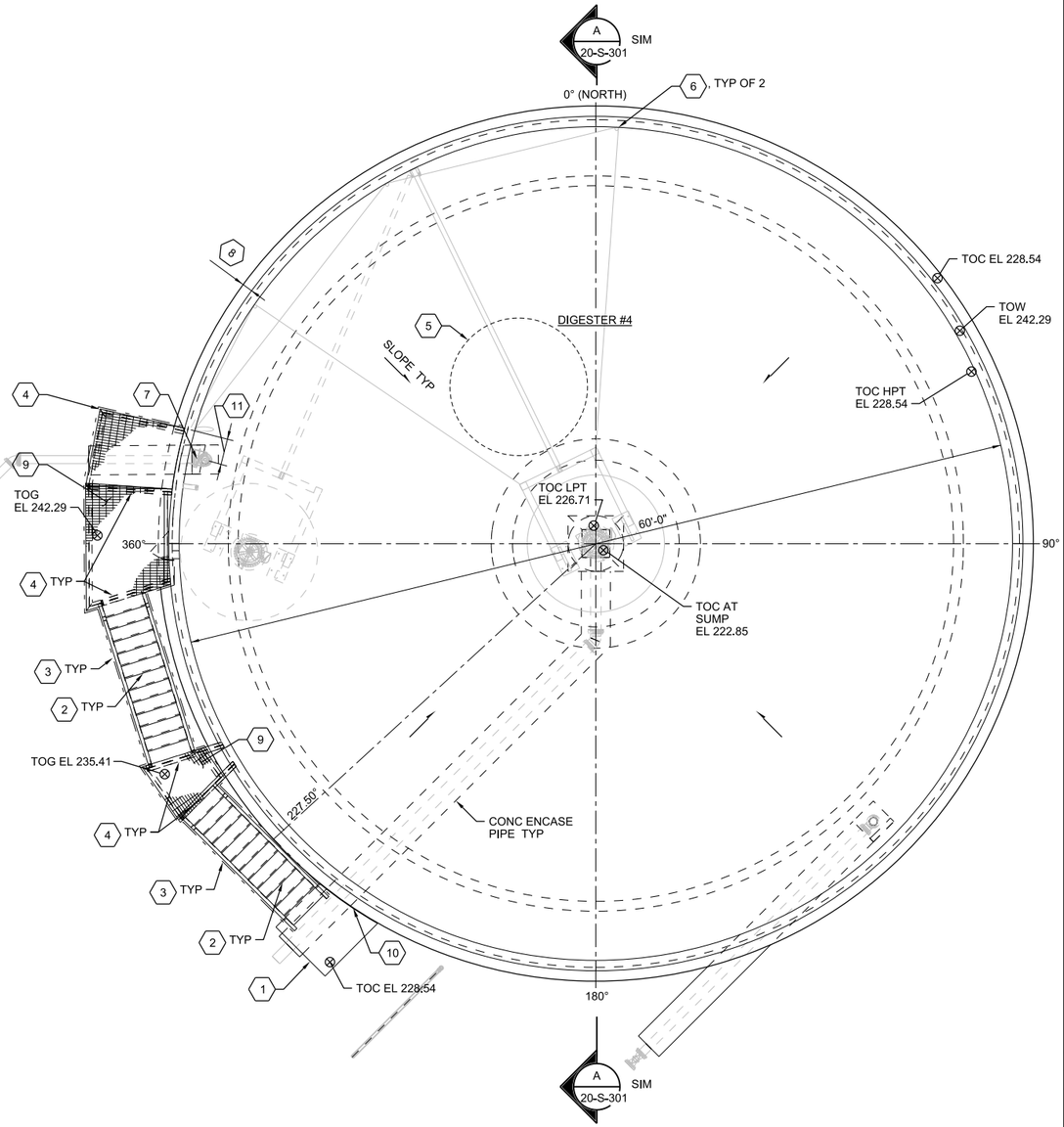
GENERAL SHEET NOTES

1. FOR ADDITIONAL INFORMATION, SEE GENERAL STRUCTURAL NOTES ON DWG 01-G-0004 AND 01-G-0005.
2. FOR GENERAL STORAGE TANK INFO, SEE SPECIFICATION SECTION 33 16 13.15.
3. TANK DESIGN SHALL INCLUDE THE CASE OF ACCIDENTAL OVERTOPPING.
4. CONCRETE ENCASE PIPES BELOW TANK SLAB. SEE DETAILS 0330-016, 0330-017, AND 0330-018. FINAL ENCASEMENT DESIGN AS REQUIRED BY PRECAST TANK BUILDER.
5. FINAL DESIGN OF ALUMINUM STAIRS, LANDINGS, BRACKETS AND CONNECTIONS TO TANK AS REQUIRED BY PRECAST TANK BUILDER.
6. MAINTAIN 15'-0" CLEAR AROUND TANK OD AS REQUIRED FOR CONSTRUCTION OF TANK.
7. TANK ELEVATIONS SHOWN ARE BASED ON EXISTING RECORD DRAWING DATA AND ASSUMED MATCH ELEVATIONS OF EXISTING DIGESTERS #1 AND #2. FIELD VERIFY PRIOR TO START OF WORK. SEE NOTE 1 ON DWG 05-C-2002.

SHEET KEYNOTES

1. CONCRETE EQUIPMENT PAD 0330-056 TYPE 'H' SIM. OMIT THICKENED EDGES AND PROVIDE 1'-4" UNIFORM THICKNESS.
2. ALUMINUM STRAIGHT STAIR RUNS AS REQUIRED BY TANK BUILDER. SEE 0551-001 SIM.
3. ALUMINUM RAILING, 0552-001 W/ TYPE 'D' ANCHORAGE.
4. ALUMINUM LANDING SUPPORTS, 0551-003 SIM. PROVIDE THICKENED CONCRETE BOSS IN WALL AS REQUIRED FOR ANCHORAGE.
5. PROVIDE FLAT AREA IN SLAB TO SUPPORT AERATOR EQUIPMENT WHEN TANK EMPTIED. COORDINATE POSITION, SIZE AND SLAB REQUIREMENTS WITH TANK BUILDER.
6. COORDINATE ANCHORAGE REQUIREMENT OF MOORING CABLE WITH TANK BUILDER.
7. COORDINATE ANCHORAGE AND LOADING REQUIREMENTS OF VALVE ATTACHED TO TOP OF TANK WALL.
8. FOOTING EXTENSION AS REQUIRED BY TANK BUILDER.
9. ALUMINUM GRATING 0553-001.
10. 1/2" PJF AT JOINT, TYP.
11. EXTEND PLATFORM 2'-0" MIN BEYOND, SEE DWG 20-D-2001.
12. 30" LOCKING SWING GATE, 0552-001.





N

PLAN
3/16"=1'-0"

NO.	DATE	DR	REVISION	CHK	APVD	BY	APVD
DSGN	DR EVERSON	PA KARABAN		CW ANSON	APVD	DR EVERSON	

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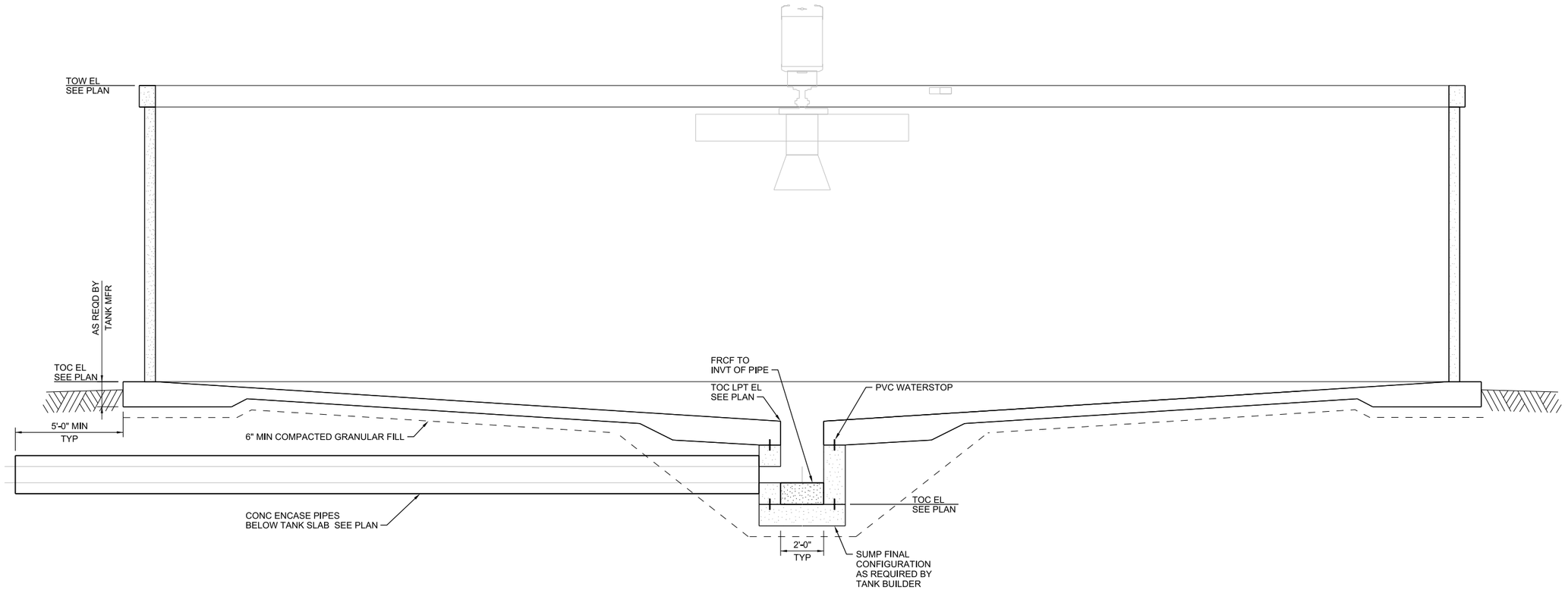
CRESTVIEW, FL

STRUCTURAL
AEROBIC DIGESTERS #3 AND #4 PLAN

AS NOTED
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	20-S-2001
SHEET	29 of 76

BID DOCUMENTS



A SECTION
3/8"=1'-0"
20-S-201

NO.	DATE	REVISION	BY	APVD
DSGN	DR EVERSON	DR	PA KARABAN	CHK	CW ANSON	APVD	DR EVERSON

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STRUCTURAL
AEROBIC DIGESTERS #3 AND #4
SECTION

BID DOCUMENTS

AS NOTED
VERIFY SCALE
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DATE	MARCH 2021
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DWG	20-S-3001
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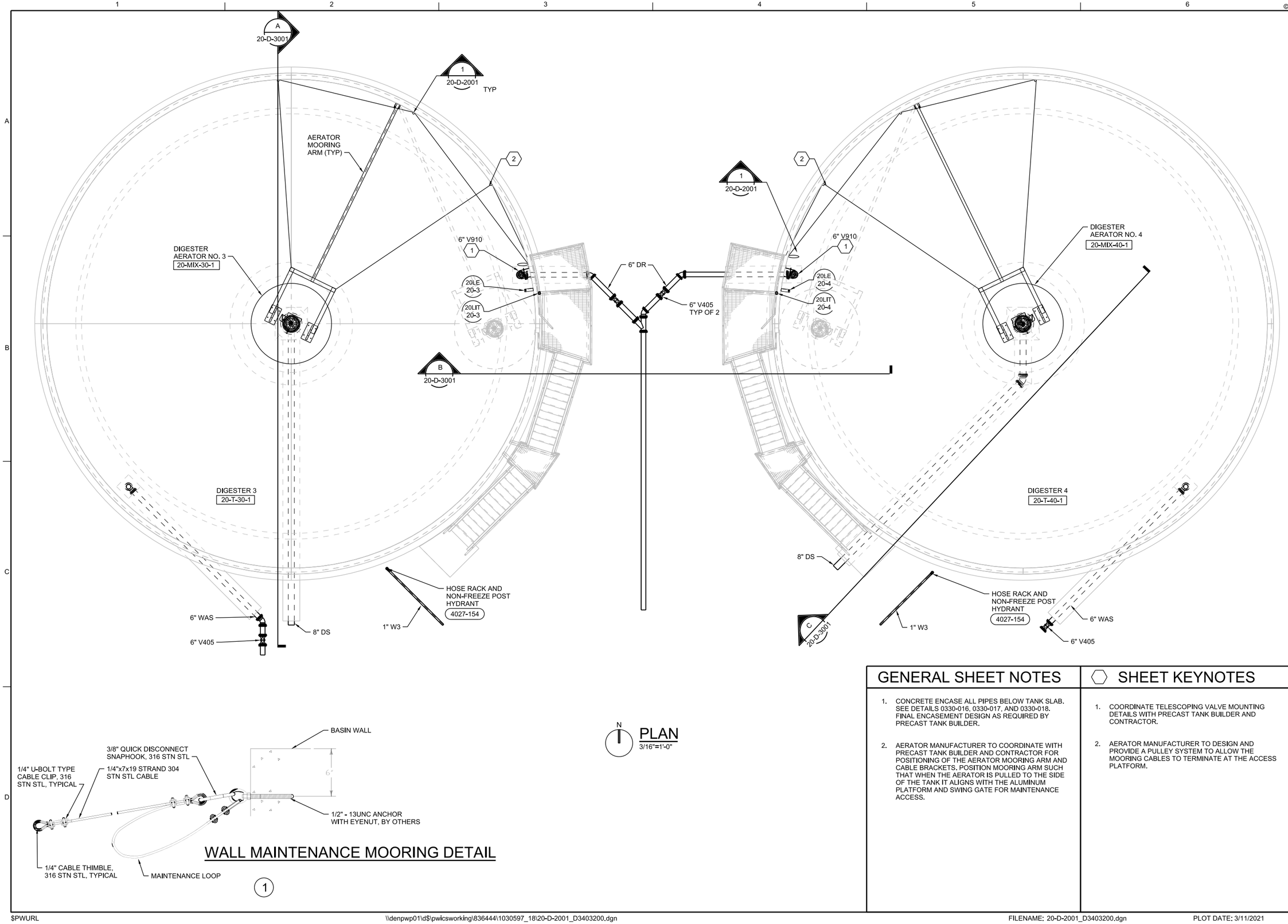

WALL MAINTENANCE MOORING DETAIL

1

N

PLAN

3/16"=1'-0"

GENERAL SHEET NOTES

1. CONCRETE ENCASE ALL PIPES BELOW TANK SLAB. SEE DETAILS 0330-016, 0330-017, AND 0330-018. FINAL ENCASEMENT DESIGN AS REQUIRED BY PRECAST TANK BUILDER.
2. AERATOR MANUFACTURER TO COORDINATE WITH PRECAST TANK BUILDER AND CONTRACTOR FOR POSITIONING OF THE AERATOR MOORING ARM AND CABLE BRACKETS. POSITION MOORING ARM SUCH THAT WHEN THE AERATOR IS PULLED TO THE SIDE OF THE TANK IT ALIGNS WITH THE ALUMINUM PLATFORM AND SWING GATE FOR MAINTENANCE ACCESS.

SHEET KEYNOTES

1. COORDINATE TELESCOPING VALVE MOUNTING DETAILS WITH PRECAST TANK BUILDER AND CONTRACTOR.
2. AERATOR MANUFACTURER TO DESIGN AND PROVIDE A PULLEY SYSTEM TO ALLOW THE MOORING CABLES TO TERMINATE AT THE ACCESS PLATFORM.

NO.	DATE	REVISION	BY	CHK	APVD
DSGN	K WADDELL	DR	KL DIAZ	R BOE	K WADDELL

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CRESTVIEW, FL

PROCESS MECHANICAL

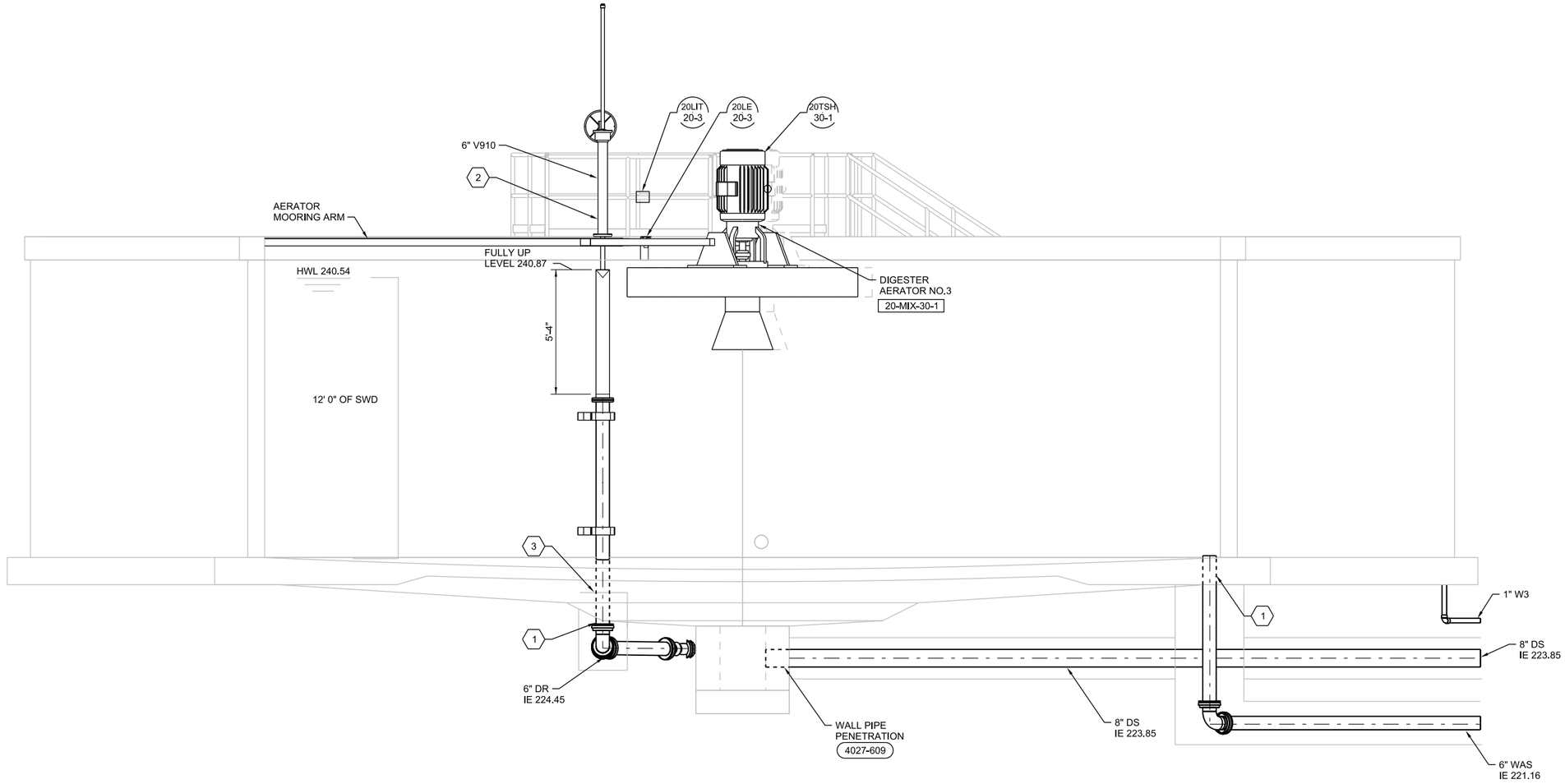
AEROBIC DIGESTERS #3 AND #4 PLAN

BID DOCUMENTS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	20-D-2001
SHEET	31 of 76



A SECTION
3/8"=1'-0"
20-D-2001

GENERAL NOTES

1. SEE 20-S-2001 FOR REQUIRED ELEVATIONS OF PROPOSED DIGESTORS.

SHEET KEYNOTES

1. FLOOR PIPE PENETRATIONS PER DETAIL 4027-622 OR AS RECOMMENDED BY TANK MANUFACTURER.
2. COORDINATE STAND-PIPE AND VALVE LOCATION SUCH THAT IT IS ACCESSIBLE OVER THE HANDRAIL.
3. TANK MANUFACTURER TO PROVIDE A LEVEL SURFACE FOR THE AERATOR TO SIT ON THE BOTTOM SLAB WHEN THE TANK IS EMPTIED. AERATOR MANUFACTURER TO COORDINATE WITH CONTRACTOR AND TANK MANUFACTURER FOR THE LOCATION OF AERATOR WHERE IT WILL SIT.

NO.	DATE	DR	CHK	APVD	BY	REVISION
DSGN	K WADDELL	KL DIAZ	R BOE	APVD	K WADDELL	

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CRESTVIEW, FL

PROCESS MECHANICAL

AEROBIC DIGESTERS #3 AND #4 SECTION

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
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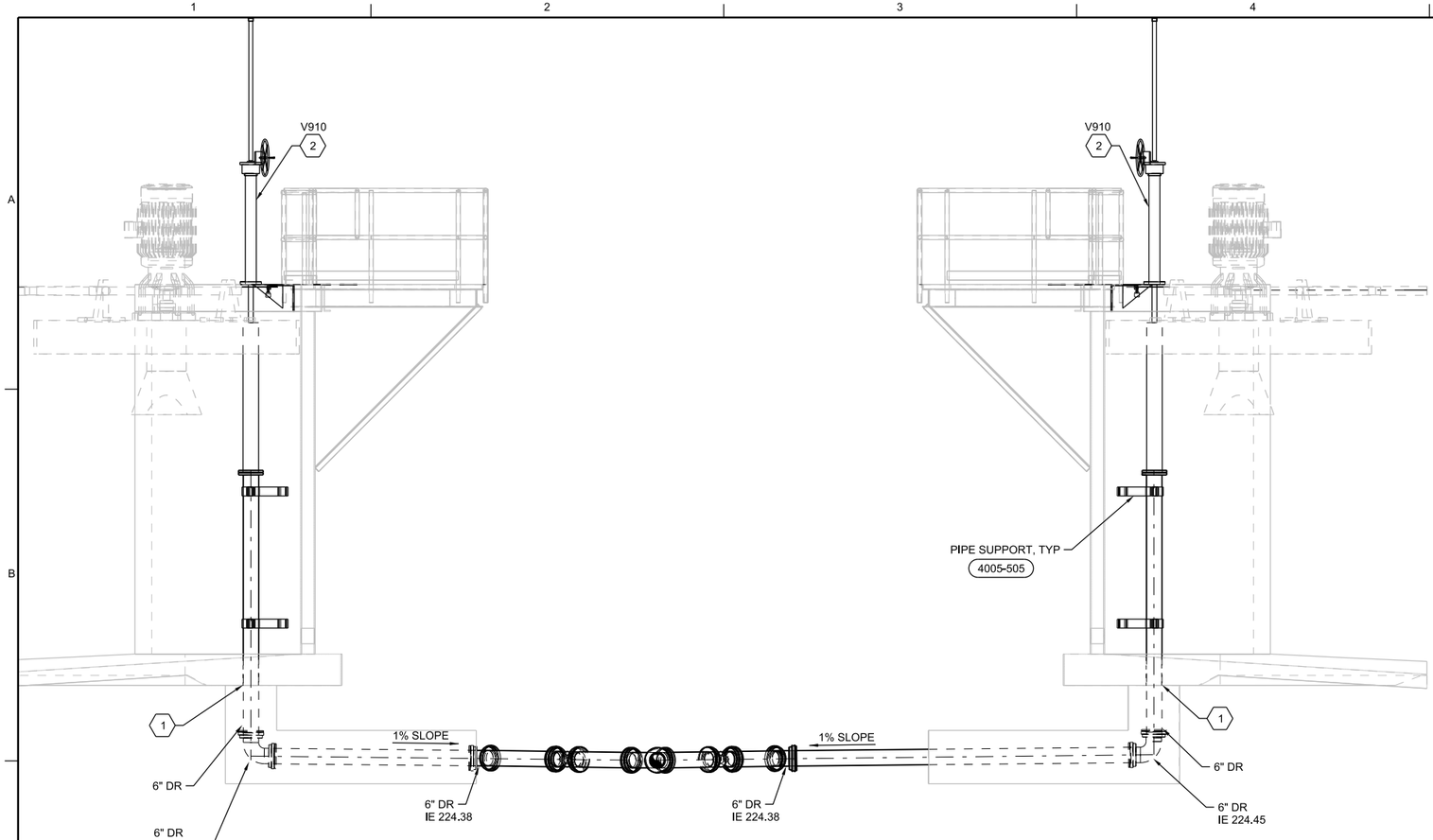
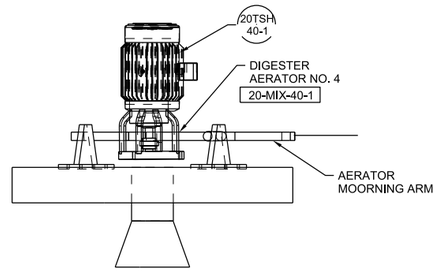
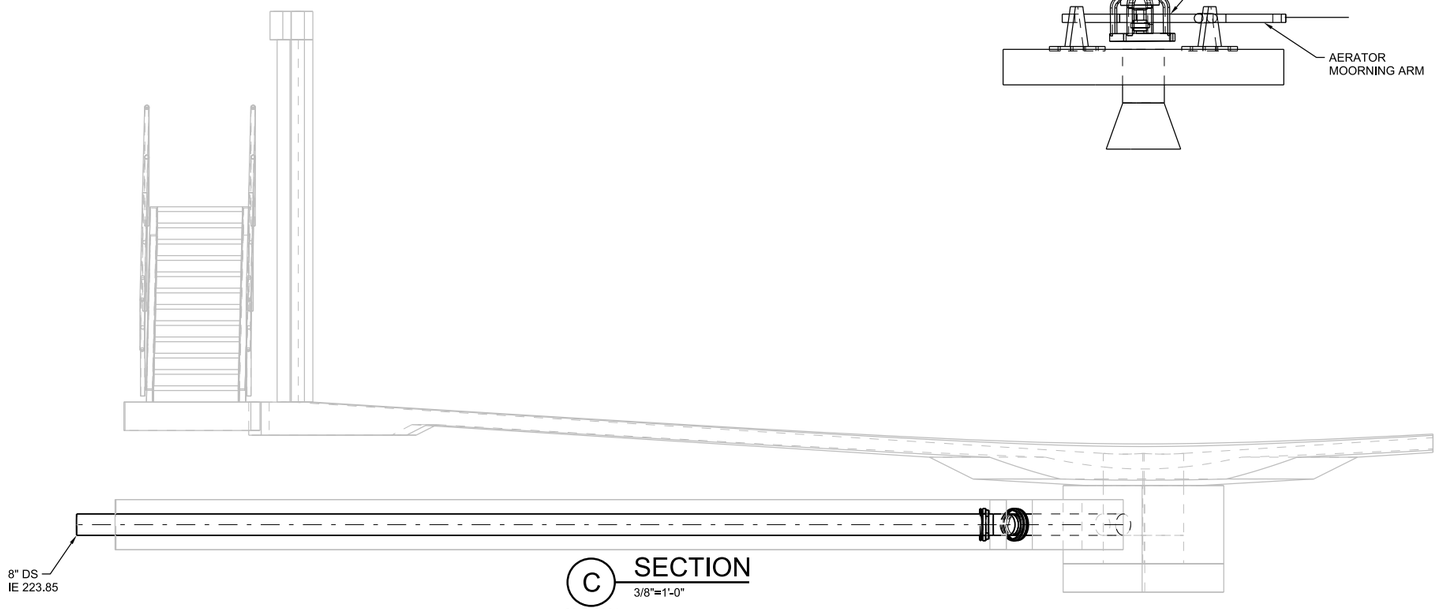


B SECTION
3/8"=1'-0"
20-D-2001

SHEET KEYNOTES

1. FLOOR PIPE PENETRATIONS PER DETAIL 4027-622 OR AS RECOMMENDED BY TANK MANUFACTURER.
2. COORDINATE STAND-PIPE AND VALVE LOCATION SUCH THAT IT IS ACCESSIBLE OVER THE HANDRAIL.
3. PIPE SUPPORTS TO BE DESIGNED BY MANUFACTURER. TELESCOPING VALVE MANUFACTURER TO PROVIDE LOADING INFORMATION AND SUPPORT RECOMMENDATIONS.





C SECTION
3/8"=1'-0"
20-D-2001

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN	K WADDELL		K DIAZ	R BOE		K WADDELL	

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CRESTVIEW, FL

PROCESS MECHANICAL

AEROBIC DIGESTERS #3 AND #4 SECTIONS

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	20-D-3002
SHEET	33 of 76

SEE SITE PLAN FOR CONTINUATION

TO DUCT BANK GROUND

[P41]

[A1]

[A1]

[P41]

AERATOR MOORING ARM (TYP)

MSC

20LIT-20-3

[C1]

20LE-20-3

20LIT-20-4

[C1]

20LE-20-4

MSC

M 20-MIX-30-1

M 20-MIX-40-1

AEROBIC DIGESTER 3
20-T-30-1

AEROBIC DIGESTER 4
20-T-40-1

#4/0 BARE COPPER (TYP)

N

PLAN
3/16"=1'-0"

GENERAL SHEET NOTES

1. ENVELOP 18 INCHES ABOVE TOP OF WALL AND 10 FEET HORIZONTALLY FROM A WETTED WALL IS CLASS 1, DIVISION 2, GROUP D AREA.
2. PROVIDE GROUND CONNECTION TO FOUNDATION REINFORCING.
3. PROVIDE GROUND CONNECTION TO STAIR AND HANDRAIL.

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
		KB HORTON	G MESSER	D NICHOLSON	APVD	KB HORTON	

BID DOCUMENTS

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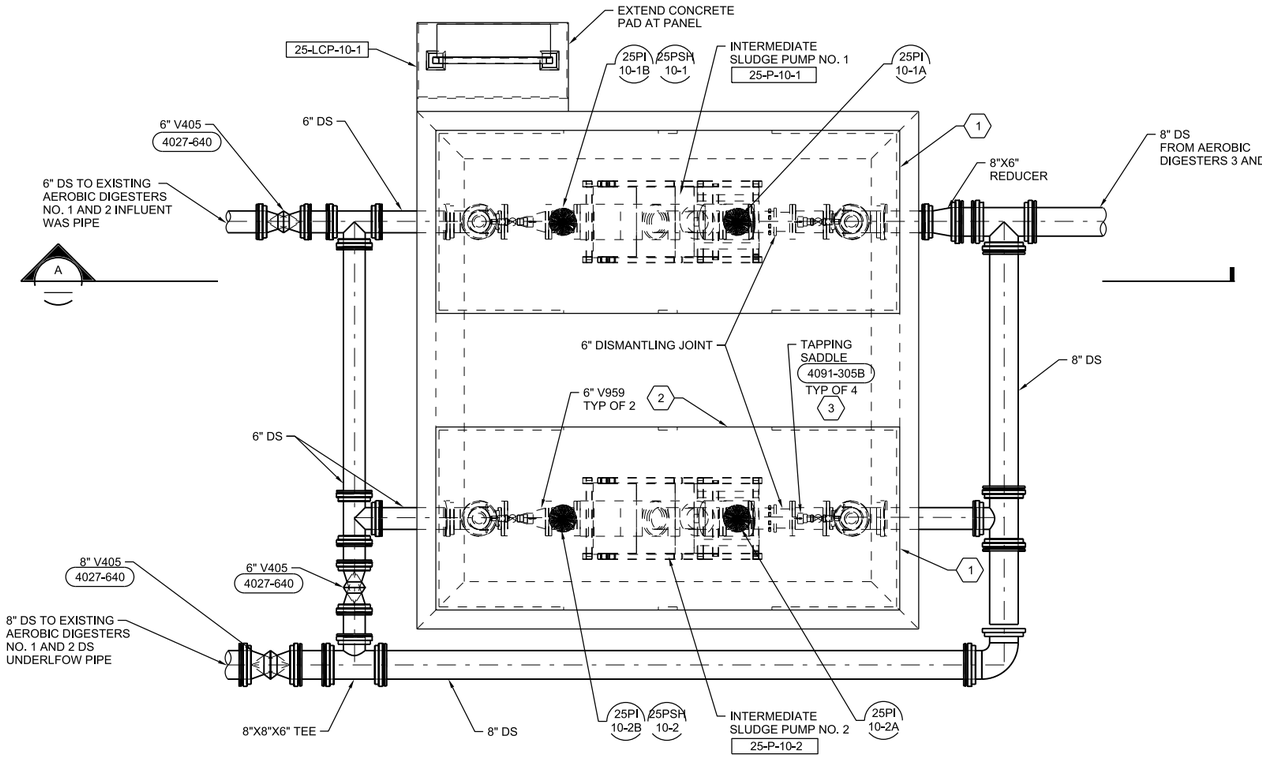
CITY OF CRESTVIEW
CRESTVIEW, FL

ELECTRICAL
AEROBIC DIGESTERS #3 AND #4 PLAN

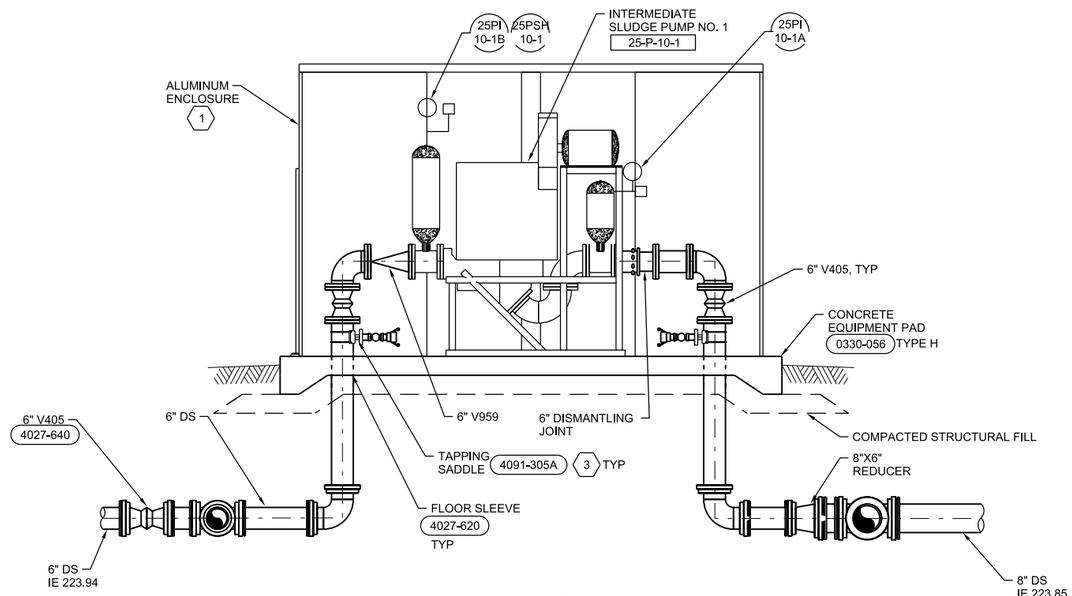
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	20-E-2001
SHEET	34 of 76



N

PLAN
1/2"=1'-0"



A SECTION
1/2"=1'-0"

SHEET KEYNOTES

1. 55"W X 144"L X 90"H (INTERNAL DIMENSIONS) 4-SECTION ALUMINUM FREEZE PROTECTION ENCLOSURE. TYP OF 2. ENCLOSURES TO BE BY AQUASHIELD OR APPROVED EQUAL. ENCLOSURES TO HAVE AN ALUMINUM LOUVER, HEATER, AND EXHAUST FAN CAPABLE OF MAINTAINING FREEZE PROTECTION WITH EXTERNAL TEMPERATURES OF -30F.
2. 39" X 90" MIN REMOVABLE ACCESS PANEL WITH LOCKABLE HANDLE (TYP OF 4 PER ENCLOSURE).
3. CLEANOUT HOSE CONNECTIONS TO INCLUDE A 1" SST PIPE SPOOL WITH A 1" SST BALL VALVE AND QUICK CONNECT FITTING.

NO.	DATE	REVISION	BY	APVD
DSGN	K WADDELL	DR	KL DIAZ	CHK	R BOE	APVD	K WADDELL

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STRUCTURAL / PROCESS MECHANICAL

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SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
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INTERMEDIATE SLUDGE TRANSFER PUMP STATION PLAN AND SECTION

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
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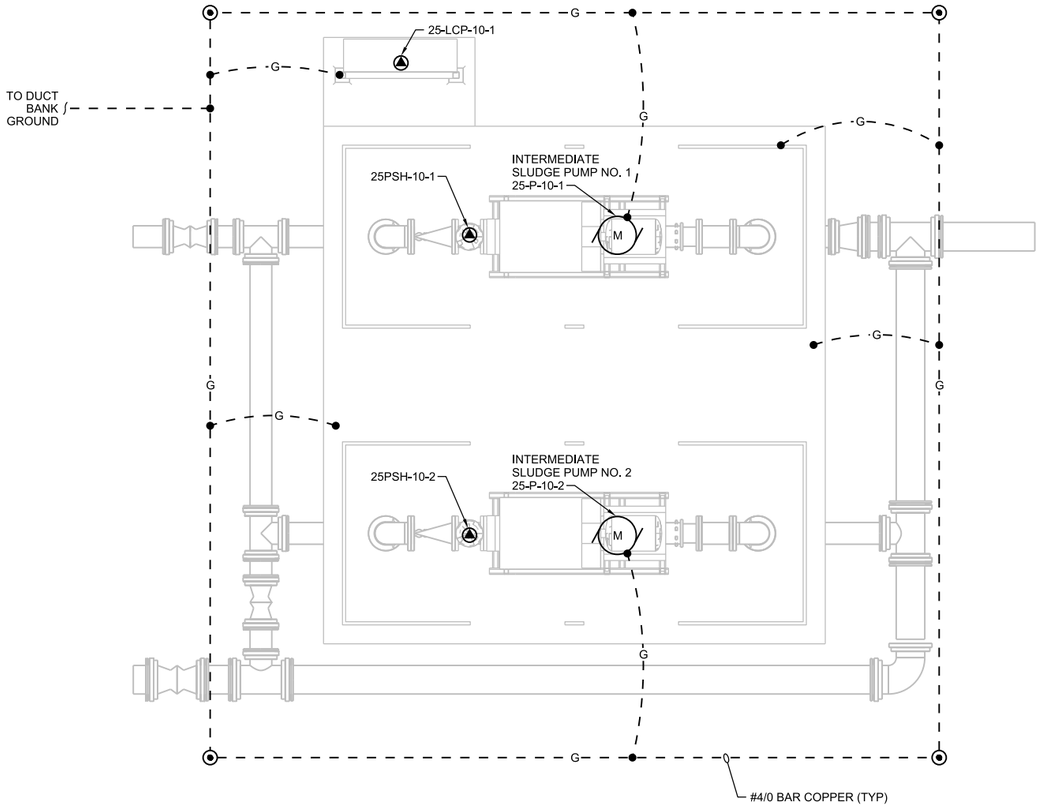

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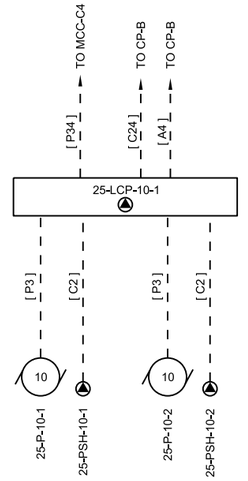
PLAN
1/2"=1'-0"



RISER DIAGRAM
NTS

GENERAL SHEET NOTES

1. PROVIDE GROUND CONNECTION TO FOUNDATION REINFORCING. BOND ALL EQUIPMENT RACKS AND SUPPORTS TO GROUND GRID.

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
REVISION		KB HORTON	A PASTRANA	D NICHOLSON			KB HORTON

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EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

ELECTRICAL
INTERMEDIATE SLUDGE TRANSFER PUMP STATION PLAN

1/2"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

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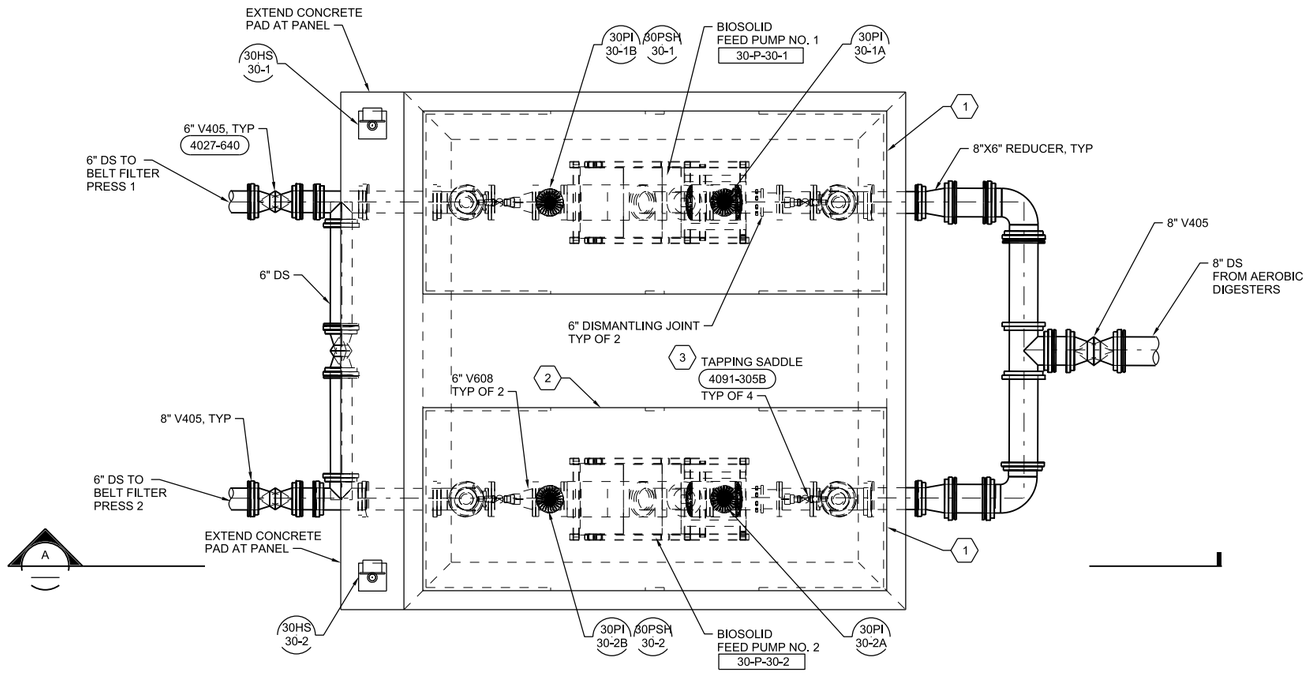
BID DOCUMENTS



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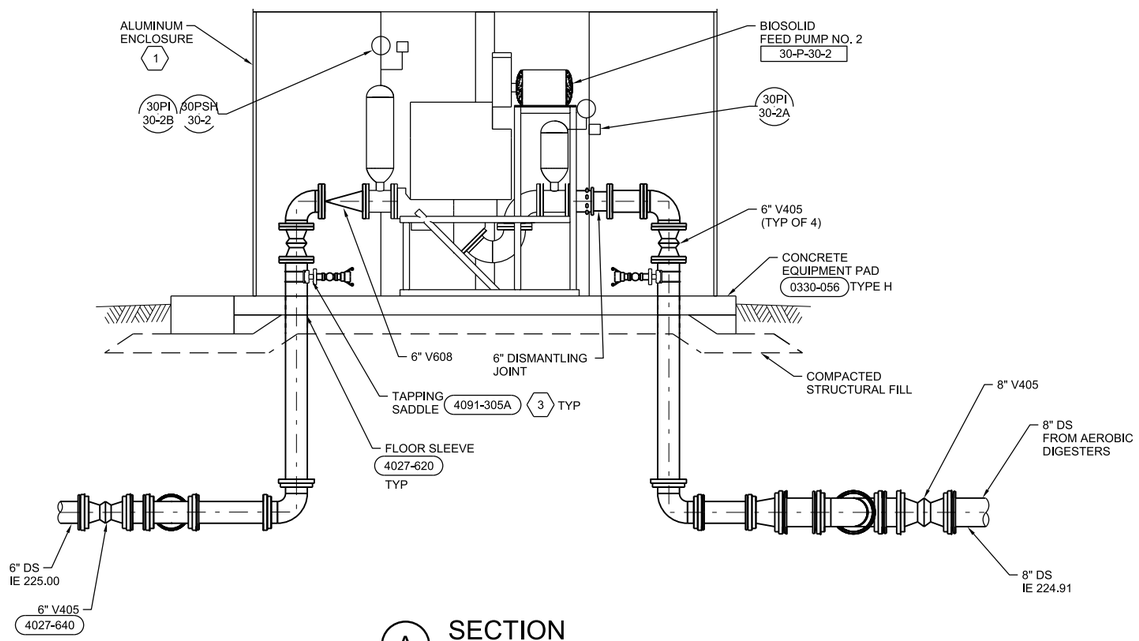
PLAN
1/2"=1'-0"



A
SECTION
1/2"=1'-0"

SHEET KEYNOTES

1. 55"W X 144"L X 90"H (INTERNAL DIMENSIONS) 4-SECTION ALUMINUM FREEZE PROTECTION ENCLOSURE. TYP OF 2. ENCLOSURES TO BE BY AQUASHIELD OR APPROVED EQUAL. ENCLOSURES TO HAVE AN ALUMINUM LOUVER, HEATER, AND EXHAUST FAN CAPABLE OF MAINTAINING FREEZE PROTECTION WITH EXTERNAL TEMPERATURES OF -30F.
2. 39" X 90" MIN REMOVABLE ACCESS PANEL WITH LOCKABLE HANDLE (TYP OF 4 PER ENCLOSURE).
3. CLEANOUT HOSE CONNECTIONS TO INCLUDE A 1" SST PIPE SPOOL WITH A 1" SST BALL VALVE AND QUICK CONNECT FITTING.

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
REVISION		K WADDELL	KL DIAZ	R BOE		K WADDELL	

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STRUCTURAL / PROCESS MECHANICAL

BIOSOLIDS FEED PUMP STATION PLAN AND SECTION

BID DOCUMENTS

VERIFY SCALE
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0 1"

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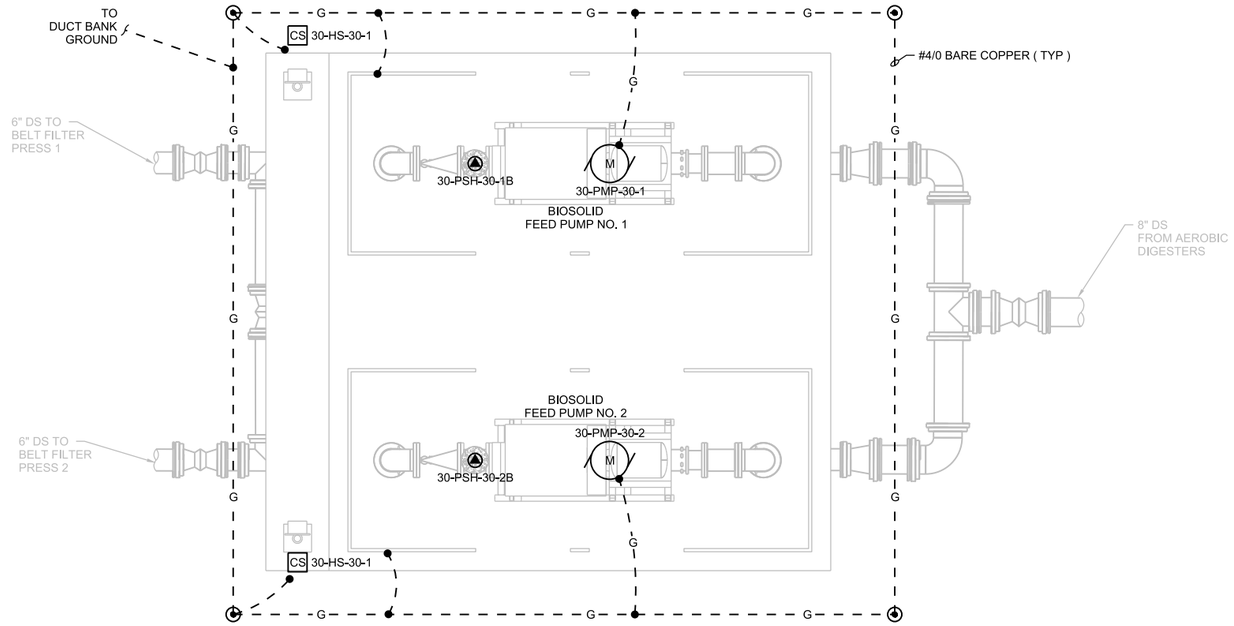
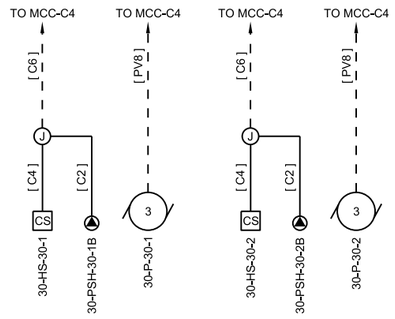


PLAN
1/2"=1'-0"



WIRING DIAGRAM
NTS

GENERAL SHEET NOTES

1. PROVIDE GROUND CONNECTION TO FOUNDATION REINFORCING. BOND ALL EQUIPMENT RACKS AND SUPPORTS TO GROUND GRID.

NO.	DATE	DR	REVISION	CHK	BY	APVD
DSGN	KB HORTON	G MESSER		D NICHOLSON	APVD	KB HORTON

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ELECTRICAL

BIOSOLIDS FEED PUMP STATION POWER PLAN

BID DOCUMENTS

VERIFY SCALE
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0 1"

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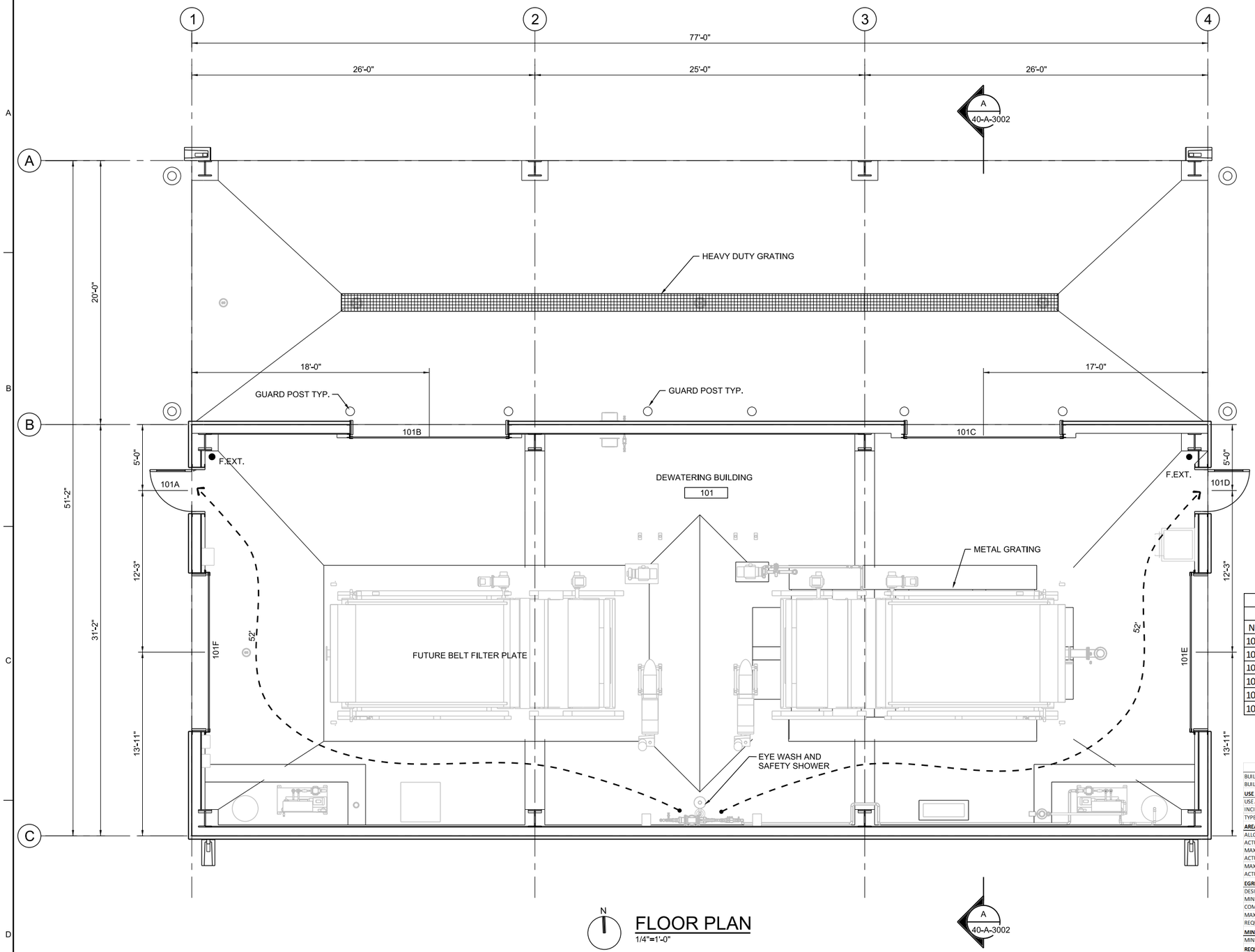

N

FLOOR PLAN
1/4"=1'-0"

A
40-A-3002

GENERAL NOTES

METAL BUILDING TO PROVIDE SUPPORT FOR FOLLOWING:-

- ROOF TOP MECHANICAL EQUIPMENT AND DUCTWORK CONVEYOR SUPPORTS HUNG FROM ROOF STRUCTURE.
- PIPING HUNG FROM ROOF STRUCTURE AND ATTACHED TO EXTERIOR WALL.
- CO-ORDINATE FRAMING MEMBERS, STRUCTURAL LOADING AND OPENING SIZES.

LEGEND:-

- ‹–'X'– • TRAVEL DISTANCE (X = TOTAL DISTANCE TO EXIT)
- ● F.EXT. FIRE EXTINGUISHER, SEE PLAN
- EYE WASH AND SAFETY SHOWER

Door Schedule					
	Door Opening		Door		
Number	Width	Height	Type	Thickness	Material
101A	3'-0"	7'-0"	Half Glazed	1 3/4"	FRP
101B	12'-0"	12'-0"	Overhead Coiling Door	-	STL
101C	12'-0"	12'-0"	Overhead Coiling Door	-	STL
101D	3'-0"	7'-0"	Half Glazed	1 3/4"	FRP
101E	12'-0"	12'-0"	Overhead Coiling Door	-	STL
101F	12'-0"	12'-0"	Overhead Coiling Door	-	STL

BUILDING CODE DATA	
BUILDING CODE	FLORIDA BUILDING CODE SEVENTH EDITION (2020)
BUILDING NAME	DEWATERING BUILDING
USE AND OCCUPANCY CLASSIFICATION AND TYPE OF CONSTRUCTION	
USE AND OCCUPANCY CLASS (CHAPTER 3)	F-2, LOW-HAZARD FACTORY INDUSTRIAL
INCIDENTAL USE GROUPS (TABLE 509)	NONE
TYPE OF CONSTRUTION (CHAPTER 6)	TYPE II-B, NONCOMBUSTIBLE, UNPROTECTED
AREA AND HEIGHT LIMITATIONS	
ALLOWABLE AREA PER FLOOR (IBC TABLE 506.2)	23,000 SF WITHOUT FRONTAGE INCREASE
ACTUAL AREA	4,192 SF
MAXIMUM NUMBER OF STORIES (TABLE 504.4)	3 STORIES
ACTUAL NUMBER OF STORIES	1 STORY
MAXIMUM ALLOWABLE HEIGHT (TABLE 504.3)	55 FEET
ACTUAL HEIGHT	26'-7"
EGRESS REQUIREMENTS	
DESIGN OCCUPANT LOAD (TABLE 1004.5)	14 OCCUPANTS @ 300 SF/PERSON OCCUPANT LOAD FACTOR
MINIMUM EGRESS WIDTH (1005 AND 1010.1)	32 INCHES CLEAR WIDTH
COMMON PATH OF TRAVEL (TABLE 1006.2.1)	75 FEET
MAX TRAVEL DISTANCE (TABLE 1017.2)	300 FEET
REQUIRED EXITS (1006.2.1)	2 EXITS REQUIRED, 2) 3'-0" EXIT DOORS PROVIDED
MINIMUM PLUMBING FIXTURES (TABLE 2902.1)	
MINIMUM DISTANCE TO TOILET (2902.3.3)	EXISTING TOILET IN ADJACENT ADMIN BUILDING LESS THAN 500 FEET AWAY
REQUIRED FIRE RESISTANT RATINGS	
BUILDING ELEMENTS HOURLY FIRE RATING (TABLE 601)	
PRIMARY STRUCTURAL FRAME	0 HOURS
EXTERIOR BEARING WALLS	0 HOURS
INTERIOR BEARING WALLS	0 HOURS
INTERIOR NON-BEARING WALLS	0 HOURS
FLOOR CONSTRUCTION	0 HOURS
ROOF CONSTRUCTION	0 HOURS
FIRE SEPARATION DISTANCE (TABLE 602)	0 HOURS, DISTANCE 10 FEET OR GREATER
FIRE PROTECTION	
AUTOMATIC SPRINKLER SYSTEM (903)	NOT REQUIRED, NOT PROVIDED
FIRE EXTINGUISHERS (906)	AT EXITS
FIRE ALARM (907)	REQUIRED, PROVIDED
ACCESSIBILITY REQUIREMENTS	
EQUIPMENT SPACES ARE NOT REQUIRED TO BE ACCESSIBLE	

NO.	DSGN	DATE	DR	REVISION	CHK	APVD	BY	APVD
			R HUSERIK	PA KARABAN	A DOLSAK	A DOLSAK	A DOLSAK	A DOLSAK

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ARCHITECTURAL
DEWATERING BUILDING
FLOOR PLAN

1/4"=1'-0"
VERIFY SCALE
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0 1"

DATE	MARCH 2021
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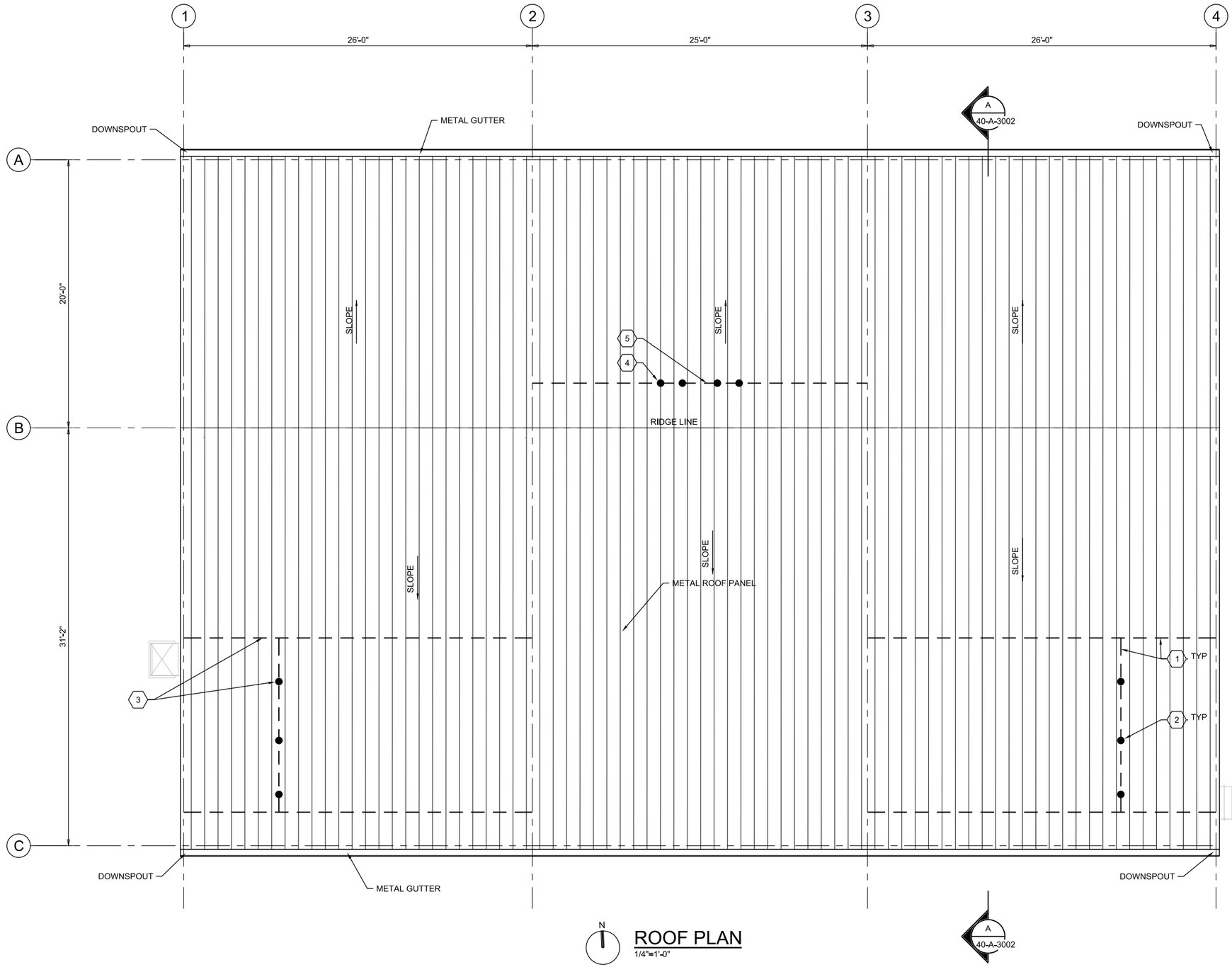

ROOF PLAN
1/4"=1'-0"

SHEET KEYNOTES

1. PIPE SUPPORT FRAMING MEMBERS DESIGNED AND PROVIDED WITH BUILDING BY BUILDING MANUFACTURER. LOCATE BEAMS BELOW CEILING LINER PANEL.
2. COORDINATE PIPE HANGER LOAD MAGNITUDES AND LOCATIONS WITH BUILDING MANUFACTURER.
3. PIPE SUPPORT FRAMING MEMBERS FOR FUTURE PIPES PROVIDED BY BUILDING MANUFACTURER SIMILAR TO EAST SIDE NOTED IN KEYNOTES 1 AND 2.
4. COORDINATE CONVEYOR HANGER LOAD MAGNITUDES AND LOCATIONS WITH BUILDING MANUFACTURER.
5. CONVEYOR SUPPORT FRAMING MEMBER DESIGNED AND PROVIDED WITH BUILDING BY BUILDING MANUFACTURER. LOCATE BEAM BELOW CEILING LINER PANEL.

NO.	DATE	DR	CHK	APVD
DSGN	R HUSERIK	PA KARABAN	A DOLSAK	APVD

REVISION BY APVD
A DOLSAK

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ROOF PLAN

BID DOCUMENTS

1/4"=1'-0"
VERIFY SCALE
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0 1"

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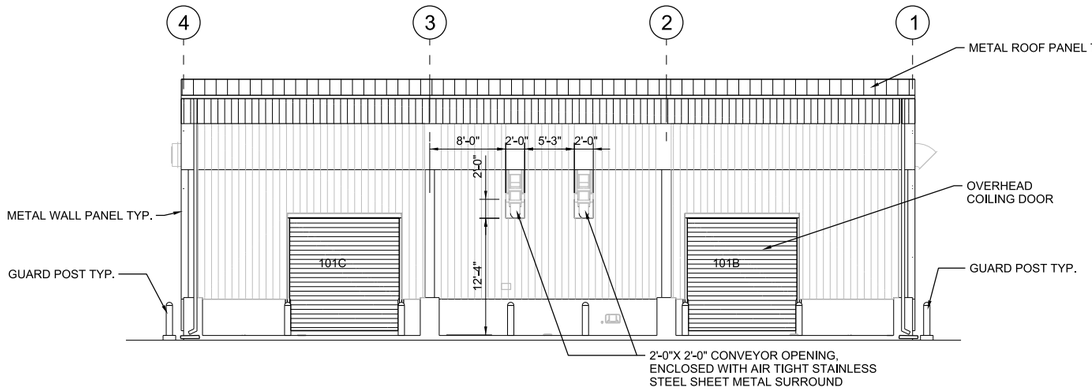
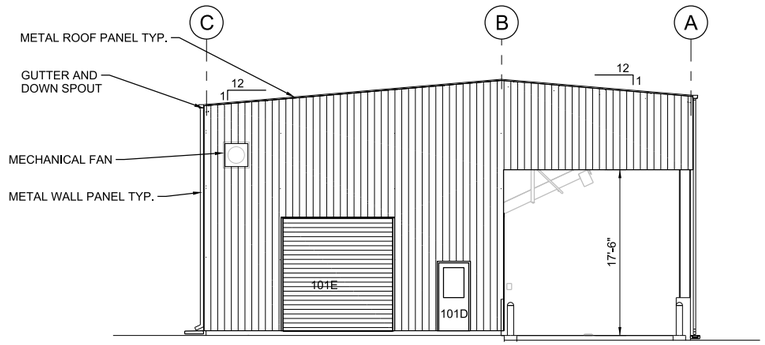
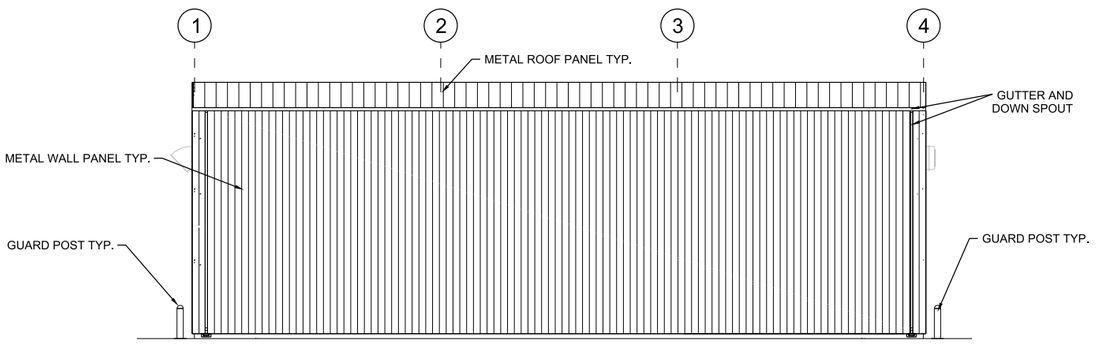


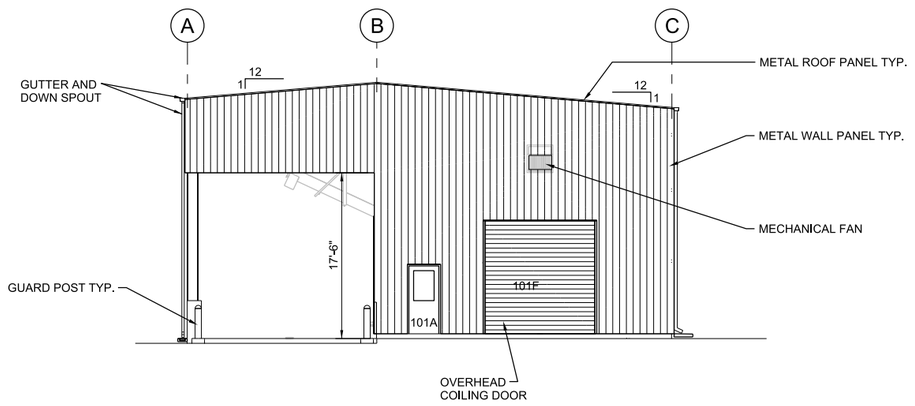
NORTH ELEVATION
1/8"=1'-0"



EAST ELEVATION
1/8"=1'-0"



SOUTH ELEVATION
1/8"=1'-0"



WEST ELEVATION
1/8"=1'-0"

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ARCHITECTURAL
DEWATERING BUILDING ELEVATIONS

1/8"=1'-0"
VERIFY SCALE
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0 1"

DATE	MARCH 2021
PROJ	D3403200
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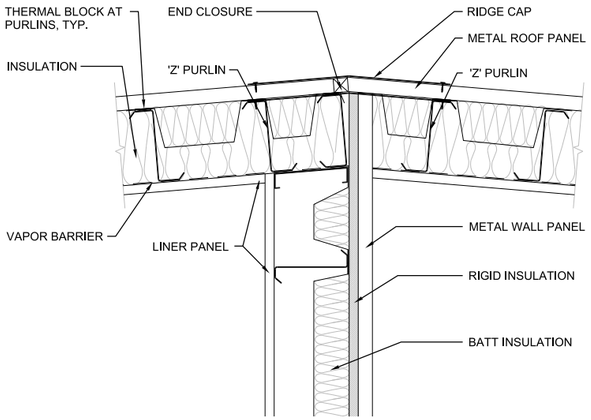
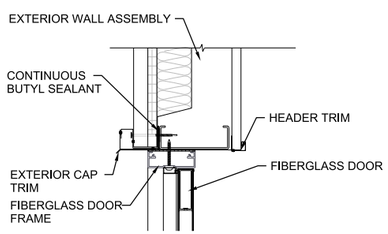
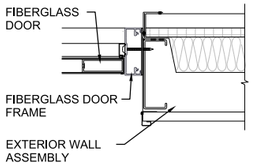


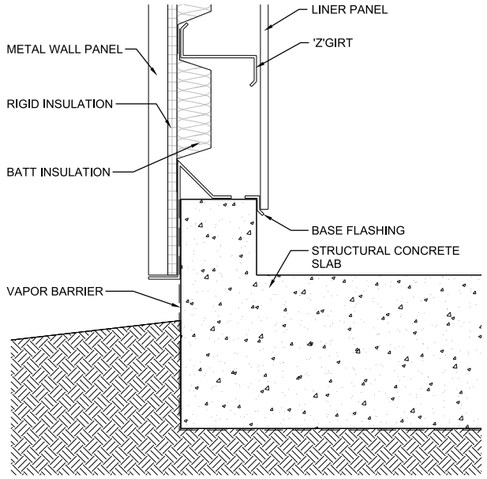
RIDGE DETAIL
1 1/2"=1"



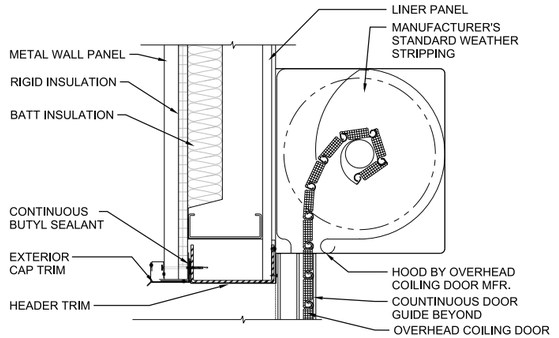
FIGERGLASS DOOR HEAD DETAIL
1 1/2"=1"



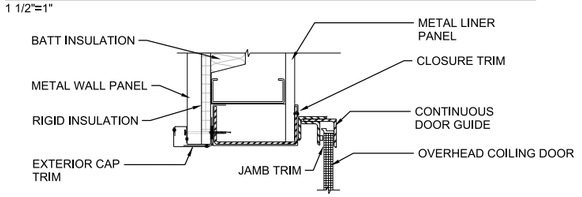
FIBERGLASS DOOR JAMB DETAIL
1 1/2"=1"



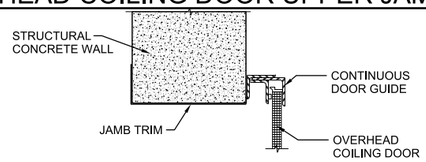
EXTERNAL WALL DETAIL
1 1/2"=1"



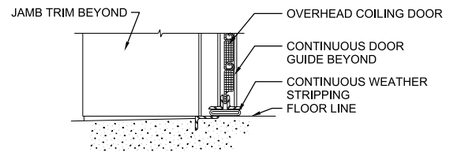
OVERHEAD COILING DOOR HEAD DETAIL
1 1/2"=1"



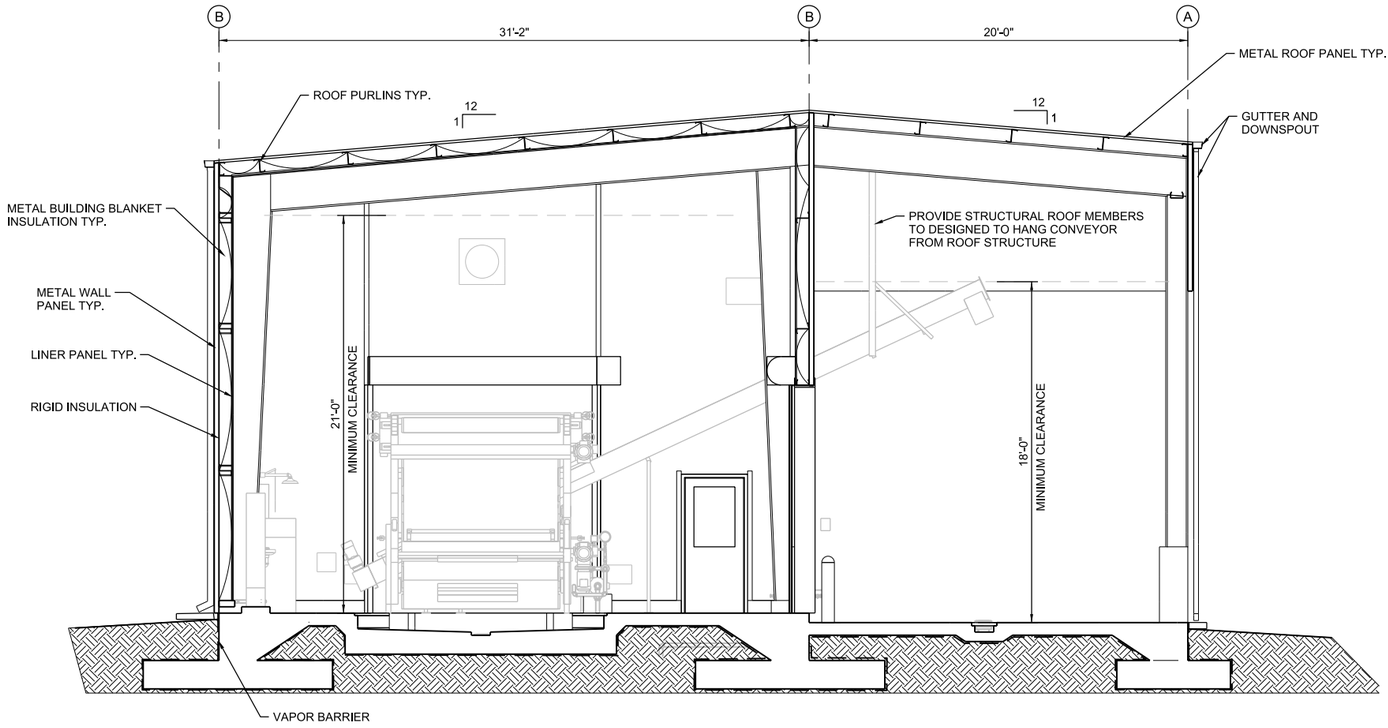
OVERHEAD COILING DOOR UPPER JAMB
1 1/2"=1"



OVERHEAD COILING DOOR LOWER JAMB
1 1/2"=1"



OVERHEAD COILING DOOR SILL DETAIL
1 1/2"=1"



A SECTION
1/4"=1'-0"
40-A-2001, 40-A-2002

NO.	DATE	DSGN	REVISION	CHK	BY	APVD
	R HUSERIK	DR	PA KARABAN	A DOLSAK	A DOLSAK	A DOLSAK

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DEWATERING BUILDING
SECTION

BID DOCUMENTS

3/8"=1'-0"	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
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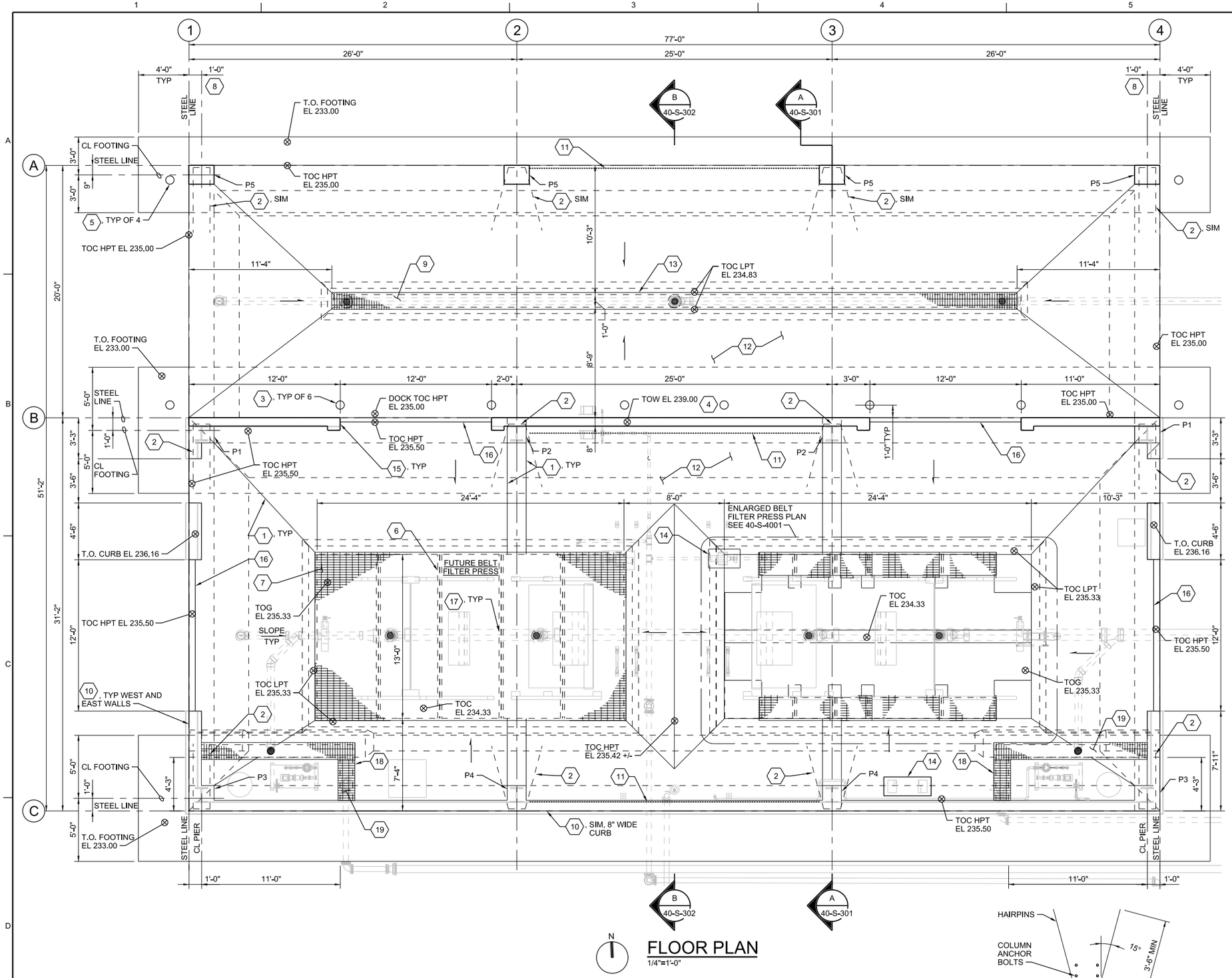
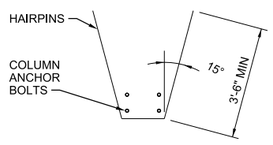


FLOOR PLAN
1/4"=1'-0"



NOTE 1: HOOKED U-BARS, SEE REFERENCED DETAIL.

HAIRPIN PLAN DETAIL
NTS

GENERAL SHEET NOTE

1. METAL BUILDING SUPPLIER TO PROVIDE ADDITIONAL ROOF BEAMS FOR SUPPORT OF SUSPENDED PIPES. SEE ROOF PLAN ON ARCHITECTURAL DRAWINGS.

SHEET KEYNOTES

1. SAWN CONTROL JOINTS 0315-192.
2. ENCLOSE COLUMN ANCHOR BOLTS WITH(2) #6 BUNDLED HAIRPINS CENTERED IN SLAB ON GRADE. LAP WITH SLAB STEEL. SEE HAIRPIN PLAN DETAIL THIS PAGE.
3. GUARD POST 0559-026. CENTER POSTS ON ENDS OF OH DOOR OPENINGS AS SHOWN.
4. 4'-0"H CONC WALL TYPICAL ALONG GRID B.
5. EXTERIOR TRAFFIC BOLLARDS, SEE CIVIL DETAILS. COORDINATE BOLLARD W/ BUILDING FOUNDATION STRIP FOOTING.
6. FRP BEAMS ATTACHED TO SUMP FLOOR FOR SUPPORT OF FRP GRATING AT FUTURE BELT FILTER PRESS AREA.
7. FRP GRATING 0682-030, W/ SUPPORT TYPE GS-2 AT FRP BEAMS AND GS-3 AT CONCRETE EDGES.
8. COORDINATE ACTUAL ENDWALL FRAME CENTER LINE WITH BUILDING MANUFACTURER.
9. HEAVY DUTY STEEL GRATING W/ GS-1 SUPPORTS 0553-001.
10. 1'-0"W X 8"H CONCRETE CURB, 0330-080. COORDINATE DEPTH OF DOOR POSTS PROVIDED BY BUILDING MANUFACTURER TO ENSURE CURB WIDTH EXCEEDS POST DEPTH.
11. METAL BUILDING BRACE RODS LOCATED IN CENTER BAY BETWEEN GRIDS 2 AND 3.
12. SLAB CONSTRUCTION (UON):
    - 8" MIN SLAB ON GRADE
    - REINFORCED WITH #5@12" OC EW CENTERED
    - OVER VAPOR RETARDER
13. 1'-0"Wx6"D TRENCH, 0330-043 TYPE 'B' SIM.
14. CONCRETE EQUIPMENT PAD 0330-056 TYPE 'E'.
15. PROVIDE THICKENED WALL AT OVERHEAD DOOR POSTS. MIN WIDTH 12" X DEPTH EQUAL TO DOOR POST DEPTH. COORDINATE WITH BUILDING SUPPLIER
16. EMBEDDED GALV ANGLE AT OH DOOR, SEE ARCHITECTURAL DRAWINGS.
17. PROVIDE BREAK AT MIDPOINT OF FRP BEAMS TO ALLOW DRAINAGE BETWEEN MODULES TO FLOOR DRAINS.
18. 1'-0"W X 6" DEEP FORMED CONCRETE TRENCH 0330-043. SLOPE TO DRAIN WITH FRCF AS NOTED IN DETAIL.
19. GRATING SUPPLIER TO PROVIDE BEARING PLATE FOR ADJACENT GRATING BEARING SUPPORT.

PIER SCHEDULE

MARK	SIZE (WPxLP)	T/ PIER ELEVATION	VERT BAR	TIES	FOUNDATION DETAILS
P1	2'-0"x2'-0"	236.16	(8) #7	#4@9"	2/ 40-S-5001
P2	1'-6"x2'-0"	236.16	(8) #7	#4@9"	2/ 40-S-5001
P3	2'-0"x2'-0"	236.16	NOTE 1	#4@9"	1/ 40-S-5001
P4	1'-6"x2'-0"	236.16	NOTE 1	#4@9"	1/ 40-S-5001
P5	2'-0"x1'-6"	239.00	(8) #7	#4@9"	3/ 40-S-5001

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN	DR EVERSON		PA KARABAN	CW ANSON			DR EVERSON

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STRUCTURAL
DEWATERING BUILDING
FLOOR PLAN AND DETAIL

AS NOTED
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
PROJ	D3403200
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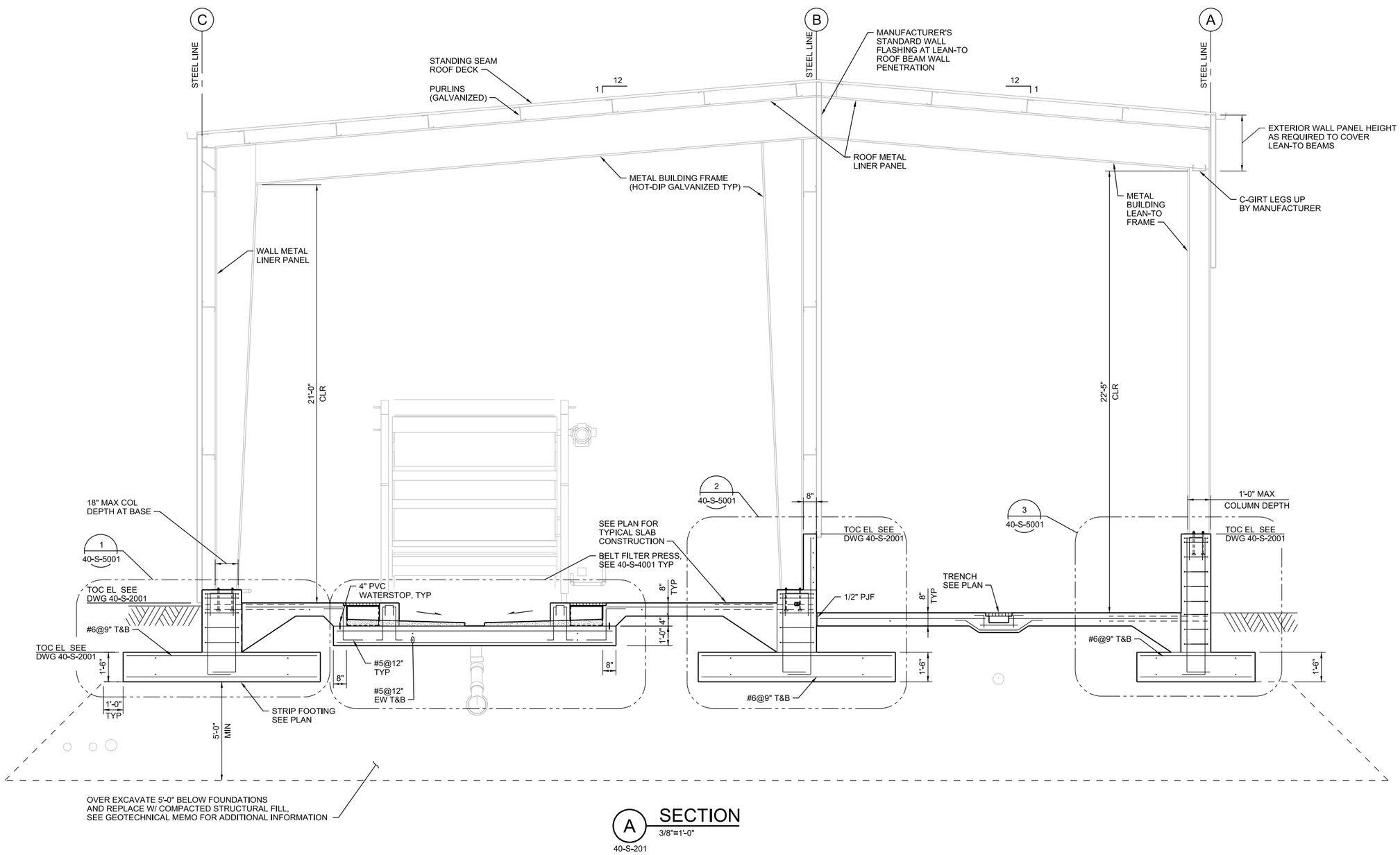

A SECTION
3/8"=1'-0"
40-S-201

NO.	DATE	REVISION	BY	APVD
DSGN	DR EVERSON	DR	PA KARABAN	CHK	CW ANSON	APVD	DR EVERSON

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STRUCTURAL
DEWATERING BUILDING SECTION

BID DOCUMENTS

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DWG	40-S-3001
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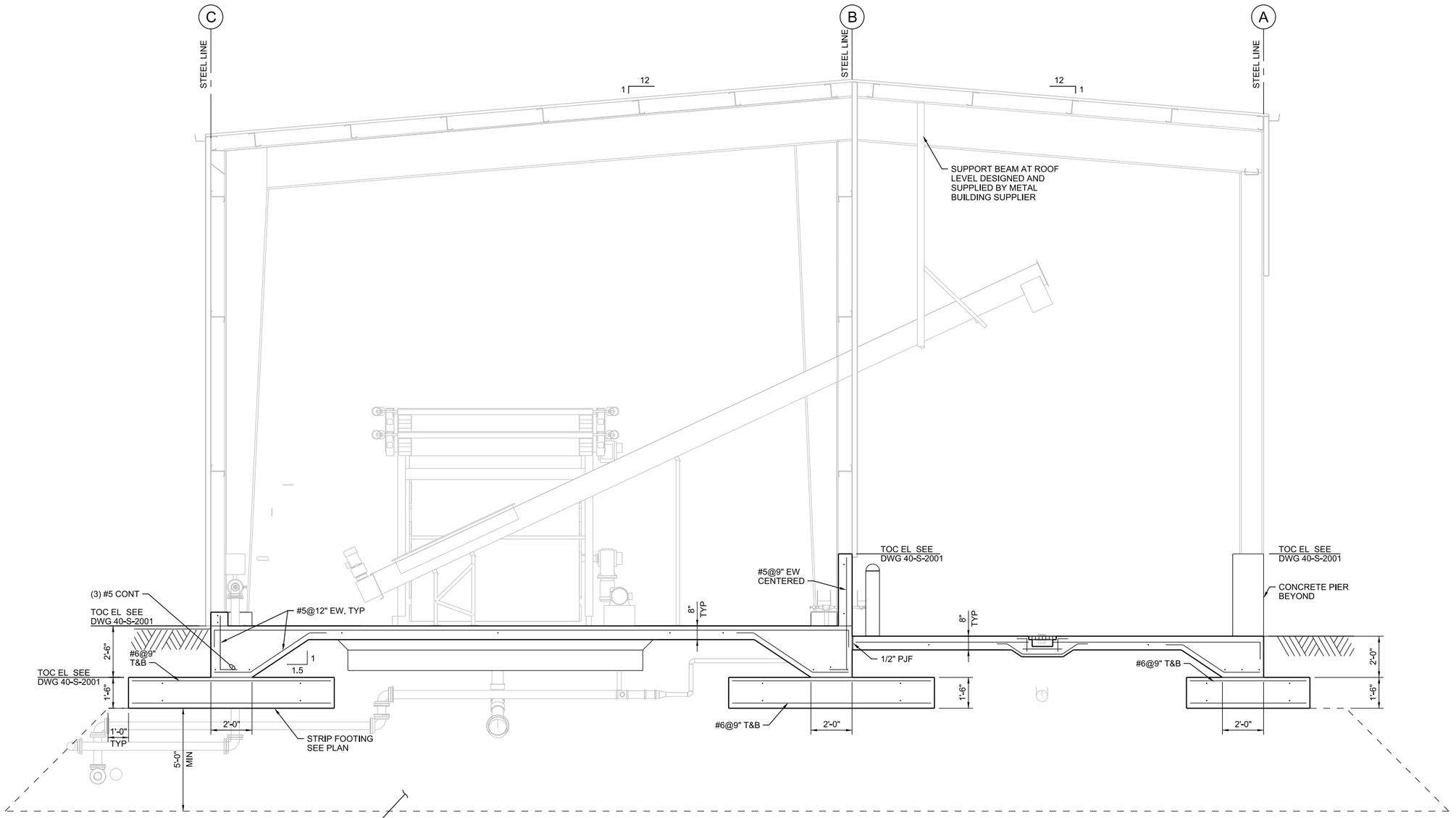

B SECTION
3/8"=1'-0"
40-S-201

NO.	DATE	REVISION	BY	CHK	APVD
DSGN	DR EVERSON	DR	PA KARABAN	CW ANSON	DR EVERSON

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STRUCTURAL
DEWATERING BUILDING SECTION

BID DOCUMENTS

AS NOTED	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
PROJ	D3403200
DWG	40-S-3002
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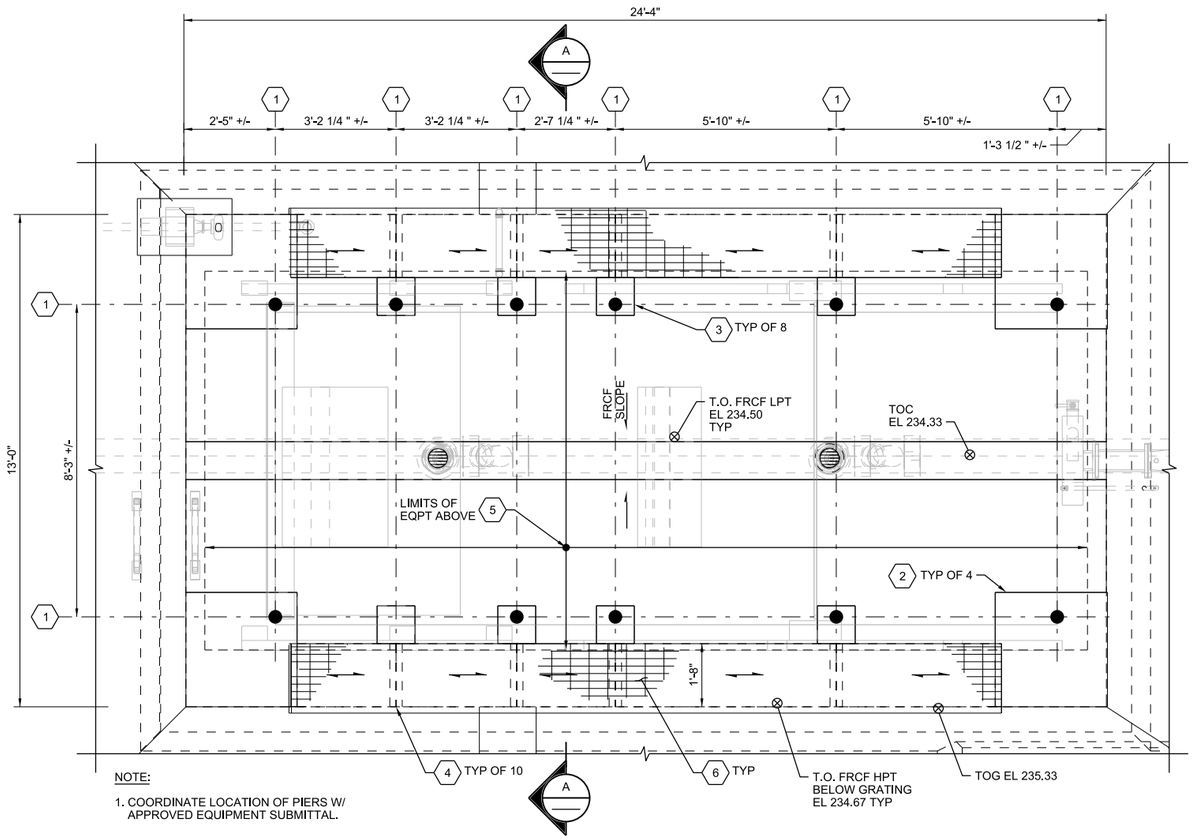


NOTE:

1. COORDINATE LOCATION OF PIERS W/ APPROVED EQUIPMENT SUBMITTAL.

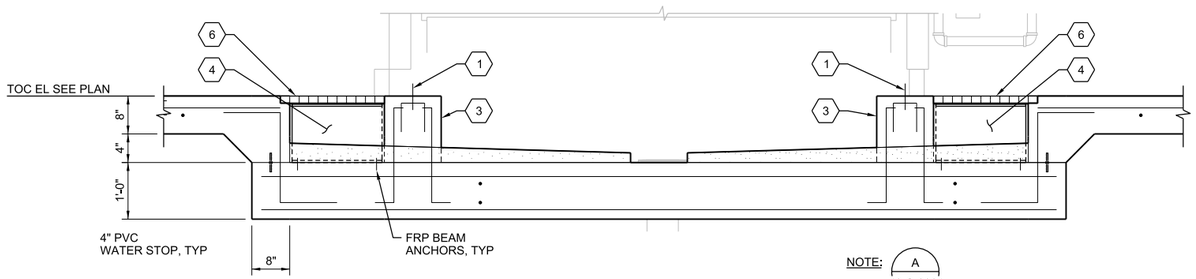
SHEET KEYNOTES

1. EQUIPMENT ANCHOR POSITION BASED ON PRELIMINARY VENDOR DATA. COORDINATE FINAL ANCHOR POSITION AND ADJUST CONCRETE SUPPORT POSITIONS AS REQUIRED.
2. CONCRETE EQUIPMENT PAD AT CORNERS FOR GRATING AND EQUIPMENT SUPPORT 0330-056 TYPE 'A'.
3. 1'-0" MIN SQ CONCRETE EQUIPMENT PADS AT EQUIPMENT ANCHOR POINTS 0330-056 TYPE 'A'.
4. FRP BEAMS FOR SUPPORT OF GRATING SECTIONS. ANCHOR TO SLAB WITH CONCRETE ANCHORS, MIN 2 EACH END. GROUT BEAM AS REQUIRED TO MAINTAIN GRATING ELEVATIONS.
5. LIMITS OF PROPOSED EQUIPMENT ABOVE SHOWN. COORDINATE ACTUAL SIZE AND POSITION REQUIRED FOR FINAL INSTALLATION.
6. FRP PULTRUDED GRATING. LIMIT SPAN TO 5'-6" MAX. PROVIDE ADDITIONAL FRP SUPPORT BEAMS WHERE REQUIRED TO MAINTAIN SPAN LIMITS. SEE DETAIL 0682-030 WITH THE FOLLOWING SUPPORT TYPES:
   BEARING ENDS AT CONC PAD: GS-1
   BEARING ENDS AT FRP BEAMS: GS-2
   NON BEARING SIDE AT CONC SLAB: GS-3

N

ENLARGED BELT FILTER PRESS PLAN

1/2"=1'-0"



A SECTION

3/4"=1'-0"

NO.	DATE	DSGN	REVISION	BY	APVD
		DR EVERSON	DR	PA KARABAN	CHK	CW ANSON	APVD	DR EVERSON

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EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

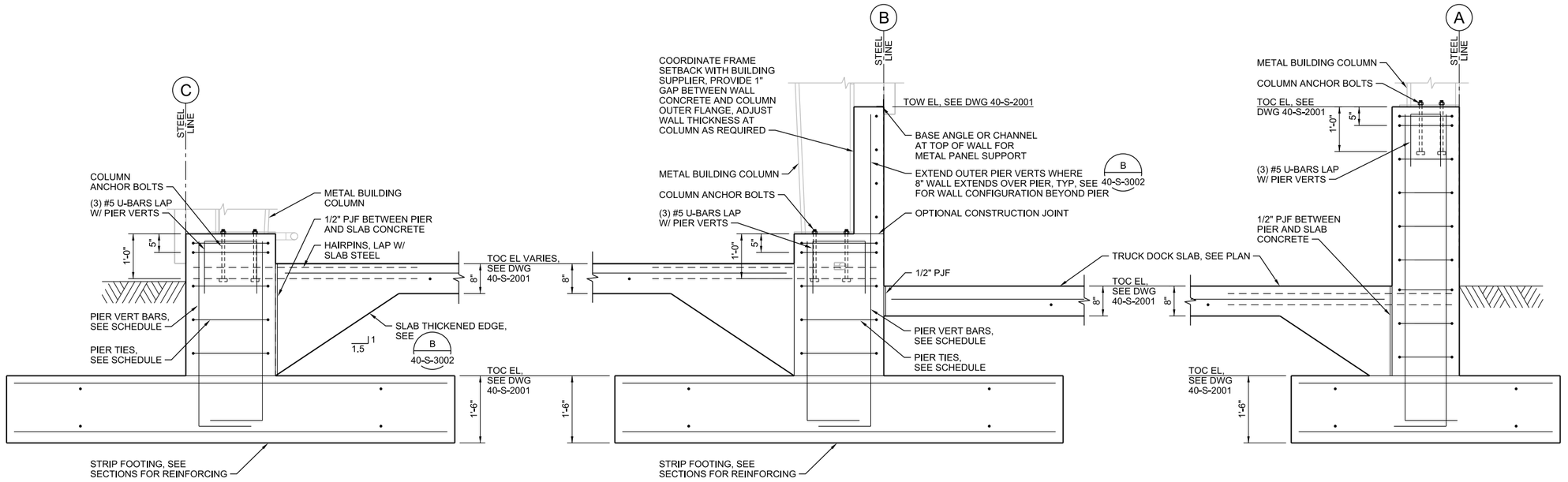
Jacobs

STRUCTURAL

BELT FILTER PRESS
ENLARGED PLAN AND SECTION

BID DOCUMENTS

AS NOTED	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
PROJ	D3403200
DWG	40-S-4001
SHEET	46 of 76



NO.	DATE	REVISION	BY	APVD
DSGN	DR EVERSON	DR	PA KARABAN	CHK	CW ANSON	APVD	DR EVERSON

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PENSACOLA, FLORIDA 32502
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CRESTVIEW, FL

STRUCTURAL
DEWATERING BUILDING DETAILS

BID DOCUMENTS

AS NOTED
VERIFY SCALE
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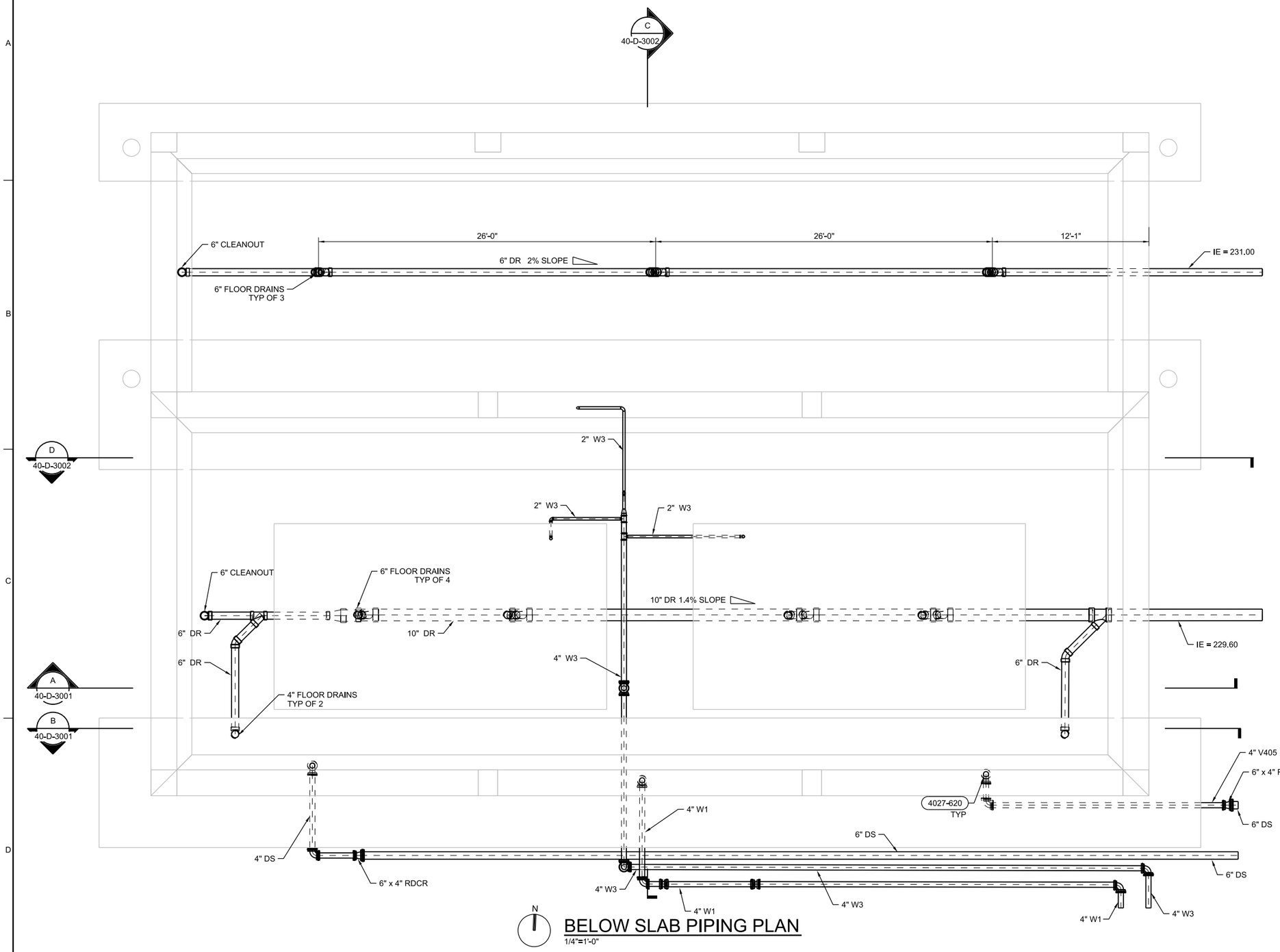
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-S-5001
SHEET	47 of 76



BELOW SLAB PIPING PLAN

1/4"=1'-0"

GENERAL NOTES

1. FLOOR DRAINS TO BE JAY R SMITH MODEL 2290 HEAVY-DUTY FLOOR DRAINS TRAFFIC RATED AND INSTALLED PER MANUFACTURER'S RECOMMENDATION.
2. COORDINATE UNDERSLAB UTILITIES WITH STRUCTURAL FOUNDATIONS TO AVOID CONFLICTS.
3. ALL FLOOR PIPE PENETRATIONS TO INCLUDE A FLOOR SLEEVE PER DETAIL 4027-620.
4. ALL PIPING UNDERNEATH BUILDING AND EXTENDING 5' BEYOND IS TO BE CONCRETE ENCASED.

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
		K WADDELL	K DIAZ	R BOE	K WADDELL	APVD	

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PENSACOLA, FLORIDA 32502
EB25861

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PROCESS MECHANICAL

DEWATERING BUILDING
BELOW SLAB PIPING PLAN

BID DOCUMENTS

VERIFY SCALE
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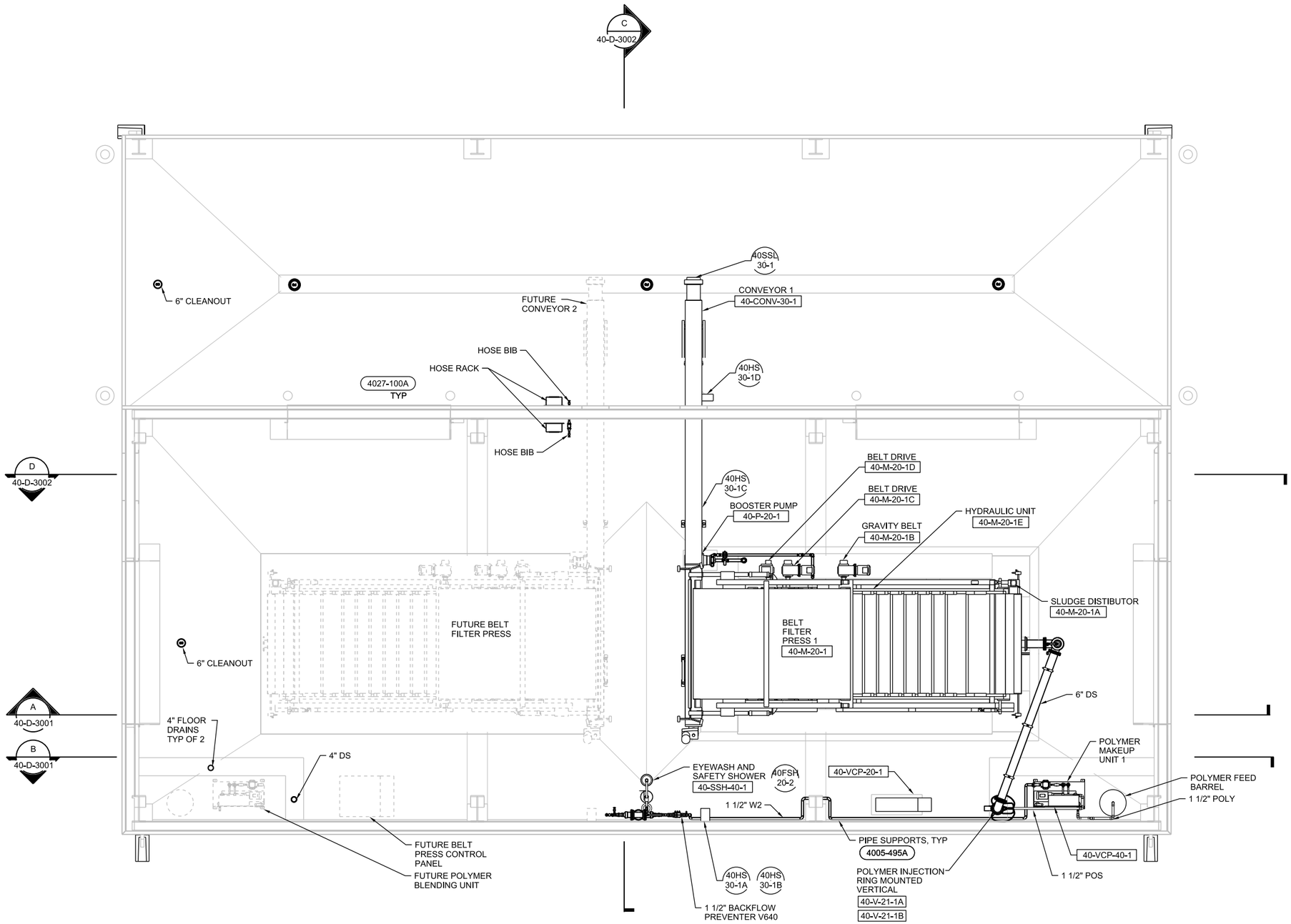
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-D-2001
SHEET	48 of 76



N

OVERALL PLAN VIEW

1/4"=1'-0"

GENERAL NOTES

1. CAKE CONVEYOR SUPPORTS SHALL BE DESIGNED AND SUPPLIED BY CONVEYOR MANUFACTURER. LOCATIONS SHOWN ARE REPRESENTATIVE.
2. CONTRACTOR TO COORDINATE WITH PREFAB. BUILDING MANUFACTURER FOR PIPE PENETRATIONS DETAILS AND SEALANTS.
3. ALL PIPES UNDERNEATH THE BUILDING SLAB AND EXTENDING 5 FEET BEYOND ARE TO BE CONCRETE ENCASED.

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
REVISION		K WADDELL	K DIAZ	R BOE		K WADDELL	

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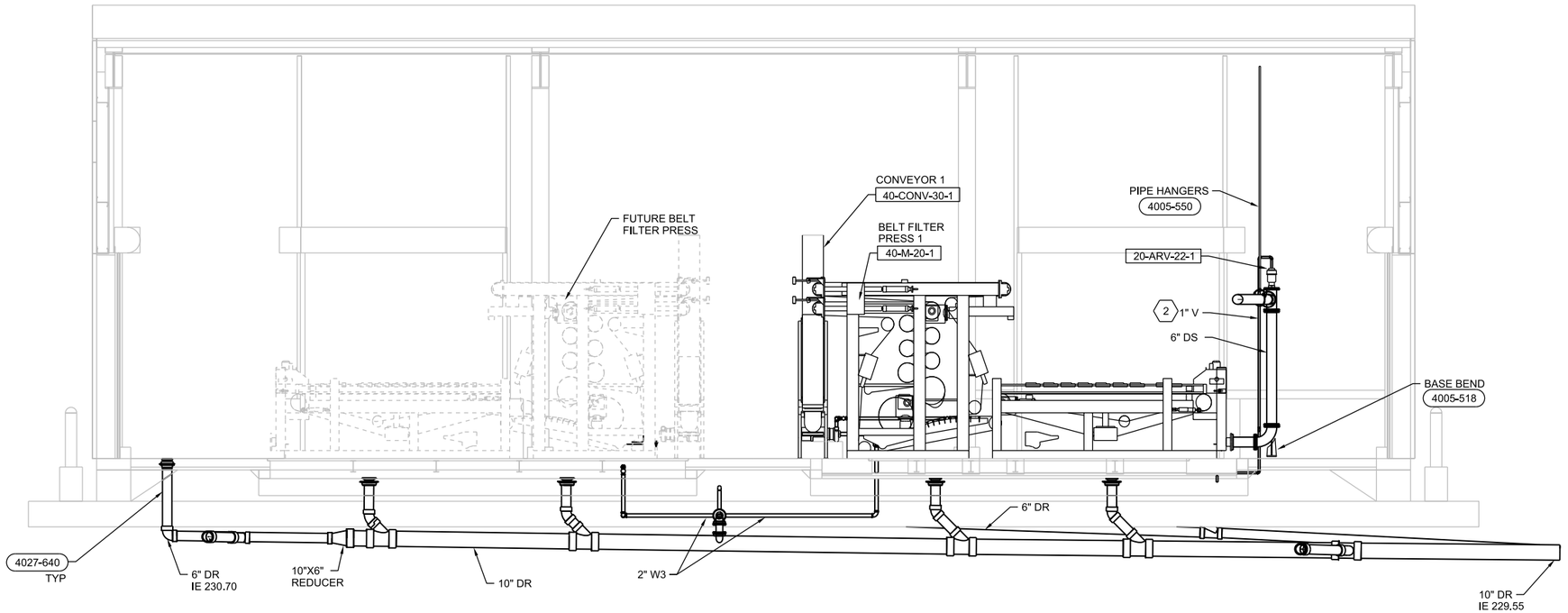
PROCESS MECHANICAL
DEWATERING BUILDING
FLOOR PLAN

BID DOCUMENTS

VERIFY SCALE

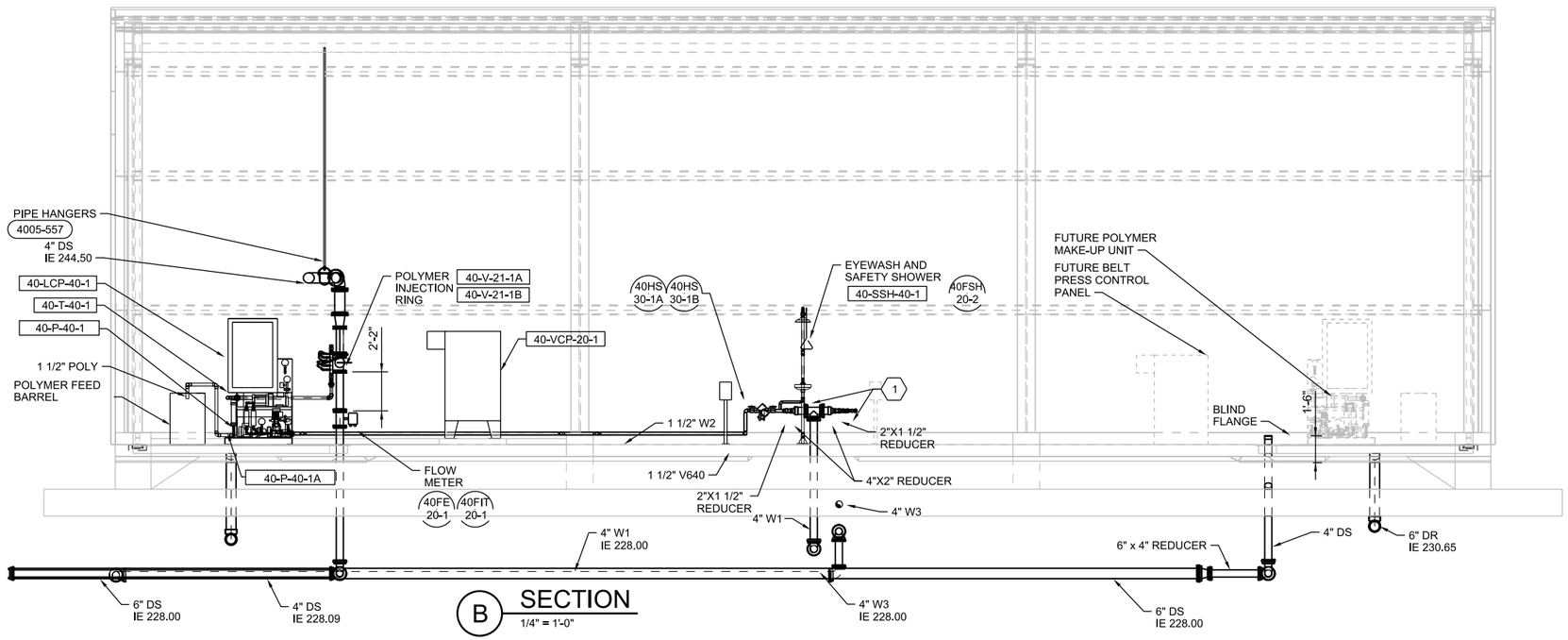
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-D-2002
SHEET	49 of 76



A SECTION
1/4" = 1'-0"

40-D-2001
40-D-2002



B SECTION
1/4" = 1'-0"

40-D-2001
40-D-2002

GENERAL NOTES

1. WATERLINES < 4" DIA THAT ARE EXPOSED, CONCRETE ENCASED, OR BURIED BELOW CONCRETE SLABS SHALL BE 316 STAINLESS STEEL.
2. PIPE SUPPORTS TO BE SIZED BY MANUFACTURER.
3. CONTRACTOR AND CONVEYOR MANUFACTURER TO COORDINATE CONVEYOR HEIGHTS AND INFLUENT CHUTE LOCATION WITH BELT PRESS MANUFACTURER.
4. COMBINE THE BELT FILTER PRESS DRAINAGE PIPING FROM THE PRESSURE SECTION INTO A COMMON 6" FILTRATE PIPE AND ROUTE PIPE TO DISCHARGE DIRECTLY INTO THE WESTERN MOST 6" FLOOR DRAIN. EXTEND THE 6" FILTRATE PIPING FROM EACH OF THE GRAVITY SECTION DRAINS AND ROUTE THE PIPES TO DISCHARGE INTO THE EASTERN MOST 6" FLOOR DRAIN.
5. CONTRACTOR AND PREFAB. BUILDING MANUFACTURER TO COORDINATE PIPE HANGER SUPPORT INSTALLATIONS. PREFAB. BUILDING MANUFACTURER TO INCORPORATE NECESSARY CROSS BEAMS OR OTHER ROOF SUPPORT MEMBERS NECESSARY FOR HANGER ATTACHMENT AND ACCOUNT FOR ALL LOADS. ADDITIONALLY ACCOUNT FOR THE FUTURE BFP PIPING BASED ON PROPOSED PIPE MIRRORED TO THE OPPOSITE SIDE AS WELL FOR PIPING THAT MAY BE ROUTED DOWN THE CENTERLINE OF THE BUILDING TO ACCOUNT FOR ALTERNATE FUTURE BFP ARRANGEMENTS.
6. ALL PIPES UNDERNEATH THE BUILDING SLAB AND EXTENDING 5 FEET BEYOND ARE TO BE CONCRETE ENCASED.

SHEET KEYNOTES

1. 1 1/4" SST PIPE ROUTED TO THE SAFETY SHOWER.
2. ROUTE THE ARV VENT DRAIN TO DISCHARGE INTO THE BFP SUMP.

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
	K WADDELL		KL DIAZ	R BOE		K WADDELL	APVD

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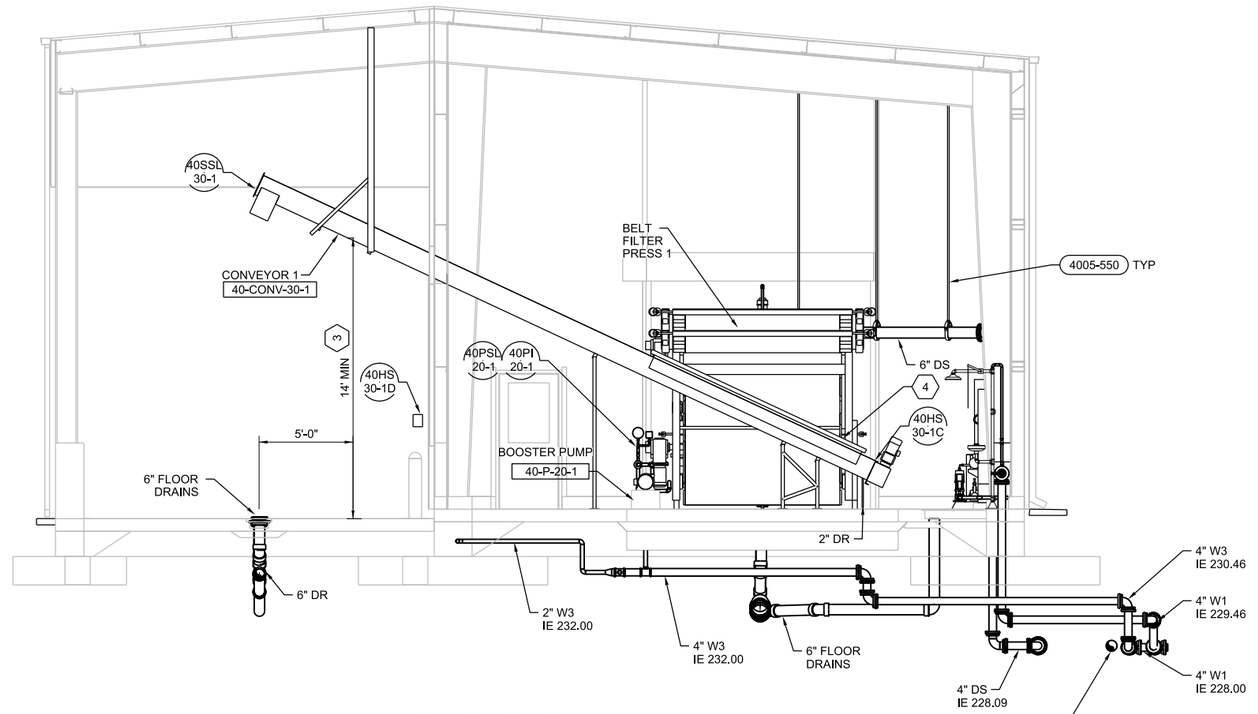
CRESTVIEW, FL

PROCESS MECHANICAL
DEWATERING BUILDING SECTIONS

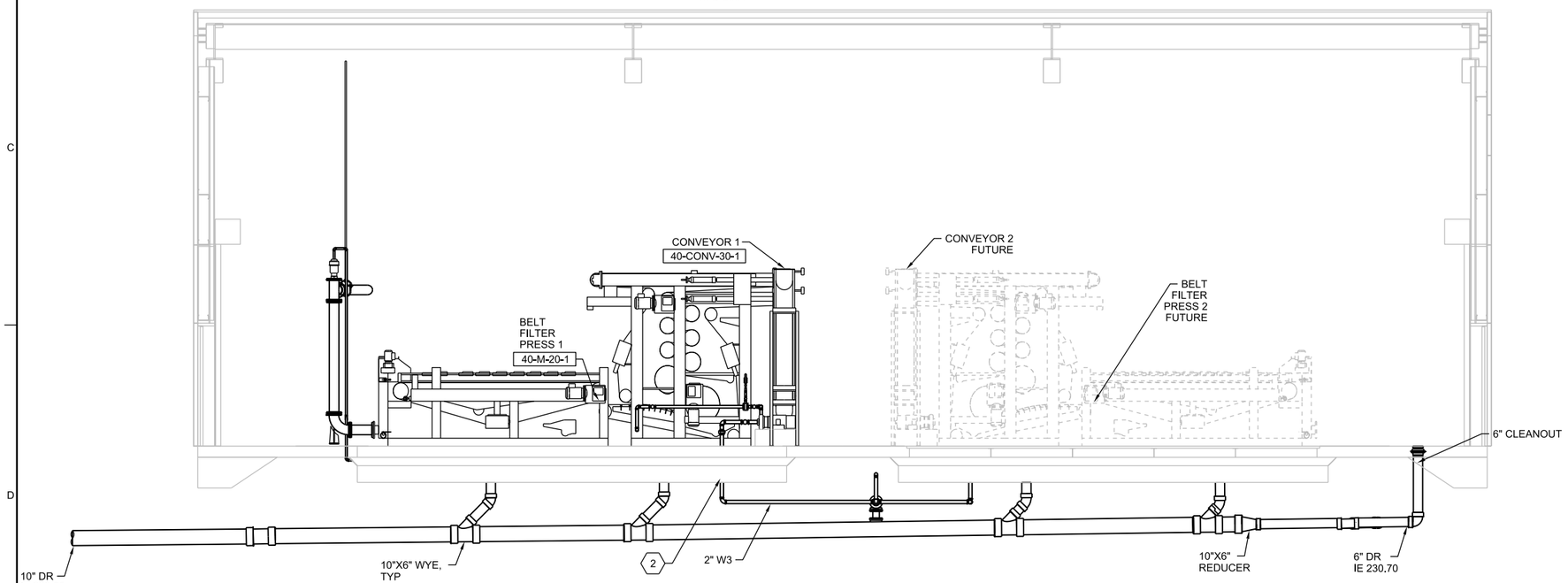
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-D-3001
SHEET	50 of 76

BID DOCUMENTS



C SECTION
1/4" = 1'-0"
40-D-2001
40-D-2001



D SECTION
1/4" = 1'-0"
40-D-2001
40-D-2001

GENERAL SHEET NOTES

1. CONVEYOR MANUFACTURER IS RESPONSIBLE FOR DESIGNING AND SUPPLYING THE CONVEYOR SUPPORTS. CONVEYOR MANUFACTURER TO COORDINATE WITH PREFAB. BUILDING MANUFACTURER FOR CONVEYOR LOADS AND HANGER SUPPORT ATTACHMENTS. PREFAB. BUILDING MANUFACTURER TO SUPPLY NECESSARY ROOF SUPPORT MEMBERS FOR ATTACHMENT AND LOAD BEARING SUPPORT.
2. COORDINATE CONVEYOR SUPPORTS WITH BFP SUMP AND GRATING.
3. CONTRACTOR, CONVEYOR MANUFACTURER, AND PREFAB. BUILDING MANUFACTURER TO COORDINATE WALL PENETRATIONS FOR THE CONVEYORS.
4. PREFAB. BUILDING MANUFACTURER TO PROVIDE ROOF SUPPORT MEMBERS FOR SUPPORTING THE PIPE HANGERS SHOWN AND FUTURE. PROVIDE ROOF SUPPORTS DOWN THE CENTERLINE OF THE BELT FILTER PRESSES ALONG WITH FROM THE SOUTH WALL TO THE CENTER SIMILARLY TO THE NEW PIPING SHOWN TO ACCOMODATE FUTURE DS PIPING.
5. ALL PIPES UNDERNEATH THE BUILDING SLAB AND EXTENDING 5 FEET BEYOND ARE TO BE CONCRETE ENCASED.

SHEET KEYNOTES

1. LOWEST POINT OF CONVEYOR AT 5' FROM CENTERLINE TO BE 14' MIN ABOVE FINISHED FLOOR.
2. INSTALL A 1 1/2" V330 ON THE W3 PIPE BELOW GRATING.
3. 14'-0" MIN CLEARANCE TO LOWEST POINT OF CONVEYOR OR SUPPORTS.
4. SCREW CONVEYOR MANUFACTURER TO DESIGN THE CONVEYOR INFLUENT OPENINGS AND COORDINATE WITH BELT PRESS MANUFACTURER AND CONTRACTOR FOR POSITIONING THE CONVEYOR IN RELATION TO THE BELT PRESS. COORDINATE WITH BUILDING MANUFACTURER FOR FINAL CONVEYOR POSITION FOR WALL OPENINGS.

NO.	DATE	REVISION	BY	APVD
DSGN	K WADDELL	DR KL DIAZ	CHK R BOE	APVD K WADDELL

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CITY OF CRESTVIEW
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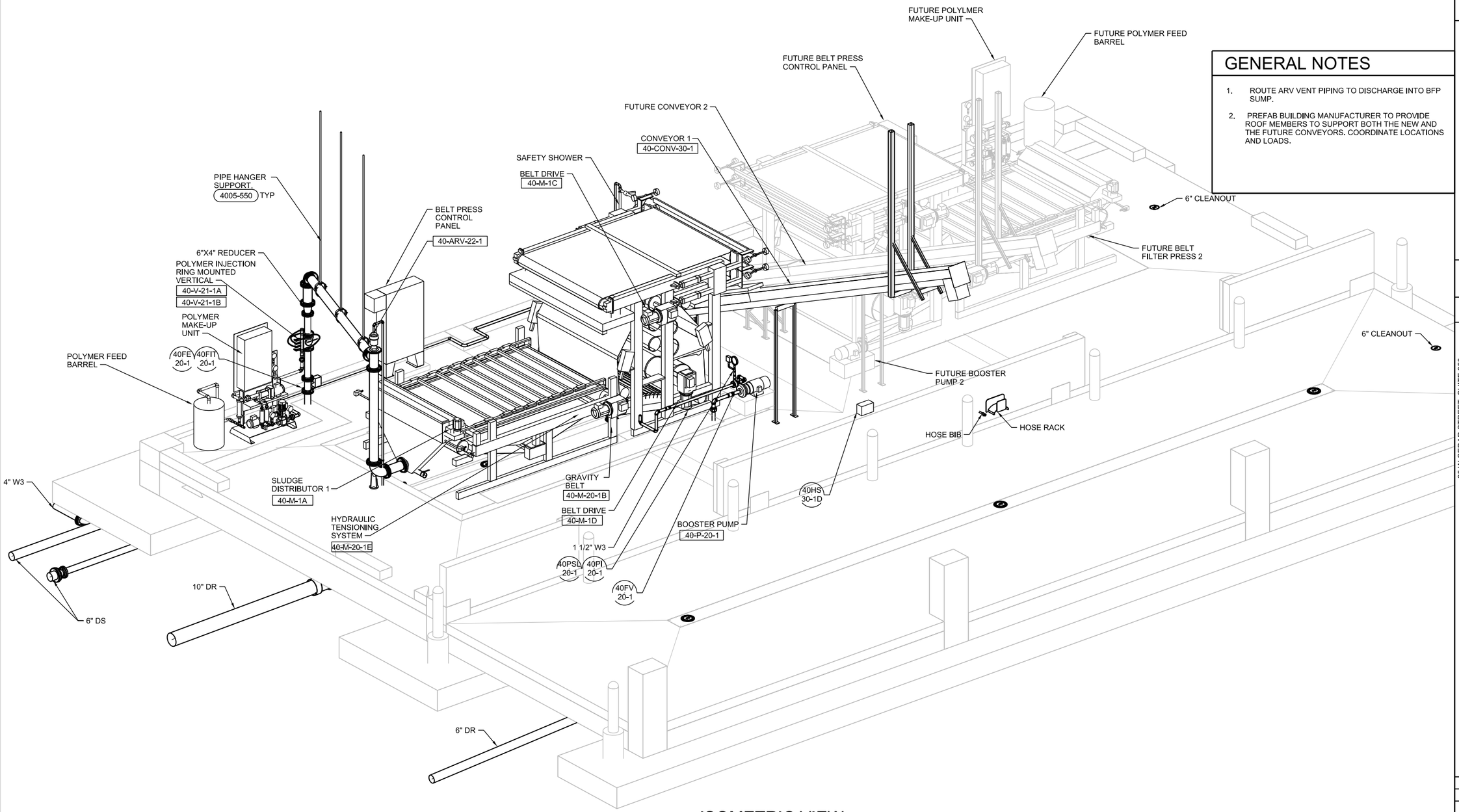
Jacobs

PROCESS MECHANICAL
DEWATERING BUILDING SECTIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-D-3002
SHEET	51 of 76

BID DOCUMENTS



ISOMETRIC VIEW
NTS

GENERAL NOTES

1. ROUTE ARV VENT PIPING TO DISCHARGE INTO BFP SUMP.
2. PREFAB BUILDING MANUFACTURER TO PROVIDE ROOF MEMBERS TO SUPPORT BOTH THE NEW AND THE FUTURE CONVEYORS. COORDINATE LOCATIONS AND LOADS.

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
	K WADDELL		KL DIAZ	R BOE	APVD	K WADDELL	

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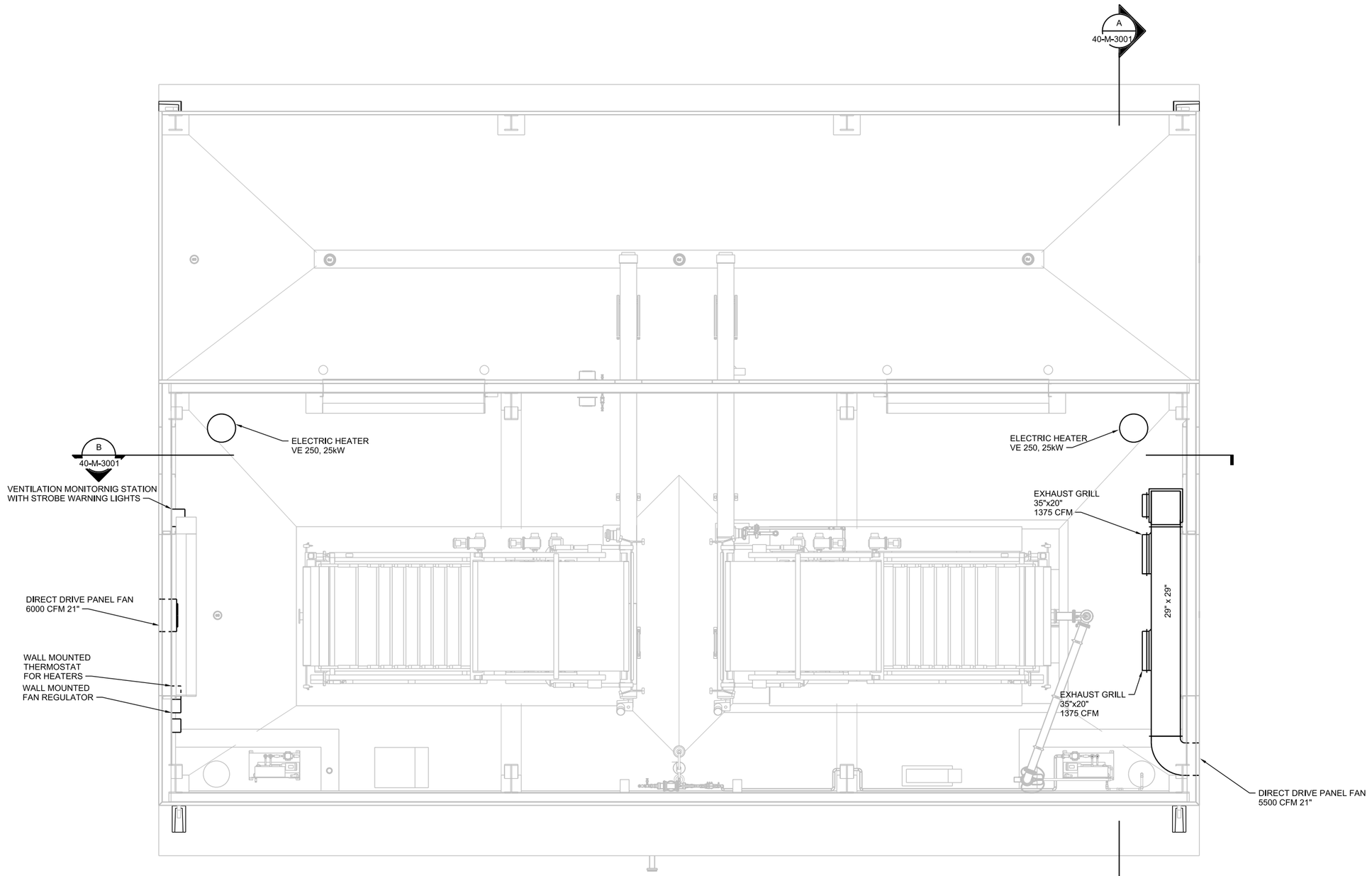
CRESTVIEW, FL

PROCESS MECHANICAL
DEWATERING BUILDING
BELT PRESS
ISOMETRIC VIEW

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-D-9001
SHEET	52 of 76

BID DOCUMENTS



N

OVERALL PLAN VIEW

1/4"=1'-0"

NO.	DATE	DR	REVISION	CHK	APVD	BY	APVD
DSGN		J BIEDA		M MOLKA	A VALIENTE		A VALIENTE

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

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CRESTVIEW, FL

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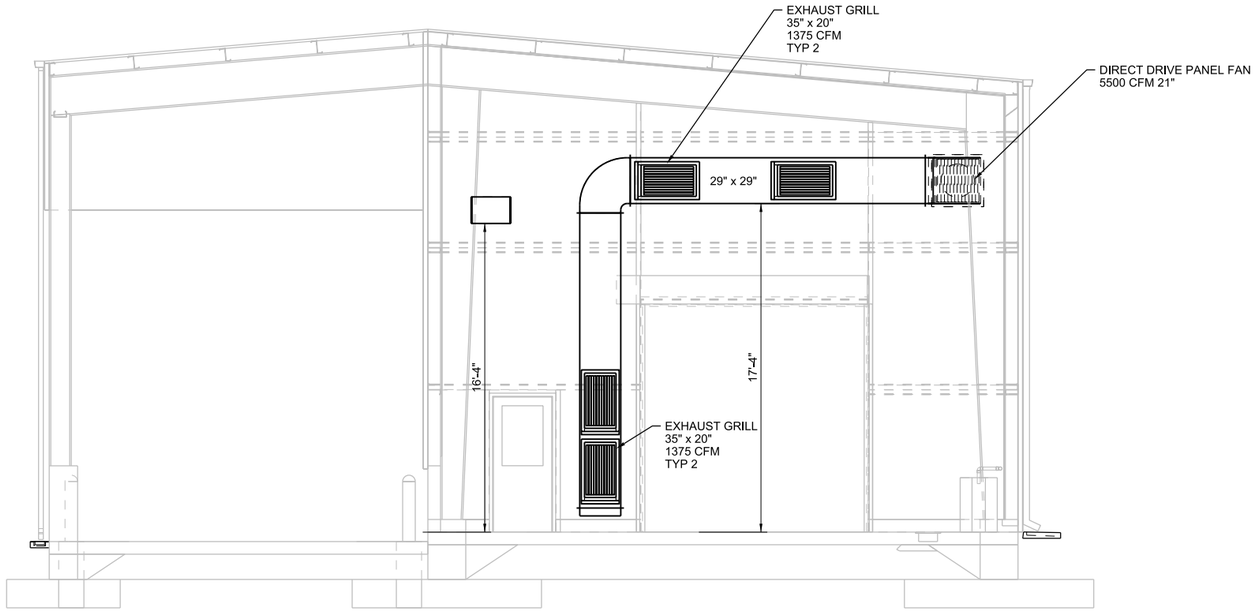
BUILDING MECHANICAL
DEWATERING BUILDING
FLOOR PLAN

BID DOCUMENTS

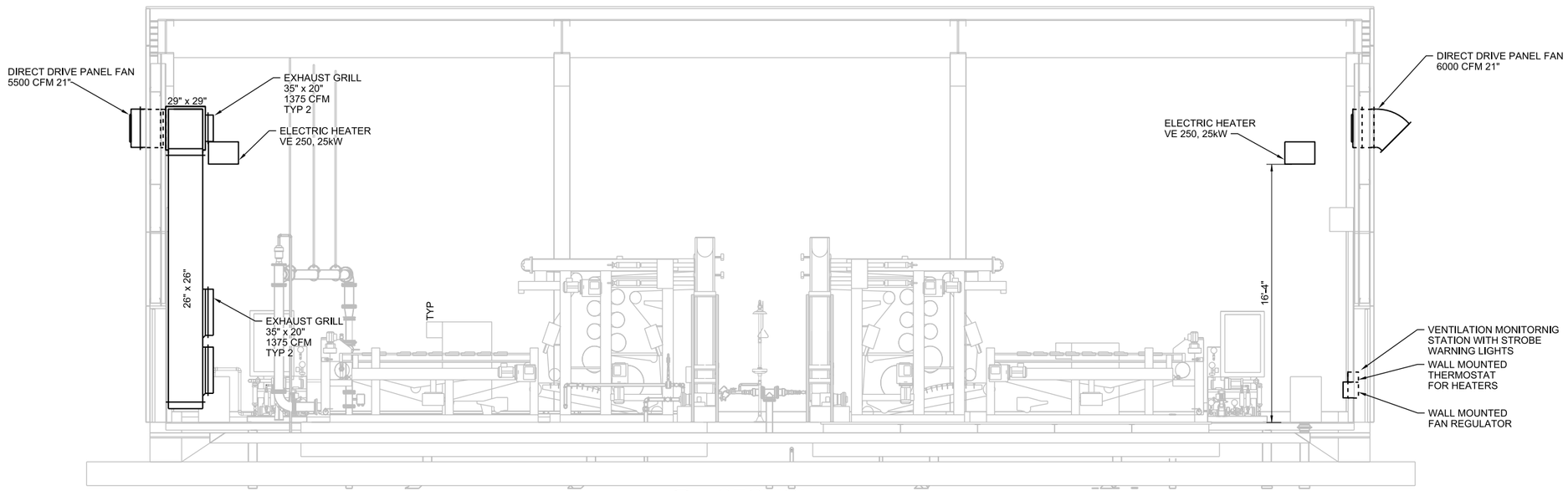
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-M-2001
SHEET	53 of 76



A SECTION
1/4" = 1'-0"



B SECTION
1/4" = 1'-0"

NO.	DATE	DR	REVISION	CHK	BY
DSGN	J BIEDA	M MOLKA	APVD	A VALIENTE	APVD

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PENSACOLA, FLORIDA 32502
EB25861

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SOLIDS HANDLING IMPROVEMENTS
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CRESTVIEW, FL

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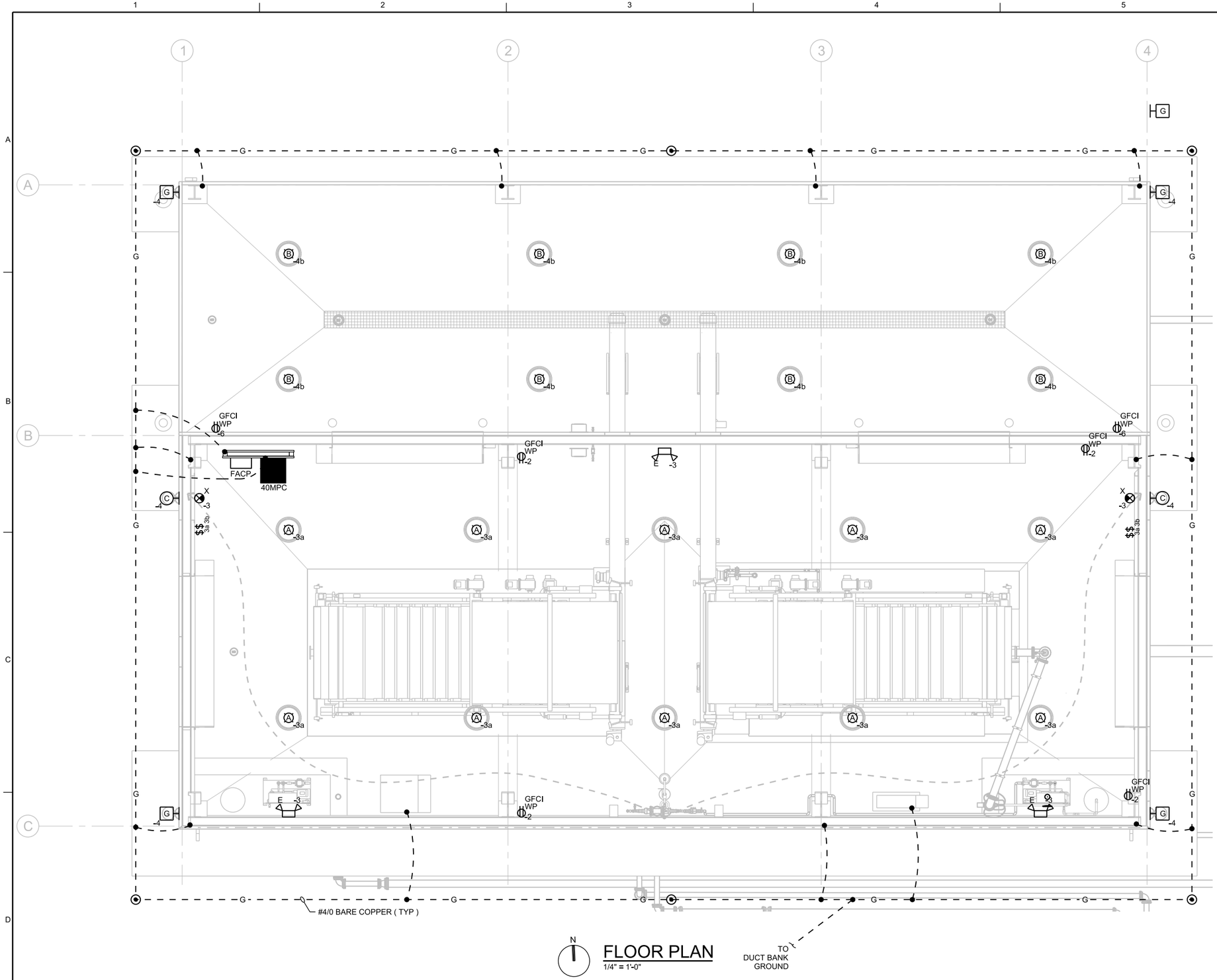
BUILDING MECHANICAL
DEWATERING BUILDING SECTIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-M-3001
SHEET	54 of 76

BID DOCUMENTS



FLOOR PLAN
1/4" = 1'-0"

GENERAL SHEET NOTES

1. POWER ALL LUMINAIRES FROM 40MPC, CIRCUIT AS INDICATED.
2. MOUNT TYPE 'A' AND TYPE 'B' LUMINAIRES 20' AFF.
3. MOUNT TYPE 'C' LUMINAIRES 6" ABOVE DOOR.
4. MOUNT TYPE 'E' LUMINAIRES 10' AFF.
5. MOUNT TYPE 'G' LUMINAIRES 17'-5" AFF.

NO.	DATE	DSGN	DR	CHK	APVD
REVISION		KB HORTON	G MESSER	D NICHOLSON	APVD
				BY	APVD
					KB HORTON

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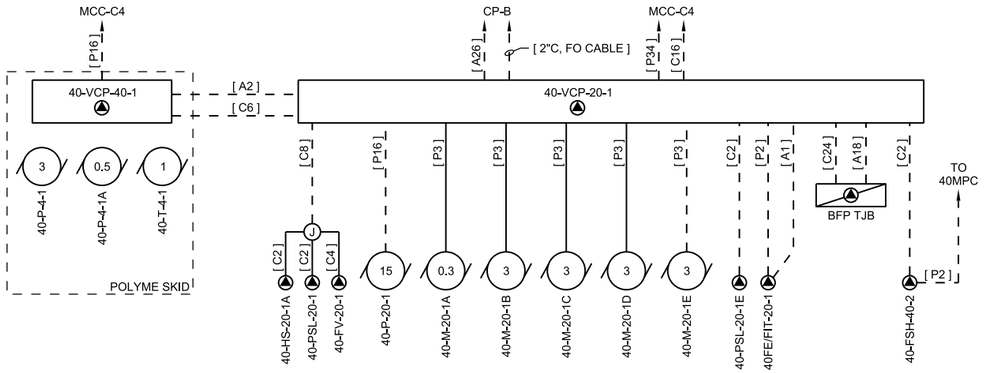
CITY OF CRESTVIEW
CRESTVIEW, FL

ELECTRICAL
DEWATERING BUILDING
LIGHTING AND FACILITY PLAN

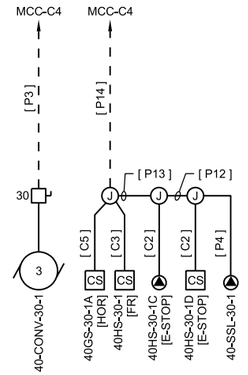
1/4"=1'-0"
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-E-2001
SHEET	55 of 76

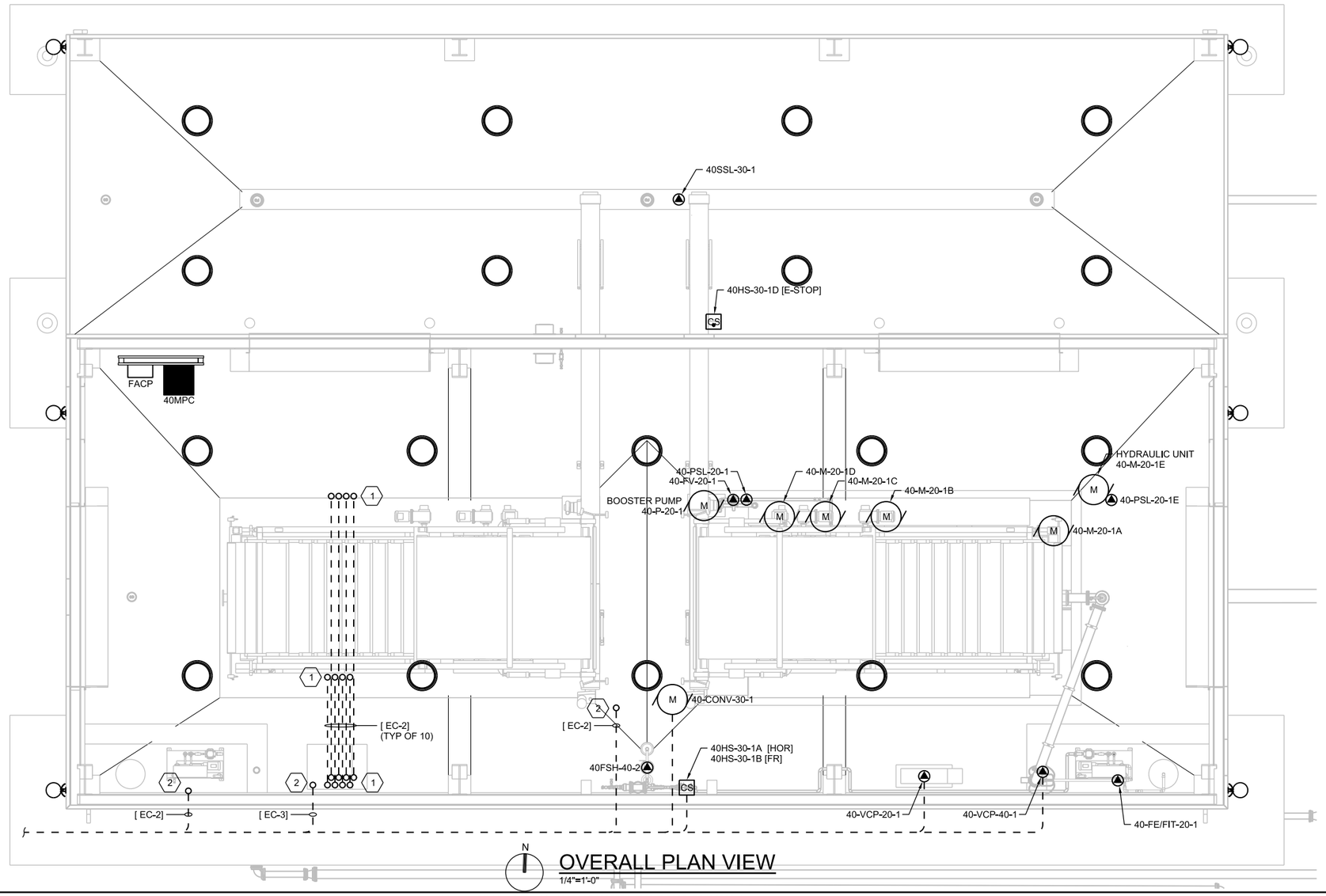
BID DOCUMENTS



WIRING DIAGRAM



WIRING DIAGRAM



OVERALL PLAN VIEW

1/4"=1'-0"

SHEET KEYNOTES

1. PROVIDE SPARE CONDUIT BETWEEN FUTURE CONTROL PANEL AND BELT FILTER PRESS. STUB UP AND CAP EMPTY CONDUIT.
2. PROVIDE SPARE CONDUIT BETWEEN DEWATERING BUILDING AND ELECTRICAL BUILDING AS SHOWN. SEE DUCT BANK FOR ADDITIONAL DETAILS. STUB AND CAP CLOSE TO BUILDING WALL.

NO.	DATE	DR	CHK	APVD	BY	APVD
DSGN	KB HORTON	G MESSER	D NICHOLSON			KB HORTON

REVISION

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PENSACOLA, FLORIDA 32502
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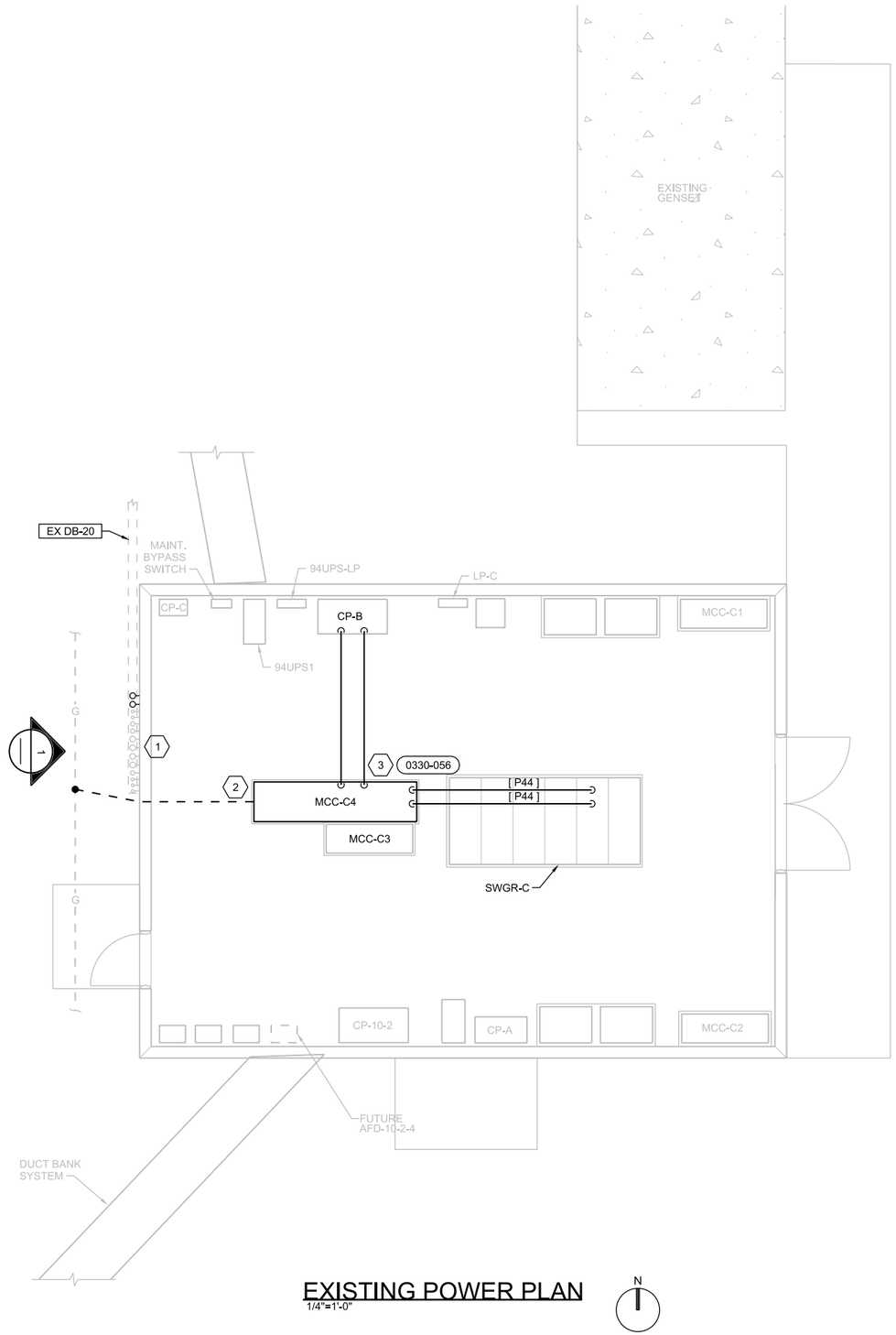
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

ELECTRICAL
DEWATERING BUILDING POWER PLAN

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	40-E-2002
SHEET	56 of 76



EXISTING POWER PLAN

1/4"=1'-0"

N

1 PHOTO 1
NTS

SHEET KEYNOTES

1. USE THE SPARE CONDUITS THAT STUB UP OUTSIDE EXISTING ELECTRICAL BUILDING AS INDICATED IN DUCT BANK SECTION. INSTALL NEW CONDUIT FROM STUB UP TO MCC-C4 AND CP-B INSIDE ELECTRICAL ROOM.
2. BOND NEW MCC-C4 TO EXISTING GROUND GRID.
3. PROVIDE TYPE E HOUSEKEEPING PAD FOR NEW MCC-C4.

NO.	DATE	REVISION	DR	CHK	APVD	BY
DSGN	KB HORTON		G MESSER	D NICHOLSON	APVD	KB HORTON

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ELECTRICAL
EXISTING ELECTRICAL BUILDING POWER PLAN

BID DOCUMENTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
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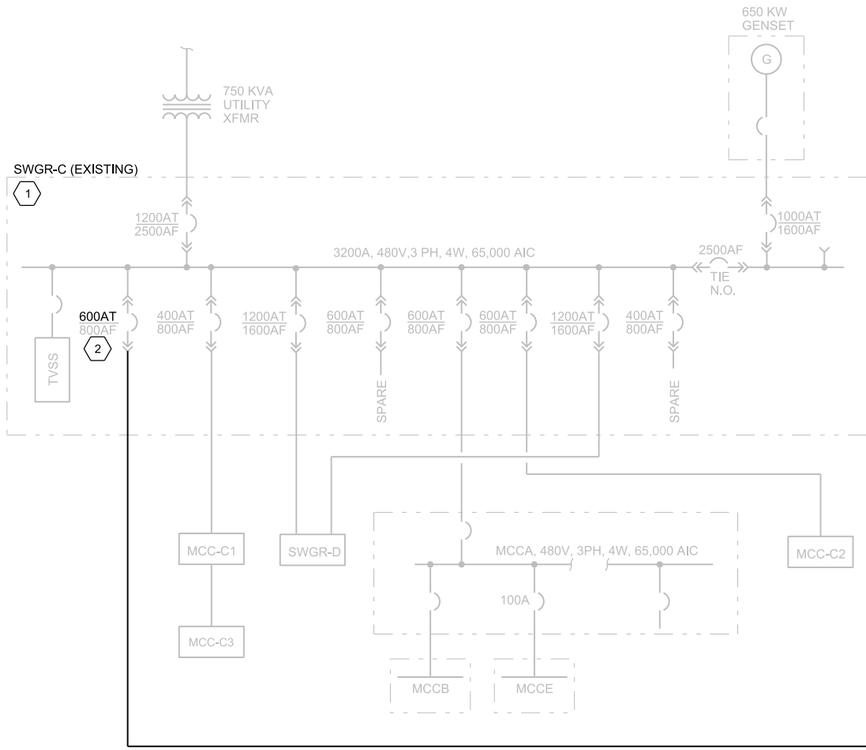
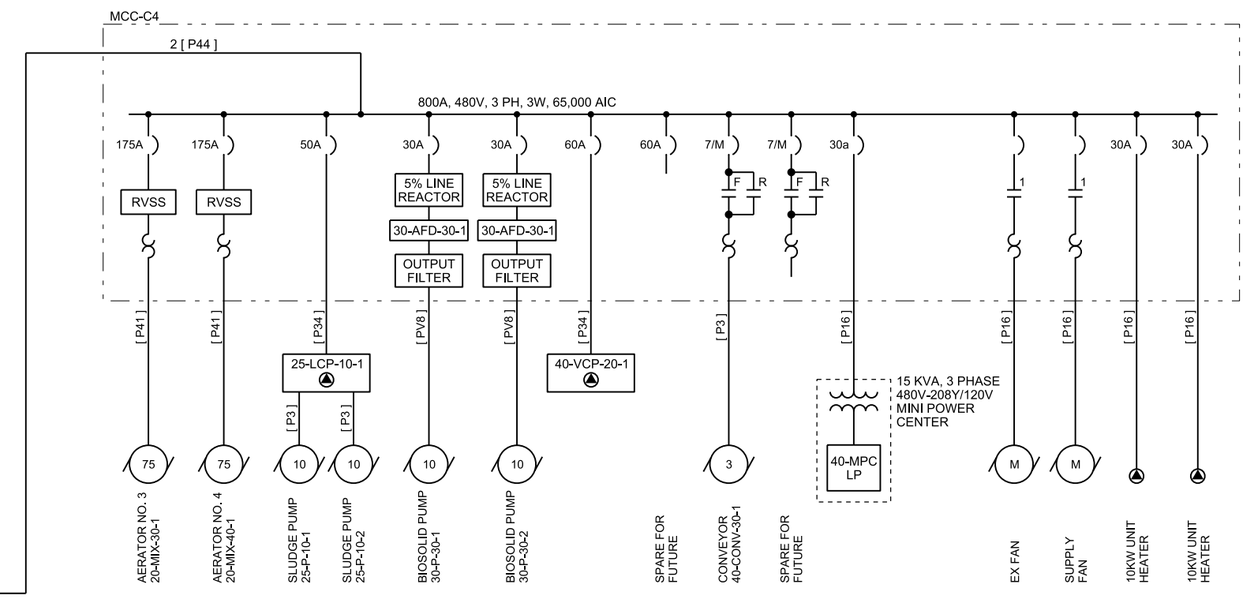
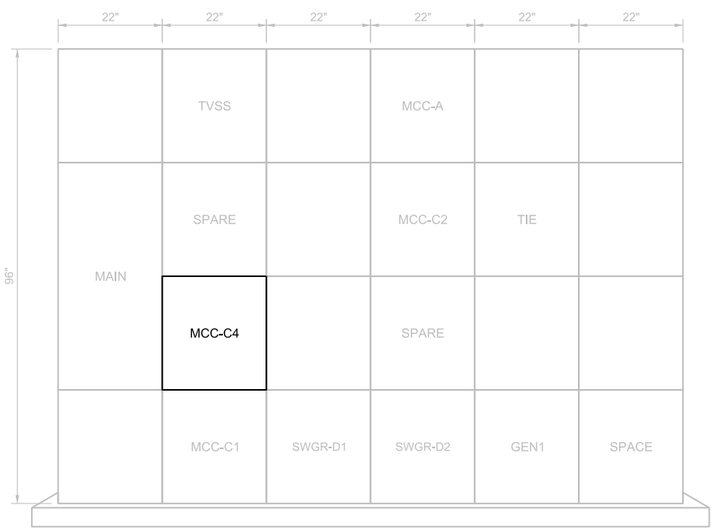
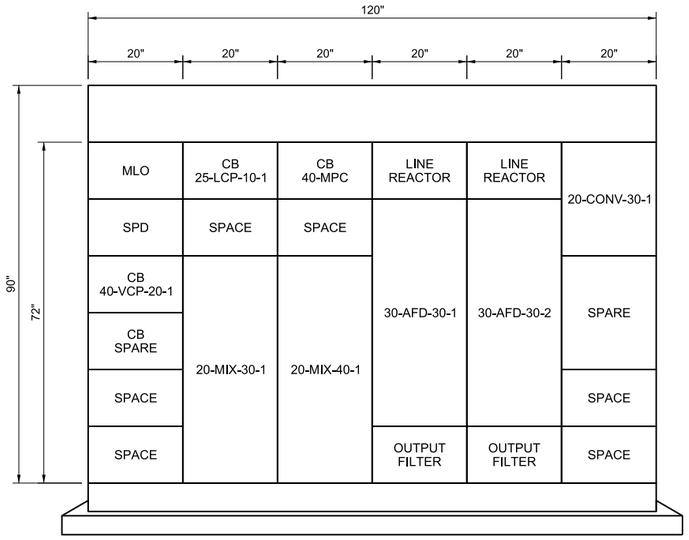
DWG	94-E-2001
SHEET	57 of 76







EXISTING SWGR-C FRONT ELEVATION
NTS



MCC-C4 FRONT ELEVATION
NTS

LOAD SUMMARY	
DESCRIPTION	AMPS
125% HISTORICAL LOAD	553.0
MCC-C4 LOAD	317.0
SWGRC DESIGN LOAD	870.0
EXPECTED PEAK LOAD	759.0
CALCULATED ISC 26,169A	

SHEET KEYNOTES

1. EXISTING SWITCHGEAR IS ISO SWITCHGEAR USING CUTLER HAMMER MAGNUM DS BREAKERS. ISO PROJECT # 35838.
2. UTILITY EXISTING SPARE CIRCUIT BREAKER. SET TRIP SETTING FOR 600A. LOADS ON MCC-C4 ARE NOT REQUIRED ON GENERATOR. SET SYSTEM TO OPEN FEEDER BREAKER WHEN ON GENERATOR.

NO.	DATE	DR	REVISION	CHK	APVD	BY	APVD
DSGN	KB HORTON	G MESSER		D NICHOLSON		KB HORTON	

Jacobs
25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

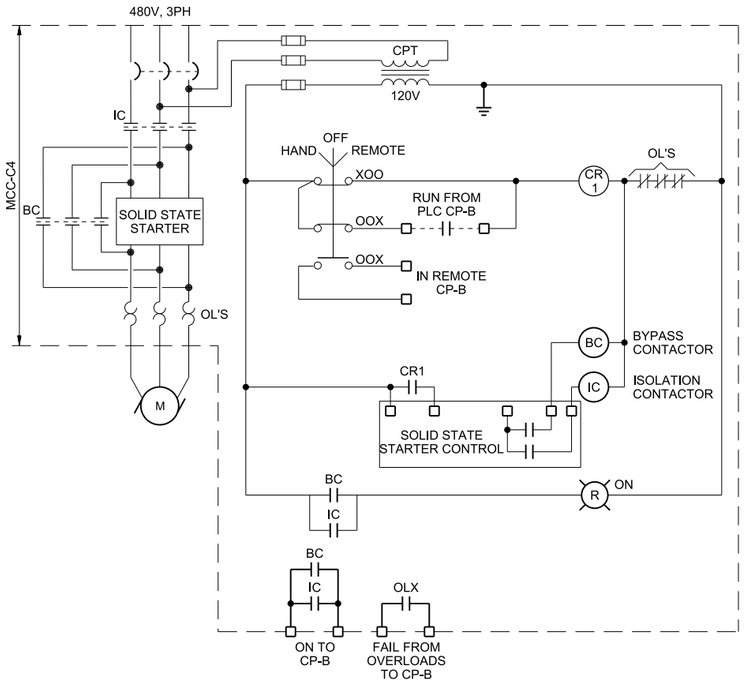
ELECTRICAL

MCC ONE-LINE DIAGRAM AND FRONT ELEVATION

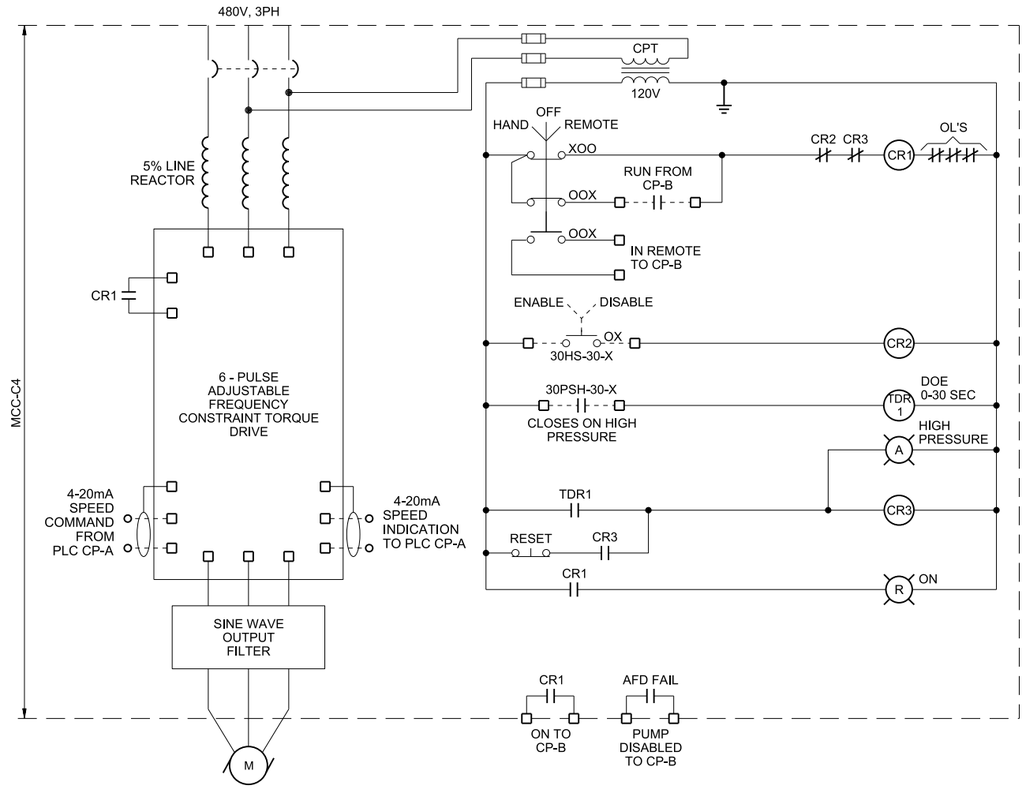
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	96-E-6001
SHEET	58 of 76

BID DOCUMENTS



AERATOR NO. 3 - 20-MIX-30-1
AERATOR NO. 4 - 20-MIX-40-1
NTS



BIOSOLID FEED PUMP NO. 1 - 30-P-30-1
BIOSOLID FEED PUMP NO. 2 - 30-P-30-2
NTS

NO.	DATE	DSGN	DR	CHK	APVD
REVISION	KB HORTON	A PASTRANA	D NICHOLSON	APVD	
BY	KB HORTON				
APVD					

Jacobs
25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
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CRESTVIEW WWTP
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CITY OF CRESTVIEW
CRESTVIEW, FL

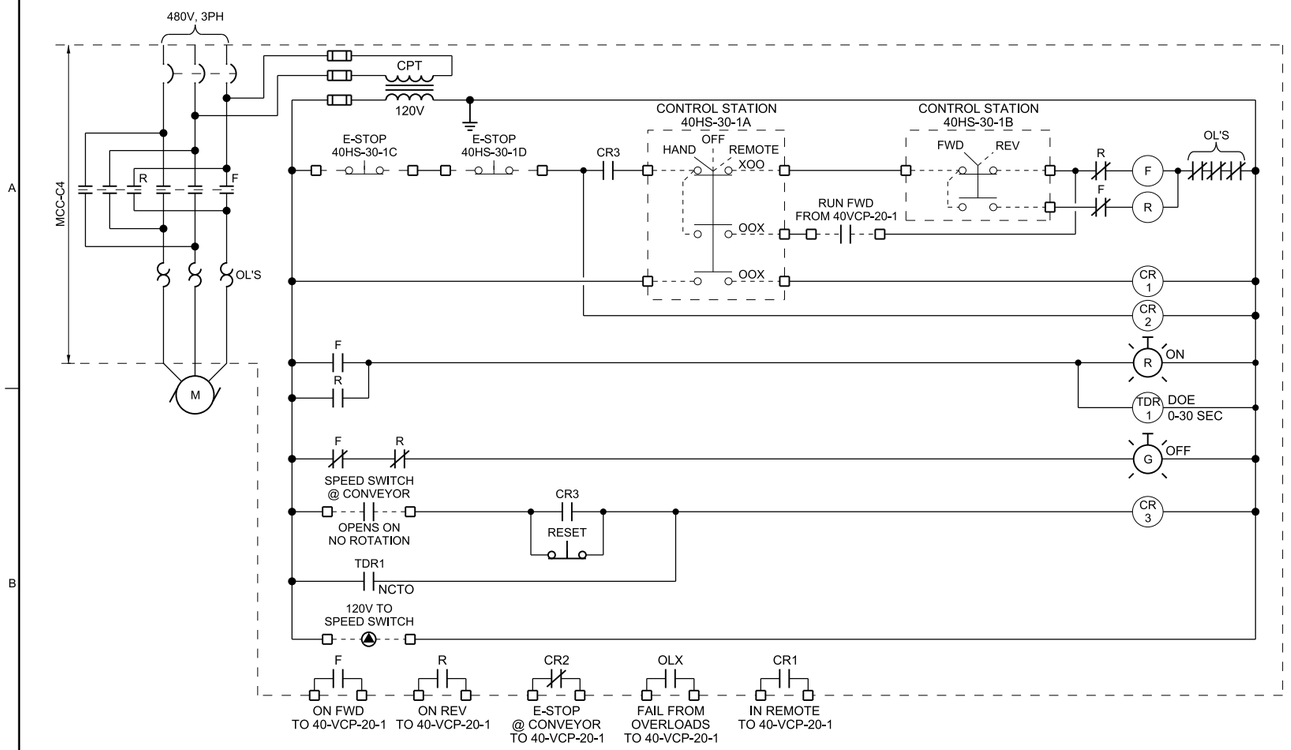
ELECTRICAL

MOTOR CONTROL DIAGRAMS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	96-E-6002
SHEET	59 of 76

BID DOCUMENTS



CONVEYOR NO. 1 - 40-CONV-30-1

NTS

PANEL: 40MPC — LOCATION: DEWATERING BUILDING
SERVICE VOLTAGE: 208/120V — PHASE: 3 — WIRE:4
TOTAL LOAD KVA: 6.9 — BUS SIZE: 100A — MAIN SIZE: 60A — TYPE:MCB
REMARKS: MINI POWER CENTER — NEUTRAL: FULL — MOUNTING: SURFACE
PRIM. CB, 15KVA TRANSFORMER AND SEC CB

LOAD IN KVA				BKR	CKT	CKT	BKR		LOAD IN KVA		
A	B	C	CIRCUIT DESCRIPTION	A/P	NO.	NO.	A/P	CIRCUIT DESCRIPTION	A	B	C
0.5			FIRE ALARM PANEL FACP	20/1	1	2	20/1	RECEPTACLES	0.5		
	1.3		DEWATERING BUILDING LIGHTS	20/1	3	4	20/1	TRUCK BAY/EXTERIOR LIGHTS		1.2	
		3.0	EYEWASH / 40FSH-40-2	20/1	5	6	20/1	EXTERIOR RECEPTACLES			0.4
			SPARE	20/1	7	8	20/1	SPARE			
			SPARE	20/1	9	10	20/1	SPARE			
			SPARE	20/1	11	12	20/1	SPARE			
			SPARE	20/1	13	14	20/1	SPARE			
			SPARE	20/1	15	16	20/1	SPARE			
			SPARE	20/1	17	18	20/1	SPARE			
0.5	1.3	3.0	TOTAL						0.5	1.2	0.4

NO.	DATE	DR	REVISION	CHK	APVD	BY
DSGN	KB HORTON	A PASTRANA		D NICHOLSON	APVD	KB HORTON

Jacobs
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PENSACOLA, FLORIDA 32502
EB25861

ELECTRICAL

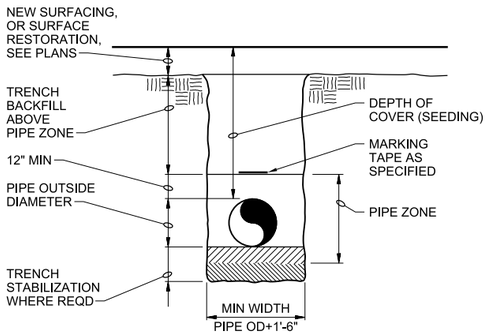
MOTOR CONTROL DIAGRAM AND PANEL SCHEDULE

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	96-E-6003
SHEET	60 of 76

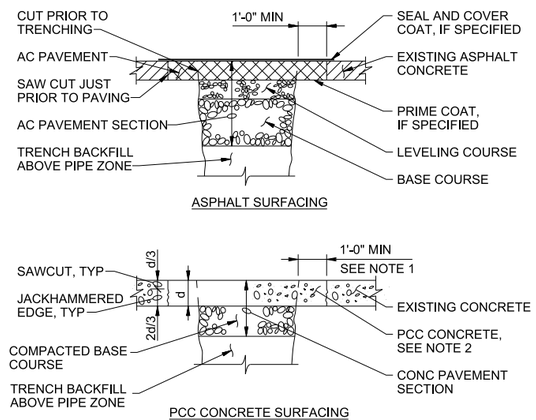
BID DOCUMENTS



TYPICAL TRENCH

NTS

3123-110



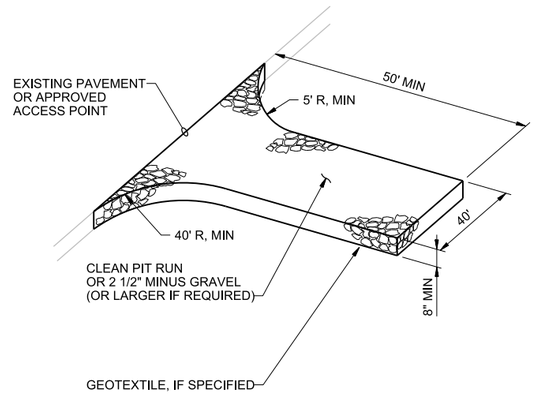
NOTES:

1. IF LOCATION OF TRENCH SAW CUT IS WITHIN 2 FEET OF AN EXISTING JOINT OR EDGE OF CONCRETE, REPLACE ENTIRE CONCRETE TO THE JOINT OR EDGE.
2. CONSTRUCT JOINTS ACROSS NEW CONCRETE TO MATCH EXISTING JOINT TYPES AND LOCATIONS.

SURFACE RESTORATION

NTS

3123-115



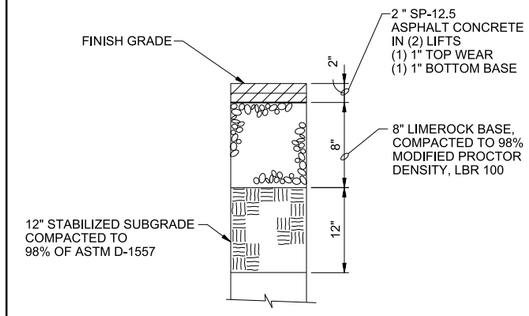
NOTES:

1. ADDITIONAL GRAVEL MAY HAVE TO BE ADDED PERIODICALLY TO MAINTAIN PROPER FUNCTION OF THE PAD.
2. REMOVE GRAVEL ENTRANCE AND REPLACE WITH NEW BASE COURSE PRIOR TO COMPLETION OF ACCESS ROAD.

GRAVEL CONSTRUCTION ENTRANCE

NTS

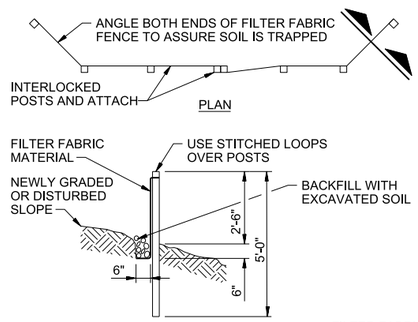
3123-115



ASPHALT CONCRETE PAVEMENT

NTS

3212-210



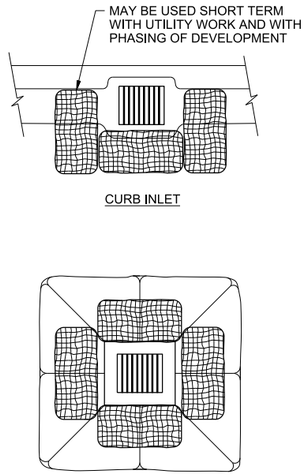
NOTES:

1. BURY BOTTOM OF FILTER FABRIC 6" VERTICALLY BELOW FINISHED GRADE.
2. WOOD OR STEEL FENCE POSTS.
3. STITCHED LOOPS TO BE INSTALLED DOWNHILL SIDE OF SLOPE.
4. COMPACT ALL AREAS OF FILTER FABRIC TRENCH.

SILT FENCE

NTS

3125-165



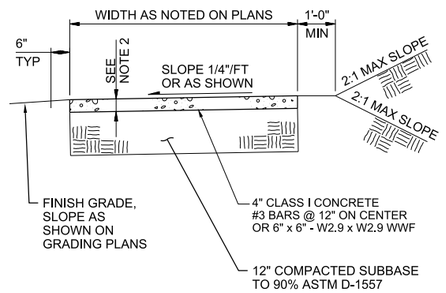
NOTE:

CONTRACTOR MAY ELECT TO USE AN EQUIVALANT FORM OF INLET PROTECTION.

BIOFILTER INLET BARRIER

NTS

3125-186



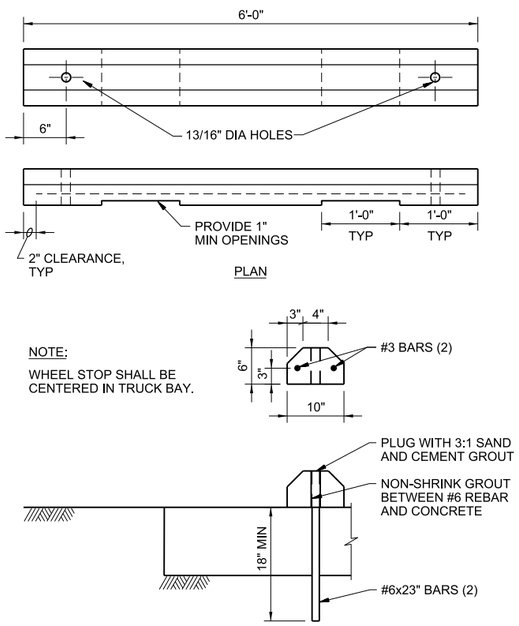
NOTES:

1. INSTALL 1/2" PREMOLDED JOINT FILLER BETWEEN THE SIDEWALK AND ALL STRUCTURES, CONCRETE PAVEMENT, AND CURBS.
2. CONTRACTION JOINTS SHALL BE INSTALLED EVERY 5' (MAX).

TYPICAL CONCRETE SIDEWALK

NTS

3213-220



PRECAST CONCRETE WHEEL STOP

NTS

3217-350

NO.	DATE	DR	REVISION	CHK	APVD	BY	APVD
DSGN	R MORRISON	C CHILDRESS		A MALONE			R MORRISON

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
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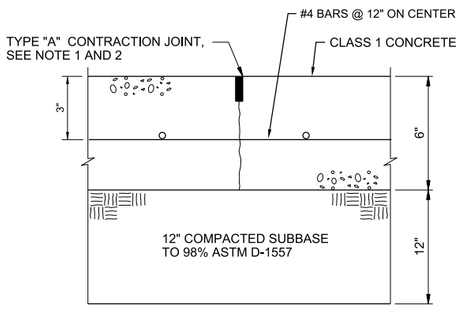
DETAILS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-C-5001
SHEET	61 of 76

BID DOCUMENTS



CONCRETE PAVEMENT & CONTRACTION JOINT

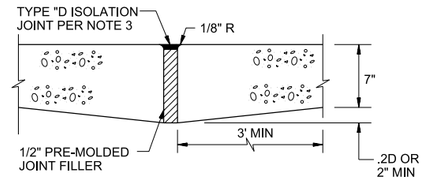
NOTES:

1. CONTRACTION JOINT SHALL BE MADE, CLEANED WITH COMPRESSED AIR, AND FILLED WITH SEALANT AS SPECIFIED.
2. CONCRETE JOINT SPACING: AS SHOWN OR MAXIMUM 15'x 15'.
3. INSTALL 1/2" PREMOLDED JOINT FILLER FULL DEPTH WHERE CONCRETE PAVEMENT ABUTS CONCRETE CURB, BUILDING OR ANY RIGID STRUCTURE.
4. THICKENED EDGES SHALL BE PLACED ADJACENT TO PAVEMENT AND ALONG PERIMETER.
5. CONTRACTOR TO SUBMIT A JOINTING PLAN TO THE ENGINEER FOR APPROVAL PRIOR TO CONSTRUCTION.

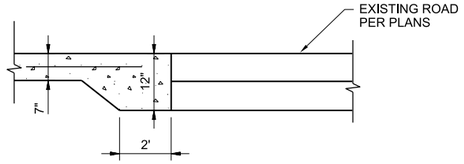
CONCRETE PAVEMENT

NTS

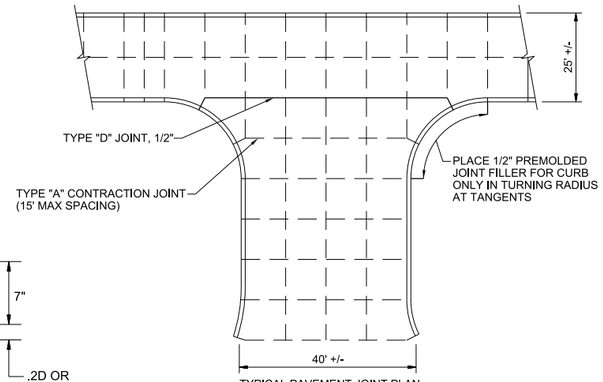
3213-240



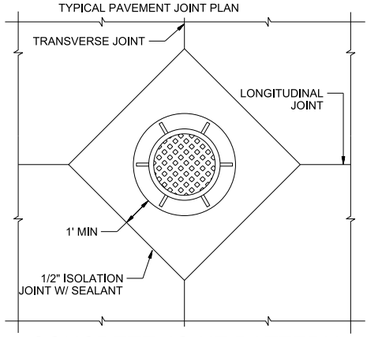
TYPE "D" ISOLATION JOINT



THICKENED EDGE AT ROAD CONNECTION AND ADJACENT TO STRUCTURES

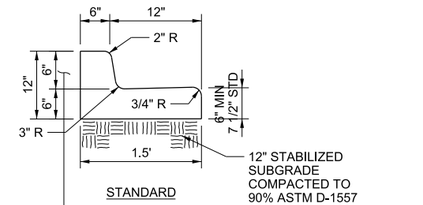


TYPICAL PAVEMENT JOINT PLAN



CONCRETE JOINT PATTERN FOR TYPICAL CONCRETE ROADWAY

NTS



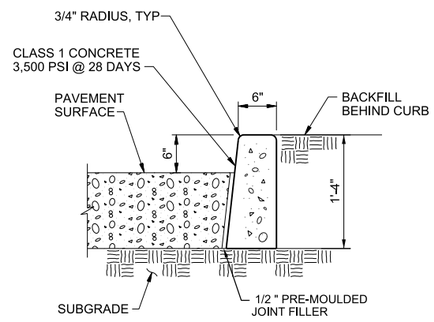
NOTE:

1. CURB AND DROP CURB TRANSITIONS SHALL BE IN ACCORDANCE WITH FDOT INDEX 300.
2. WHEN USED ON THE HIGH SIDE OF ROADWAYS, THE CROSS-SLOPE OF THE GUTTER SHALL MATCH THE CROSS-SLOPE OF THE ADJACENT PAVEMENT AND THE THICKNESS OF THE LIP SHALL BE 6", UNLESS OTHERWISE SHOWN ON THE PLANS.

FDOT TYPE "F" (MODIFIED) CONCRETE CURB AND GUTTER

NTS

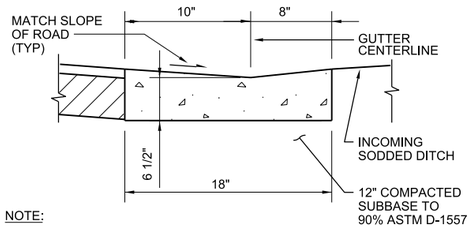
3216-310



CONCRETE STANDARD CURB

NTS

3216-315



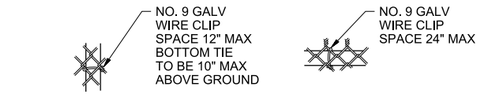
NOTE:

1. CURB AND DROP CURB TRANSITIONS SHALL BE IN ACCORDANCE WITH FDOT INDEX 300.
2. SLOPE OF DROP CURB SHALL MATCH ADJOINING PAVEMENT.

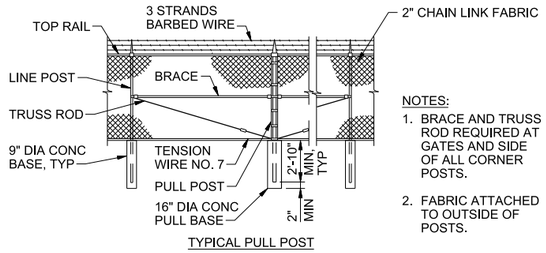
DROP CURB

NTS

3216-340



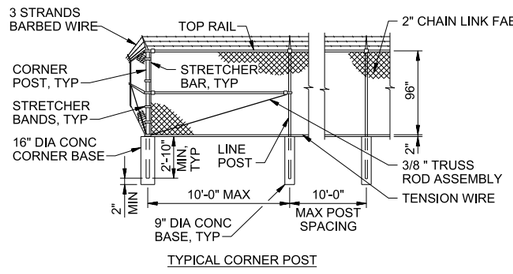
LINE POST CONNECTION TOP RAIL CONNECTION



NOTES:

1. BRACE AND TRUSS ROD REQUIRED AT GATES AND SIDE OF ALL CORNER POSTS.
2. FABRIC ATTACHED TO OUTSIDE OF POSTS.

TYPICAL PULL POST

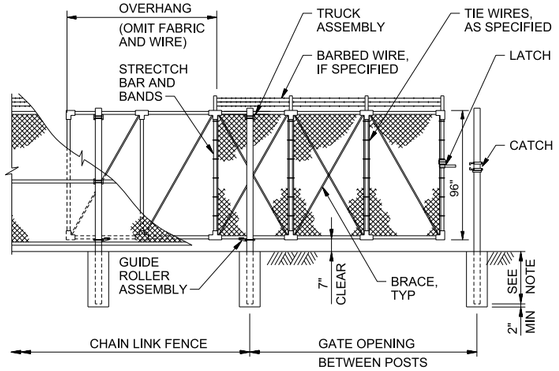


TYPICAL CORNER POST

CHAIN LINK FENCE

NTS

3231-410



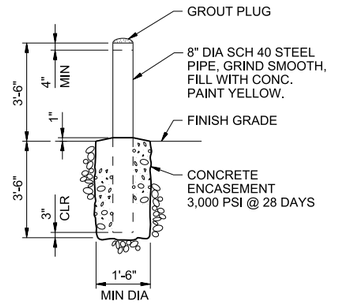
NOTE:

POST SETS PER MANUFACTURER'S RECOMMENDATIONS FOR GATE OPENING AND GATE POST SIZES.

CANTILEVER SLIDE GATE

NTS

3231-415



NOTES:

1. WHEN PLACED IN AREAS OF CONCRETE PAVEMENT, POUR ONLY THE FIRST 36" OF CONCRETE ENCASEMENT TO ALLOW FOR THE 6" OF PAVEMENT.

BOLLARD - EXTERIOR

NTS

3471-810

NO.	DATE	DSGN	REVISION	DR	CHK	APVD	BY	APVD
		R MORRISON		C CHILDRESS	A MALONE			R MORRISON

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
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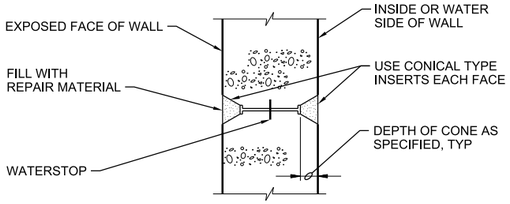
DETAILS

BID DOCUMENTS

VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
PROJ	D3403200
DWG	99-C-5002
SHEET	62 of 76



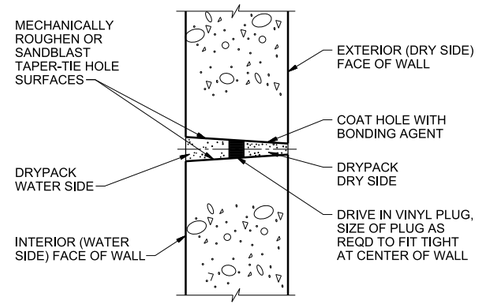
NOTE:

THE SPACING OF FORM TIES ON EXPOSED PORTIONS OF WALLS SHALL BE APPROXIMATELY EQUAL HORIZONTALLY AND VERTICALLY AND SHALL BE UNIFORM IN EACH DIRECTION.

FORM SNAP-TIE HOLE

NTS

0310-051



NOTE:

MINIMUM HOLE DIAMETER AT EXTERIOR FACE = 1". TAPER HOLE SO THAT MINIMUM HOLE DIAMETER AT INTERIOR FACE = 1 1/4"

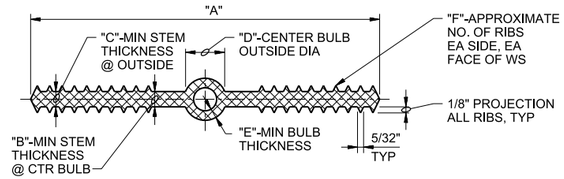
CONSTRUCTION STEPS:

1. SANDBLAST OR MECHANICALLY ROUGHEN WITH ELECTRIC EQUIPMENT.
2. DRIVE IN VINYL PLUG.
3. COAT HOLE ON DRY SIDE OF PLUG AND WHILE BONDING AGENT IS TACKY, DRYPACK.
4. COAT HOLE ON WATER SIDE OF PLUG AND WHILE BONDING AGENT IS TACKY, DRYPACK.
5. USE CATEGORY II, NON-SHRINK GROUT AS SPECIFIED.

ALTERNATE FORM TIE THROUGH BOLT

NTS

0310-052



SIZE	"A"	"B"	"C"	"D"	"E"	"F"
4"x3/16"	4"	3/16"	3/16"	3/4"	1/4"	4
6"x3/8"	6"	3/8"	3/8"	7/8"	1/4"	6
9"x3/8"	9"	3/8"	3/8"	1"	1/4"	8

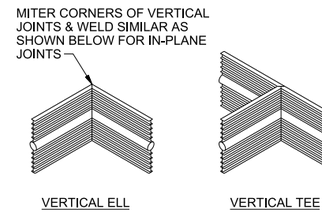
NOTES:

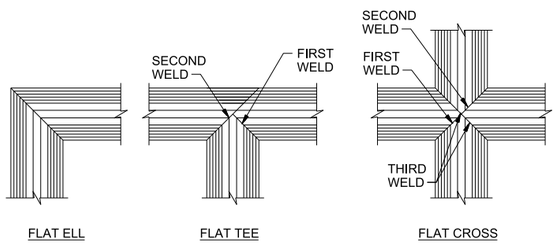
1. NON-ROUND CENTER BULBS SHALL HAVE A MINIMUM OUTSIDE DIMENSION OF 'D'.
2. SEE SPLICE DETAIL 0315-011
3. BULB TYPE WATERSTOP SHOWN IS REQUIRED FOR EXPANSION AND CONTROL JOINTS. SIMILAR WATERSTOPS WITHOUT CENTER BULB MAY BE SUBSTITUTED AT CONSTRUCTION JOINTS.
4. USE 6 INCH WATERSTOPS IN ALL CONSTRUCTION JOINTS UNLESS SPECIFICALLY SHOWN OTHERWISE.

PLASTIC WATERSTOP

NTS

0315-001





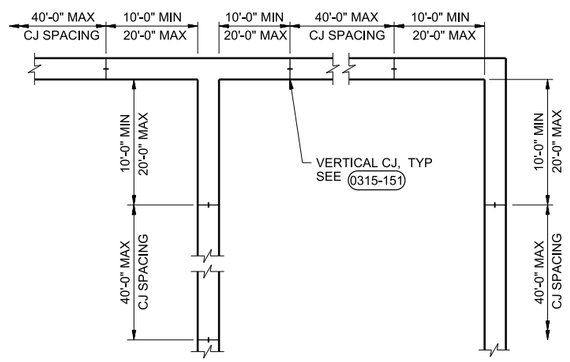
NOTE:

ALL WELDS SHALL BE PER WATERSTOP MANUFACTURER'S RECOMMENDATIONS.

WATERSTOP JOINTS

NTS

0315-011



PLAN

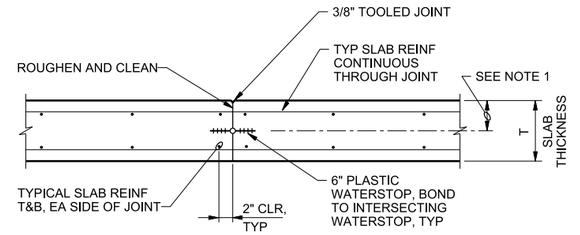
NOTES:

1. COORDINATE CONSTRUCTION JOINT LOCATIONS AND TIME BETWEEN CONCRETE POURS WITH SPECIFICATION 03 30 00.
2. LOCATE WALL CONSTRUCTION JOINTS AS SHOWN, UNLESS INDICATED OTHERWISE.

WALL CONSTRUCTION JOINT SPACING

NTS

0315-131



NOTE:

1. WATERSTOP DEPTH = T/2.

SLAB CONSTRUCTION JOINT

NTS

0315-142

NO.	DSGN	DATE	BY	REVISION	CHK	APVD
	DR EVERSON		DR	PA KARABAN	CW ANSON	DR EVERSON

Jacobs
25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
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CRESTVIEW, FL

STRUCTURAL

STANDARD DETAILS

NTS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
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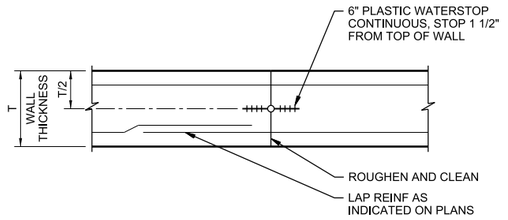
DWG	99-S-5001
SHEET	63 of 76

BID DOCUMENTS



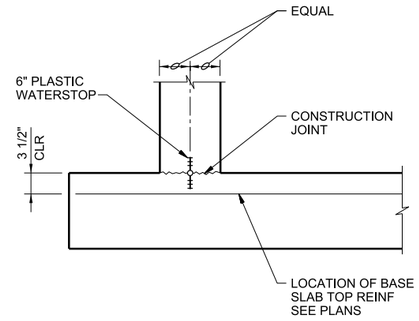
PLAN

NOTES:

1. ALL REINFORCEMENT CONTINUOUS ACROSS JOINT.
2. FOR LOCATIONS, SEE (0315-131)

WALL VERTICAL CONSTRUCTION JOINT (0315-151)

NTS

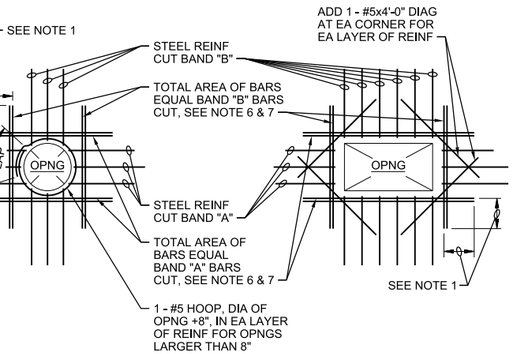


NOTES:

1. FOR WALLS WITH SINGLE MAT OF REINFORCING LOCATE WATERSTOP ON LIQUID FACE, 1" CLEAR OF REINFORCEMENT.
2. SECURE WATERSTOP IN-PLACE AS SPECIFIED.

WALL BASE CONSTRUCTION JOINT (0315-154)

NTS

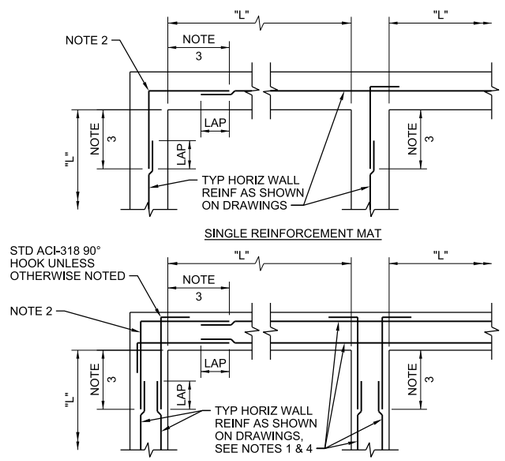


NOTES:

1. PROVIDE MINIMUM LAP, SEE GENERAL STRUCTURAL NOTES.
2. TYPICAL FOR ALL OPENINGS IN CONCRETE WALLS OF BELOW GRADE AND HYDRAULIC STRUCTURES AND ALL STRUCTURAL CONCRETE SLABS UNLESS INDICATED OTHERWISE ON PLANS.
3. DO NOT WELD REINFORCEMENT TO PIPE SLEEVES AND INSERTS.
4. PROVIDE A MINIMUM OF 2 "A" BARS AND 2 "B" BARS EACH SIDE OF OPENING (1 EACH FACE), INCLUDING DOWELS AND CORNER BARS, TYPICAL.
5. FOR OPENINGS LARGER THAN 8'-0", REINFORCE SAME AS FOR 8'-0" OPENINGS.
6. SPACE AT 3 BAR DIAMETERS (OR 3" MINIMUM) ON CENTER. LOCATE HALF OF TOTAL AREA ON EACH SIDE OF OPENING.
7. AT OPENINGS WITHIN 12" OF AN INTERSECTING WALL OR SLAB, PROVIDE ONLY THE EXTRA REINFORCEMENT WHICH WILL FIT, AT THE BAR SPACING IN NOTE 6.

OPENING REINFORCEMENT (0330-001)

NTS



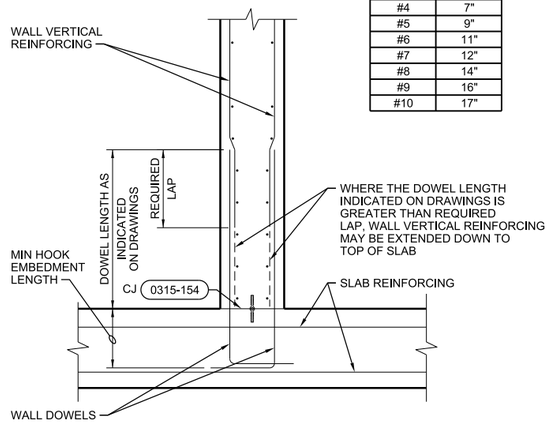
NOTES:

1. WHERE SHOWN ON PLANS, ADDITIONAL HORIZONTAL WALL CORNER AND INTERSECTION REINFORCEMENT SHALL BE ALTERNATED WITH THE TYPICAL HORIZONTAL REINFORCEMENT SHOWN IN THIS DETAIL.
2. CORNER BARS SHALL MATCH SIZE OF TYPICAL HORIZONTAL REINFORCEMENT SHOWN IN SECTIONS.
3. EXCEPT WHERE OTHERWISE SHOWN ON THE DRAWINGS, THE LENGTH INDICATED AS "NOTE 3" SHALL BE THE LESSER OF L/4, 10 FEET, OR 1.0 TIMES THE HEIGHT OF THE WALL, EXCEPT THAT IN NO CASE SHALL IT BE LESS THAN 2 FEET.
4. TYPICAL HORIZONTAL REINFORCEMENT SHALL BE LAPPED WHERE SHOWN OR AS INDICATED IN THE GENERAL STRUCTURAL NOTES.
5. WHERE LAPPED BARS ARE DIFFERENT SIZE, USE THE LAP LENGTH REQUIRED FOR THE SMALLER OF THE TWO REINFORCEMENT BARS BEING SPLICED.

TYPICAL WALL CORNER & INTERSECTION REINFORCEMENT (0330-003)

NTS

ACI MINIMUM HOOK EMBEDMENT LENGTH	
BAR SIZE	MIN EMBED
#4	7"
#5	9"
#6	11"
#7	12"
#8	14"
#9	16"
#10	17"



WALL SECTION

NOTE:

UNLESS NOTED OTHERWISE, ALL DOWEL HOOKS SHALL EXTEND TO AND BE TIED OFF TO BOTTOM MAT OF SLAB REINFORCING.

VERTICAL WALL REINFORCING/ DOWEL PLACEMENT (0330-005)

NTS

NO.	DATE	REVISION	BY	APVD
DSGN	DR EVERSON	DR PA KARABAN	CHK CW ANSON	APVD DR EVERSON

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25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

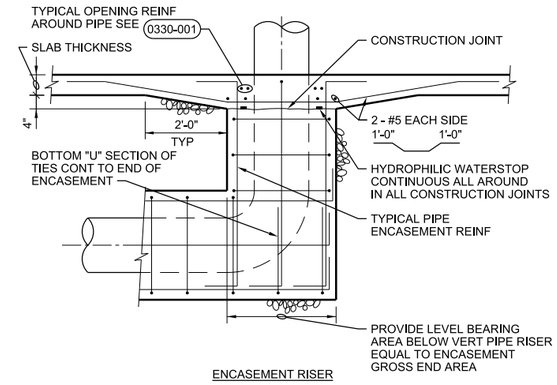
STRUCTURAL

STANDARD DETAILS

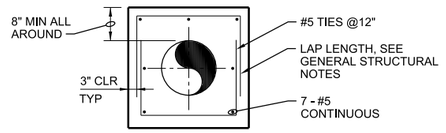
NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-S-5002
SHEET	64 of 76

BID DOCUMENTS



ENCASEMENT RISER



SECTION

NOTES:

1. SECTION APPLIES TO PIPES W/ DIAMETERS 18" AND SMALLER. FOR 20" DIAMETER PIPES AND LARGER, SEE (0330-017)
2. WHEN PIPE ENCASEMENT IS CLOSER THAN 4" TO SLAB ABOVE, TIE SLAB & ENCASEMENT TOGETHER. SEE (0330-018)

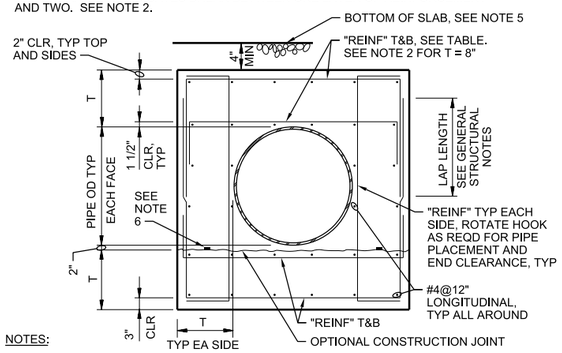
PIPE ENCASEMENT

NTS

0330-016

PIPE ENCASEMENT TABLE								
PIPE DIA (IN.)	H=10 FEET		H=20 FEET		H=30 FEET		H=40 FEET	
	T (in)	REINF	T (in)	REINF	T (in)	REINF	T (in)	REINF
20 THRU 30	8	#5@12"	10	#5@12"	10	#5@12"	10	#6@12"
36 THRU 42	10	#5@12"	10	#6@12"	10	#7@12"	10	#6@6"
48 THRU 54	10	#6@12"	10	#7@12"	10	#7@6"	12	#7@6"
UP TO 60	10	#6@12"	10	#6@6"	14	#7@6"	14	#7@6"

HEAVY DARK LINE INDICATES BREAK BETWEEN ONE LAYER OF REINFORCEMENT AND TWO. SEE NOTE 2.



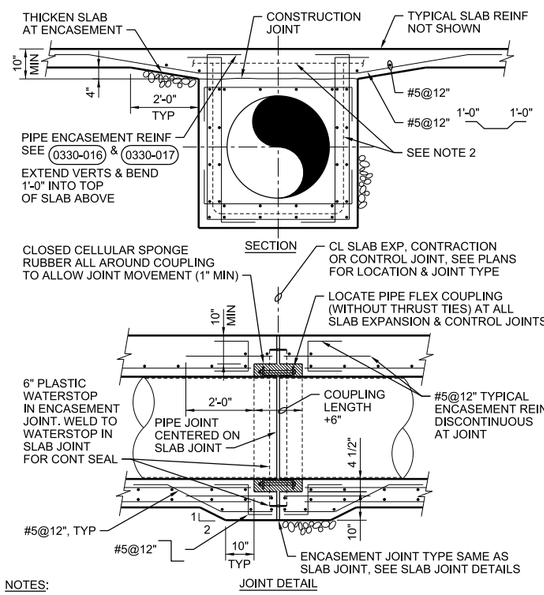
NOTES:

1. THIS DETAIL APPLIES TO PIPE DIAMETER OF 20" AND LARGER. FOR SMALLER THAN 20", SEE DETAIL (0330-016).
2. FOR T=8" REINFORCEMENT SHALL BE ONE LAYER AND CENTERED IN SLABS OR WALLS. SIM (0330-016).
3. FOR ENCASEMENT AT PIPE RISER, SEE (0330-016).
4. "H" IS FILL HEIGHT OR WATER DEPTH OR COMBINATION ABOVE PIPE.
5. WHEN PIPE ENCASEMENT CLOSER THAN 4" TO SLAB ABOVE, TIE SLAB & ENCASEMENT TOGETHER. SEE (0330-018).
6. HYDROPHILIC WATERSTOP CONTINUOUS ALL AROUND IN ALL CONSTRUCTION JOINTS.

PIPE ENCASEMENT

NTS

0330-017



SECTION

JOINT DETAIL

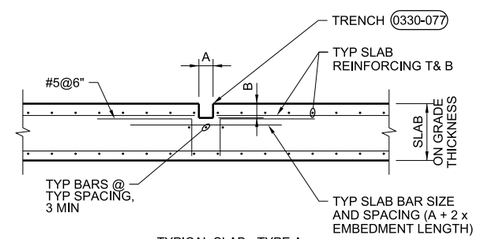
NOTES:

1. TIE PIPE ENCASEMENT TO SLAB AS SHOWN WHEN DISTANCE BETWEEN PIPE ENCASEMENT AND BOTTOM OF SLAB IS LESS THAN 4".
2. 6" PLASTIC WS IN ENCASEMENT JOINTS. WELD TO WS IN SLAB JOINTS.

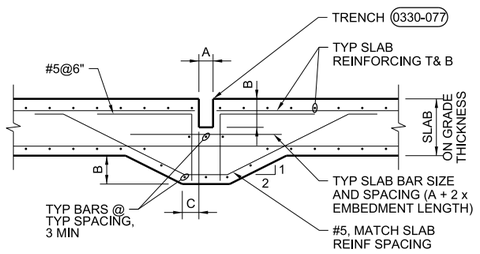
PIPE ENCASEMENT AT SLAB

NTS

0330-018



TYPICAL SLAB - TYPE A



THICKENED SLAB - TYPE B

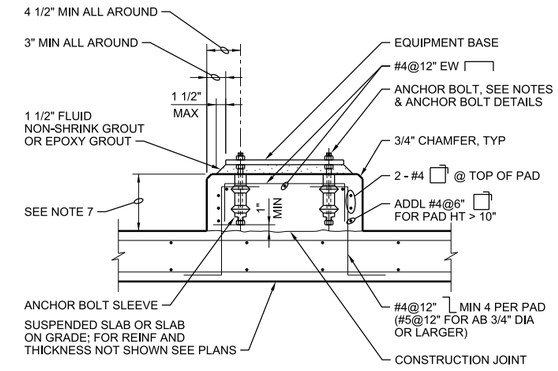
DIMENSIONS:

A = TRENCH WIDTH:	SEE PLANS
B = TRENCH DEPTH:	SEE PLANS
C = 6" WHEN:	A < 1'-0"
C = 1'-0" WHEN:	A ≥ 1'-0"

TRENCH REINFORCING

NTS

0330-043



TYPE 'A'

GENERAL NOTE:

FOR GENERAL NOTES SEE DETAIL 4 OF 4.

CONCRETE EQUIPMENT PAD - TYPE 'A'

NTS

DETAIL 1 OF 4

0330-056

NO.	DATE	REVISION	BY	APVD
DSGN	DR EVERSON	DR PA KARABAN	CHK CW ANSON	APVD DR EVERSON

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EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

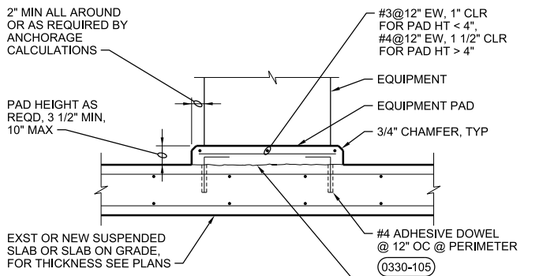
STRUCTURAL

STANDARD DETAILS

BID DOCUMENTS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-S-5003
SHEET	65 of 76



NOTES:

1. WHEN ANCHORAGE OF EQUIPMENT TO PAD IS REQUIRED, USE CONCRETE ANCHORS SPECIFIED.
2. CONCRETE PADS FOR ELECTRICAL EQUIPMENT SHALL BE 3 1/2" HIGH, UNLESS NOTED OTHERWISE.

TYPE 'E'

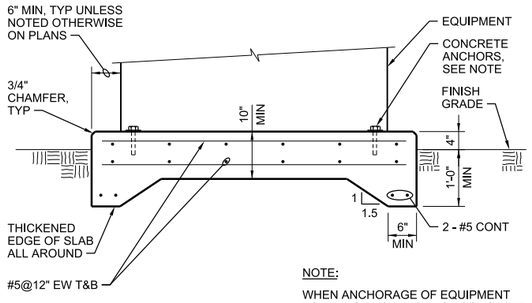
GENERAL NOTE:
FOR GENERAL NOTES SEE DETAIL 4 OF 4.

DETAIL 2 OF 4

CONCRETE EQUIPMENT PAD - TYPE 'E'

0330-056

NTS



NOTE:

WHEN ANCHORAGE OF EQUIPMENT TO PAD IS REQUIRED, USE CONCRETE ANCHORS SPECIFIED.

TYPE 'H'

GENERAL NOTE:
FOR GENERAL NOTES SEE DETAIL 4 OF 4.

DETAIL 3 OF 4

CONCRETE EQUIPMENT PAD - TYPE 'H'

0330-056

NTS

NOTES:

1. PAD SIZE SHALL BE MINIMUM INDICATED OR AS SHOWN ON THE PLANS OR AS INDICATED BY THE MANUFACTURER AND APPROVED BY THE ENGINEER.
2. THE SIZE, NUMBER, TYPE, LOCATION, AND THREAD PROJECTION OF THE ANCHOR BOLTS SHALL BE DETERMINED BY THE EQUIPMENT MANUFACTURER AND AS APPROVED BY THE ENGINEER. ANCHOR BOLTS SHALL BE HELD IN POSITION WITH A TEMPLATE OR OTHER ACCEPTABLE MEANS, MATCHING THE BASE PLATE, WHILE PAD IS BEING PLACED.
3. ANCHOR BOLT SLEEVES SHALL BE USED TO PROVIDE MINIMUM ANCHOR BOLT MOVEMENT OF 1/2" IN ALL HORIZONTAL DIRECTIONS. THE MINIMUM SLEEVE LENGTH SHALL BE 8 TIMES THE BOLT DIAMETER.
4. ANCHOR BOLT SLEEVES SHALL HAVE A MINIMUM INTERNAL DIAMETER 1" GREATER THAN BOLT DIAMETER AND A MAXIMUM INTERNAL DIAMETER 3" GREATER THAN ANCHOR BOLT DIAMETER. SLEEVES SHALL BE FILLED WITH NON-SHRINK GROUT AFTER BOLTS ARE ALIGNED. SEE 0330-057.
5. EQUIPMENT BASES SHALL BE INSTALLED LEVEL UNLESS INDICATED OTHERWISE.
6. WEDGES, SHIMS, OR LEVELING NUTS SHALL BE USED TO SUPPORT THE BASE WHILE THE GROUT IS PLACED. WEDGES OR SHIMS SHALL BE REMOVED AFTER GROUT IS SET AND PACK VOID WITH GROUT.
7. HEIGHT OF PADS SHALL BE MINIMUM REQUIRED FOR ANCHOR BOLT CLEARANCE TO KEEP ANCHOR BOLT ABOVE SUPPORTING SLAB (SEE TABLE BELOW). WHERE EQUIPMENT OR PIPING ELEVATION REQUIRE A PAD HEIGHT LESS THAN THE MINIMUM SHOWN, USE TYPE "B" EQUIPMENT PAD WITH BLOCKOUT.
8. TYPE "D" PAD SHALL BE USED ONLY WHERE SPECIFICALLY INDICATED. PLACE THE SURROUNDING FLOOR SLAB AFTER THE EQUIPMENT PAD.
9. AT CONTRACTOR'S OPTION, CONCRETE ANCHORS MAY BE USED IN LIEU OF CAST-IN-PLACE ANCHOR BOLTS FOR EQUIPMENT ANCHOR BOLTS LESS THAN 3/4" DIAMETER WHEN APPROVED BY THE EQUIPMENT MANUFACTURER AND APPROVED BY THE ENGINEER. ANCHORS SHALL BE INSTALLED WITH 4" MINIMUM EDGE DISTANCE IN EACH DIRECTION.

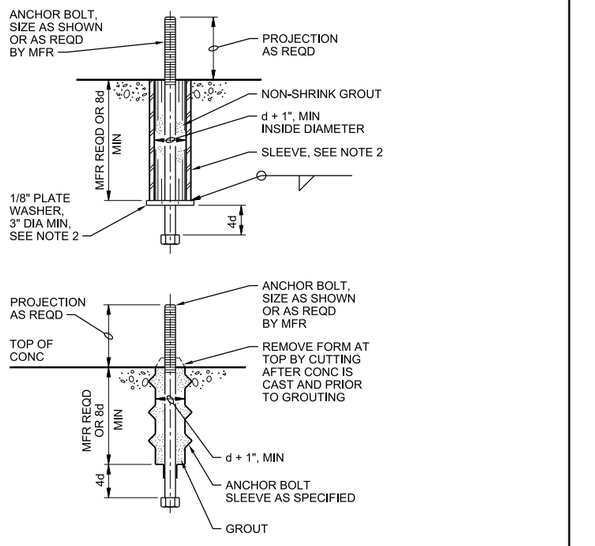
AB DIA (IN.)	1/2	5/8	3/4	7/8	1	1 1/4	1 3/8	1 1/2	1 3/4	2
MIN PAD HT (IN.)	7	8 1/2	10	11	12 1/2	15	16 1/2	18	21	24

DETAIL 4 OF 4

CONCRETE EQUIPMENT PAD - NOTES

0330-056

NTS



MACHINERY ANCHOR BOLT DETAIL

NOTES:

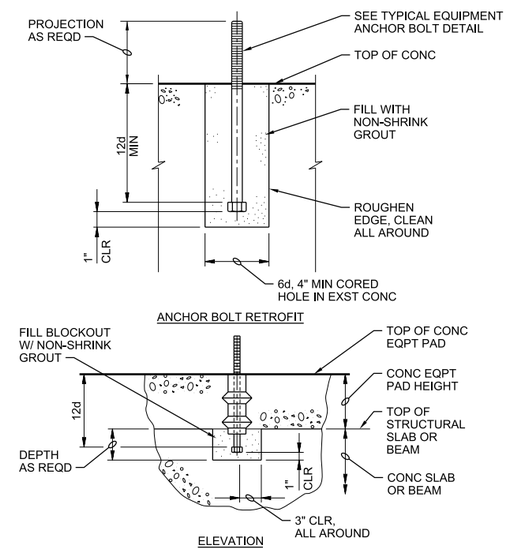
1. FOR CONCRETE EQUIPMENT PAD DETAILS AND NOTES NOT SHOWN SEE 0330-056
2. MATERIAL TO MATCH BOLT.

DETAIL 1 OF 2

ANCHOR BOLT DETAILS

0330-057

NTS



ANCHOR BOLT RETROFIT

ELEVATION

ANCHOR BOLT BLOCKOUT

NOTES:

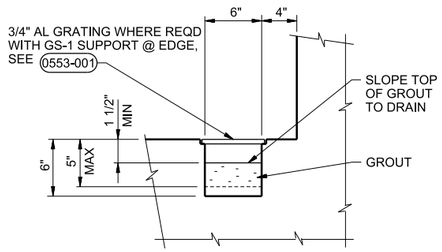
1. FOR CONCRETE EQUIPMENT PAD DETAILS AND NOTES NOT SHOWN SEE 0330-056
2. MATERIAL TO MATCH BOLT.

DETAIL 2 OF 2

ANCHOR BOLT DETAILS

0330-057

NTS



NOTES:

1. PROVIDE GRATING WHERE GUTTER CROSSES WALKWAY OR WORKING AREAS.
2. WHERE TRENCH IS ADJACENT TO WALL DO NOT PROVIDE GRATING UNLESS SPECIFICALLY SHOWN.

FORMED CONCRETE TRENCH

0330-077

NTS

NO.	DATE	DR	CHK	APVD	BY	REVISION
DSGN	DR EVERSON	PA KARABAN	CW ANSON	APVD	DR EVERSON	

Jacobs
25 W CEDAR STREET, SUITE 350
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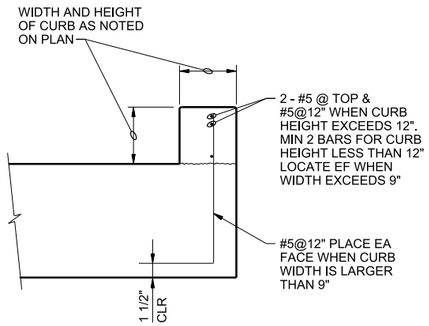
CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

STRUCTURAL

STANDARD DETAILS

BID DOCUMENTS

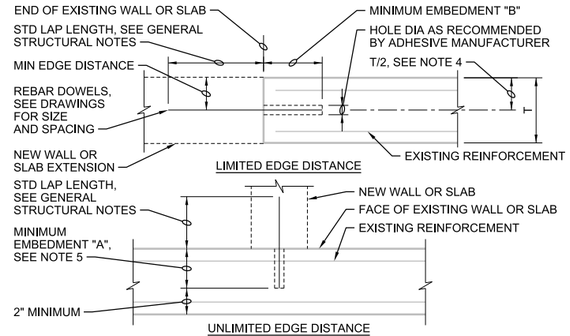
NTS	
VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"	
DATE	MARCH 2021
PROJ	D3403200
DWG	99-S-5004
SHEET	66 of 76



CONCRETE CURB

NTS

0330-080



DOWEL SIZE	MINIMUM EDGE DISTANCE	MINIMUM EMBEDMENT "A"	MINIMUM EMBEDMENT "B"
#3	2 1/2"	5"	8"
#4	3 1/2"	7"	11"
#5	4"	8"	13"
#6	5"	10 1/2"	16"
#7	6"	12 1/2"	20"
#8	7"	14"	22"
#9	7 1/2"	15"	24"

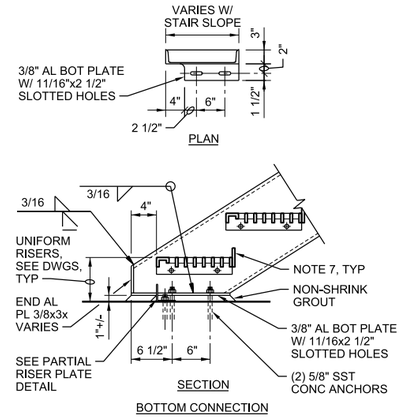
NOTES:

1. CONFORM TO REQUIREMENTS OF SPECIFICATION SECTION 03 63 00, CONCRETE DOWELING.
2. FOLLOW ADHESIVE MANUFACTURER'S INSTRUCTIONS FOR INSTALLATION.
3. USE MINIMUM EMBEDMENTS SHOWN, EXCEPT USE MANUFACTURER'S MINIMUM RECOMMENDED EMBEDMENT IF GREATER.
4. LOCATE DOWELS CENTERED IN WALL OR SLAB UNLESS OTHERWISE NOTED ON DRAWINGS. WHERE 2 ROWS OF DOWELS INDICATED, STAGGER SPACING & LOCATE ALTERNATING DOWELS AT MINIMUM EDGE DISTANCE FROM OPPOSITE FACES.
5. PROVIDE MINIMUM EMBEDMENT "A" SHOWN IN TABLE UNLESS SHORTER EMBEDMENT DEPTH IS CALLED OUT ON DRAWINGS.

ADHESIVE DOWEL

NTS

0330-105



NOTES:

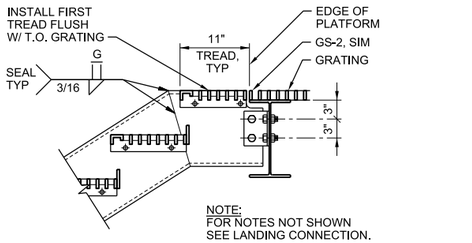
1. PROVIDE PROTECTION FOR DISSIMILAR METALS AND FOR ALUMINUM IN CONTACT WITH CONCRETE PER SPECIFICATIONS.
2. AMERICAN STANDARD C12x7.41 ALUMINUM STRINGERS TYPICAL EXCEPT WHERE OTHERWISE NOTED ON PLANS.
3. STAIR RAILING NOT SHOWN.
4. STAIR MANUFACTURER TO COORDINATE BOLTED TREADS AND RAILING CONNECTIONS.
5. ALL FASTENERS SHALL BE STAINLESS STEEL.
6. FIELD VERIFY DIMENSIONS AND ELEVATIONS PRIOR TO FABRICATION.
7. FOR RISER PLATE SEE PARTIAL RISER PLATE DETAIL UNLESS NOTED OTHERWISE. CLEARANCE BETWEEN TOP OF RISER PLATE AND BOTTOM OF TREAD TO BE 3 3/4" MAXIMUM. FOR STAIRS WITH PICKET RAILING EXTEND RISER PLATE PER FULL RISER PLATE DETAIL.

DETAIL 1 OF 5

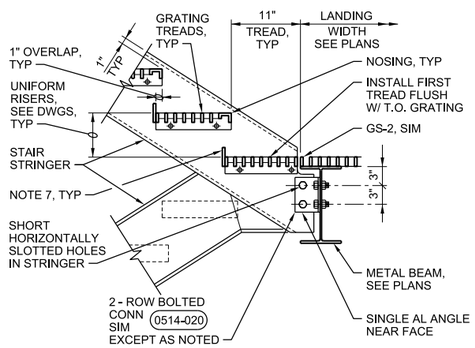
STAIR DETAILS - ALUMINUM

NTS

0512-001



TOP CONNECTION - ALUMINUM



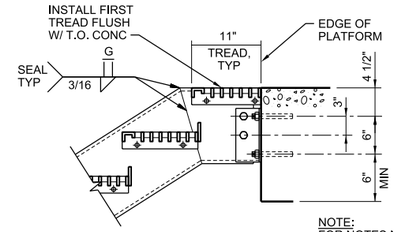
LANDING CONNECTION - ALUMINUM

DETAIL 2 OF 5

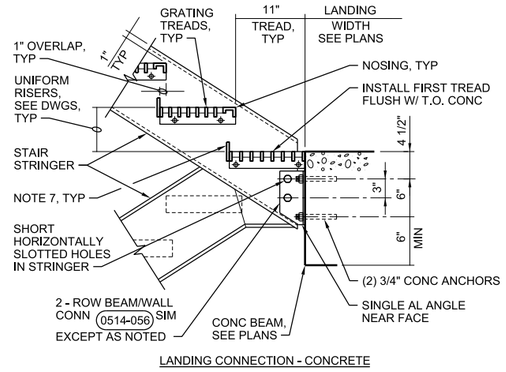
STAIR DETAILS - ALUMINUM

NTS

0551-001



TOP CONNECTION - CONCRETE



LANDING CONNECTION - CONCRETE

DETAIL 3 OF 5

STAIR DETAILS - ALUMINUM

NTS

0551-001

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN	DR EVERSON		PA KARABAN	CW ANSON			DR EVERSON

25 W CEDAR STREET, SUITE 350
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EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

STRUCTURAL

STANDARD DETAILS

BID DOCUMENTS

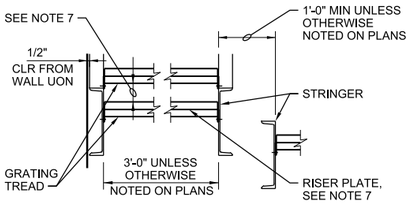
NTS

VERIFY SCALE

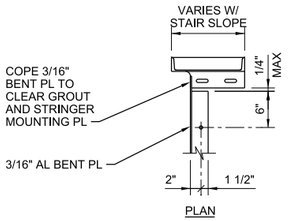
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-S-5005
SHEET	67 of 76

STAIRWAY WIDTH	TREAD BEARING BARS
	ALUMINUM TREAD
2'-3" OR LESS	1" x 3/16"
2'-9" OR LESS	1 1/4" x 3/16"
3'-3" OR LESS	1 1/2" x 3/16"
4'-7" OR LESS	1 3/4" x 3/16"



STAIR TREADS



PLAN

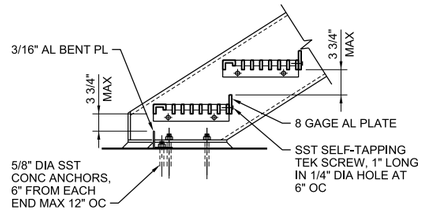
BOTTOM CLOSURE PLATE

DETAIL 4 OF 5

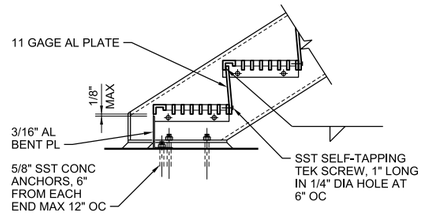
STAIR DETAILS - ALUMINUM

NTS

0551-001



PARTIAL RISER PLATE



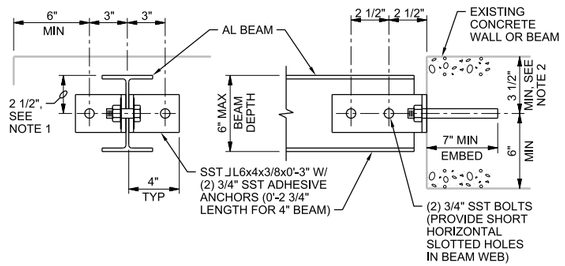
FULL RISER PLATE

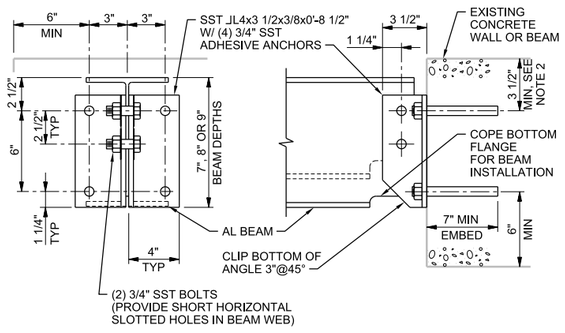
DETAIL 5 OF 5

STAIR DETAILS - ALUMINUM

NTS

0512-001



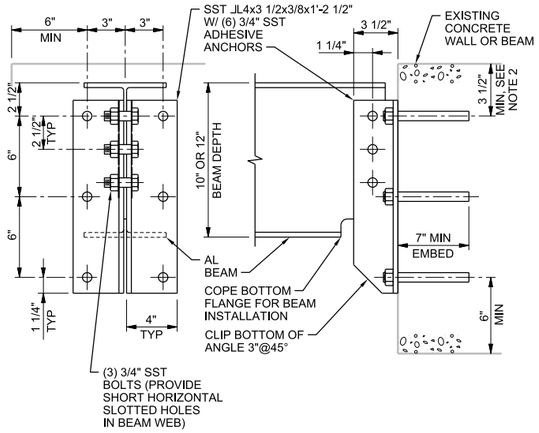


DETAIL 1 OF 2

STAIR LANDING SUPPORT - ALUMINUM

NTS

0514-056



NOTES:

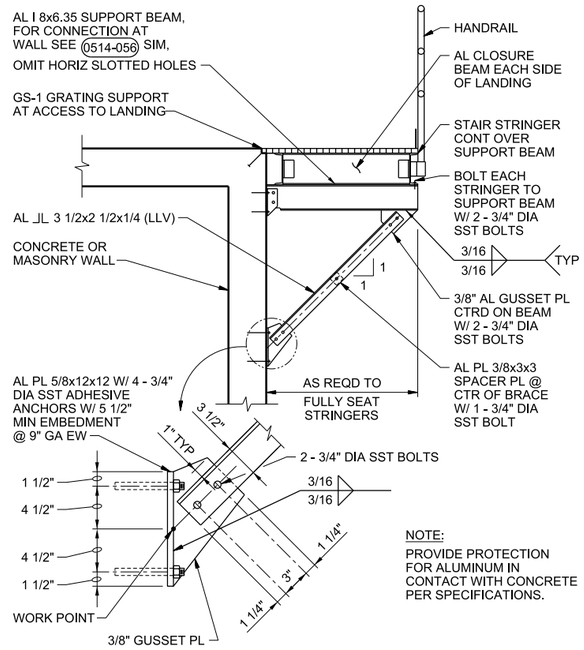
1. 2 1/2" DIMENSION TYPICAL EXCEPT 2" FOR 4" BEAMS.
2. DO NOT CUT EXISTING CONCRETE BEAM TOP REINFORCING DURING DRILL-IN ANCHOR INSTALLATION. FIELD LOCATE BEAM REINFORCING PRIOR TO FABRICATION WITH GROUND PENETRATING RADAR OR OTHER ACCEPTABLE MEANS. ADD LENGTH TO CLIP ANGLES AS REQUIRED TO LOWER ANCHORS TO CLEAR REINFORCING WHILE MAINTAINING SPACING AND EDGE DISTANCE AS SHOWN.
3. WHERE BOTH ENDS OF BEAM ARE ATTACHED TO A WALL, PROVIDE LONG HORIZONTALLY SLOTTED HOLES IN BEAM WEB AT ONE END. TIGHTEN NUTS SNUG TIGHT, BACK OFF 1/2 TURN, AND LOCK WITH DOUBLE NUT.
4. PROVIDE PROTECTION FOR DISSIMILAR MATERIALS PER SPECIFICATIONS.

DETAIL 2 OF 2

STAIR LANDING SUPPORT - ALUMINUM

NTS

0514-056



NOTE:
PROVIDE PROTECTION FOR ALUMINUM IN CONTACT WITH CONCRETE PER SPECIFICATIONS.

DETAIL 1 OF 1

STAIR LANDING SUPPORT - ALUMINUM

NTS

0551-003

NO.	DSGN	DATE	REVISION	CHK	APVD	BY	APVD
	DR EVERSON	DR EVERSON	PA KARABAN	CW ANSON			DR EVERSON

Jacobs
25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

STRUCTURAL

STANDARD DETAILS

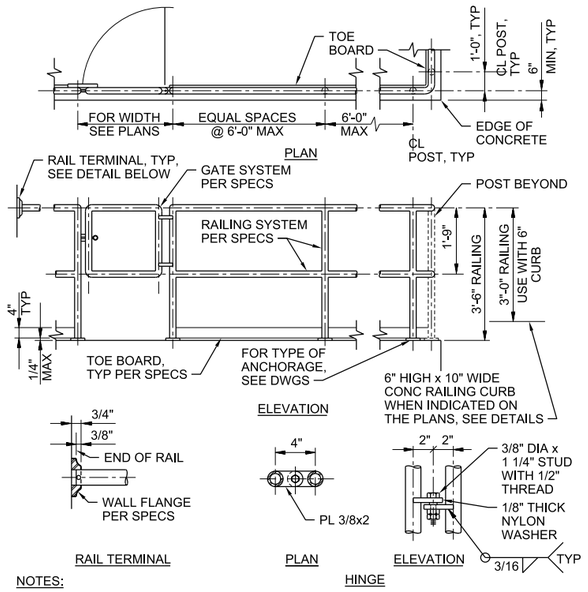
BID DOCUMENTS

NTS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-S-5006
SHEET	68 of 76



NOTES:

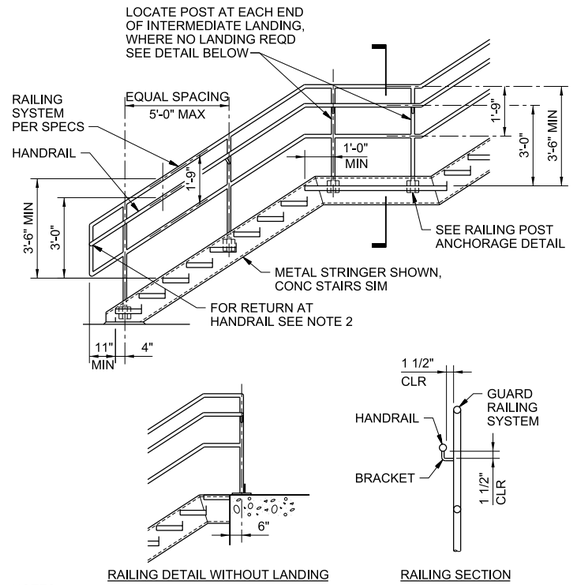
1. FASTEN RAIL TO WALL FLANGE PER MANUFACTURER'S RECOMMENDATIONS.
2. WALL FLANGE TO BE MOUNTED TO WALL WITH (2) 3/8" DIA SST WEDGE ANCHORS.
3. AT CONTRACTOR'S OPTION FABRICATE HINGES OR PROVIDE OTHER HINGES PER SPECIFICATIONS. ANODIZE FINISH AFTER ALL WELDING PER SPECIFICATIONS.

DETAIL 1 OF 3

RAILING - 2 RAIL - ALUMINUM

NTS

0552-001



NOTES:

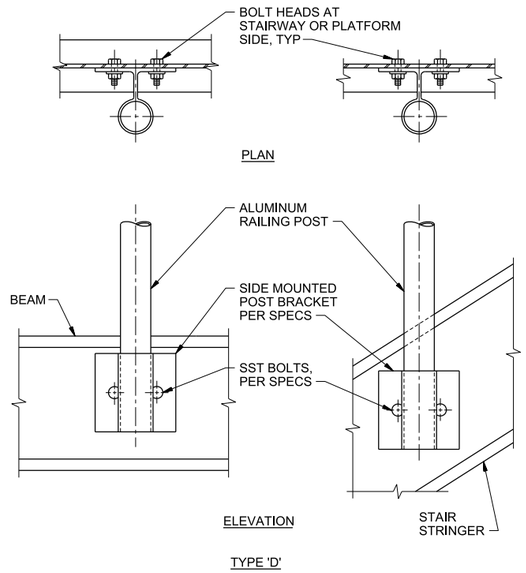
1. PROVIDE TOE BOARD AT LANDING WHERE REQUIRED.
2. RETURN ENDS OF HANDRAIL TO GUARD AT BOTH ENDS.

DETAIL 2 OF 3

RAILING - 2 RAIL STAIR - ALUMINUM (IBC)

NTS

0552-001



NOTE:

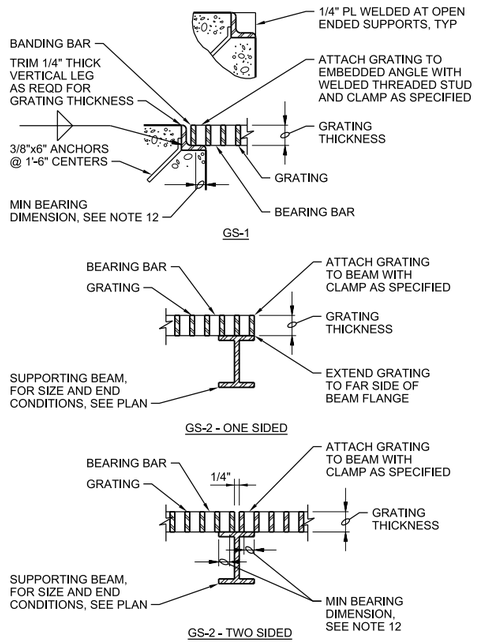
PROVIDE PROTECTION FOR DISSIMILAR METALS PER SPECIFICATIONS.

DETAIL 3 OF 3

RAILING POST ANCHORAGE TYPE 'D' - ALUMINUM

NTS

0552-001

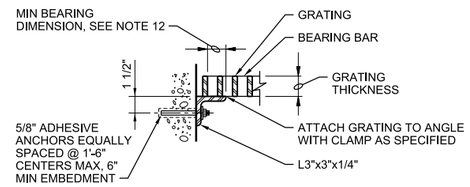


DETAIL 1 OF 4

STANDARD GRATING

NTS

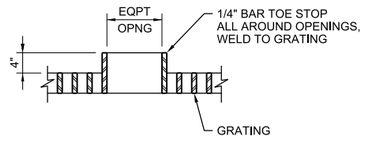
0553-001



NOTES:

1. USE GS-3 ONLY FOR LIGHT DUTY GRATING, TYPE 'A'.
2. INSTALL ANCHORS MAXIMUM 4" FROM EACH END.
3. WHEN ANCHOR IS WITHIN 4" OF A CONCRETE EDGE, UTILIZE MANUFACTURER'S LOW-TORQUE INSTALLATION PROCEDURES.

GS-3



EQUIPMENT OPENINGS

DETAIL 2 OF 4

STANDARD GRATING

NTS

0553-001

NO.	DATE	REVISION	BY	APVD
DSGN	DR EVERSON	DR PA KARABAN	CHK CW ANSON	APVD DR EVERSON

Jacobs
25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

STRUCTURAL

STANDARD DETAILS

BID DOCUMENTS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-S-5007
SHEET	69 of 76

GENERAL NOTES:

1. GRATING SHALL BE LIGHT DUTY GRATING UNLESS OTHERWISE NOTED ON DRAWINGS.
2. GRATING SPAN IS INDICATED BY ◄——► , SEE PLAN.
3. INDIVIDUAL GRATING SECTIONS SHALL NOT EXCEED 3'-0" IN WIDTH OR WEIGH MORE THAN 150 POUNDS, UNLESS INDICATED OTHERWISE, FOR TYPES 'A' & 'B' GRATING. TYPE 'C' GRATING SHALL HAVE A MINIMUM WIDTH OF 2'-0" REGARDLESS OF WEIGHT.
4. SHOP DRAWINGS BASED ON FIELD DIMENSIONS SHALL BE SUBMITTED TO THE ENGINEER PRIOR TO FABRICATION.
5. MATERIAL FOR SUPPORTS OF STEEL AND ALUMINUM GRATING TO BE SAME AS GRATING, EXCEPT METAL SUPPORTS THAT ARE TO BE EMBEDDED IN CONCRETE SHALL BE TYPE 316 STAINLESS STEEL.
6. UNLESS NOTED OTHERWISE ON PLANS, GRATING THICKNESS SHALL BE AS TABULATED IN "GRATING THICKNESS TABLE" FOR APPLICABLE GRATING TYPE.
7. FOR SERRATED BEARING BARS, INCREASE GRATING THICKNESSES SHOWN IN TABLES BY 1/4".
8. BEARING BAR THICKNESS FOR GRATING TO BE 3/16" MINIMUM. SEE SPECIFICATIONS FOR SPACING OF BEARING AND CROSS BARS.
9. BAND ALL EDGES. MATCH DEPTH OF BEARING BAR.
10. TYPE OF MATERIAL USED SHALL BE AS SHOWN ON PLANS OR AS SPECIFIED. THIS STANDARD DETAIL INCLUDES 2 TYPES, ALTHOUGH BOTH MAY NOT BE INCLUDED IN PROJECT.
11. THE HORIZONTAL CLEARANCE BETWEEN THE GRATING AND GRATING SUPPORTS SHALL NOT BE LESS THAN 1/4" NOR GREATER THAN 1/2" AND AS SPECIFIED.
12. MINIMUM BEARING HORIZONTAL DIMENSION = 1" FOR GRATING DEPTH 2 1/4" OR LESS. MINIMUM BEARING HORIZONTAL DIMENSION = 2" FOR GRATING DEPTH GREATER THAN 2 1/4"

DETAIL 3 OF 4

STANDARD GRATING

NTS

0553-001

LIGHT DUTY GRATING
TYPE 'A'
(100 PSF)

GRATING THICKNESS TABLE

MAXIMUM SPAN	STEEL	ALUMINUM
3'-6"	1"	1 1/4"
4'-0"	1"	1 1/2"
4'-6"	1"	1 3/4"
5'-0"	1 1/4"	1 3/4"
5'-6"	1 1/4"	2"
6'-0"	1 1/2"	2 1/4"
6'-6"	1 1/2"	2 1/4"
7'-0"	1 3/4"	2 1/2"

MEDIUM DUTY GRATING
TYPE 'B'
(500 PSF)

GRATING THICKNESS TABLE

MAXIMUM SPAN	STEEL	ALUMINUM
< 2'-0"	1"	1"
2'-6"	1"	1 1/4"
3'-0"	1 1/4"	1 1/2"
3'-6"	1 1/4"	1 3/4"
4'-0"	1 1/2"	2"
4'-6"	1 3/4"	2 1/4"
5'-0"	1 3/4"	2 1/2"
5'-6"	2"	DO NOT USE ALUMINUM GRATING
6'-0"	2 1/4"	
6'-6"	2 1/2"	

HEAVY DUTY GRATING
TYPE 'C'
(H 20 WHEEL LOAD)

GRATING THICKNESS TABLE

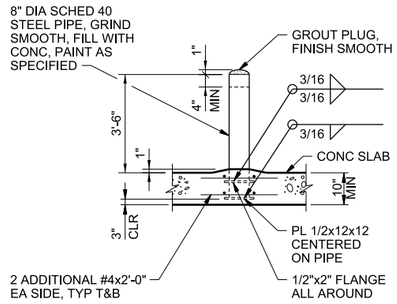
MAXIMUM SPAN	STEEL	ALUMINUM
1'-0"	2"x3/16"	DO NOT USE ALUMINUM GRATING
1'-8"	2 1/2"x1/4"	
2'-0"	2 1/2"x3/8" OR 3"x1/4"	
2'-6"	3"x3/8" OR 4"x1/4"	
3'-3"	3 1/2"x3/8"	
4'-0"	4"x3/8"	
5'-0"	4 1/2"x3/8"	

DETAIL 4 OF 4

STANDARD GRATING

NTS

0553-001

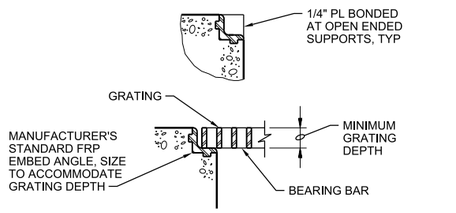


NOTES:
1. HOT DIPPED GALVANIZE AFTER FABRICATION.
2. FOR EXTERIOR GUARD POST, SEE (3471-810)

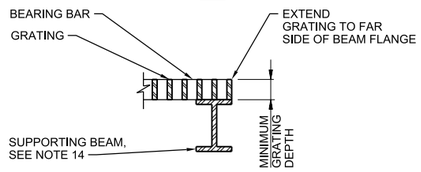
GUARD POST - INTERIOR

NTS

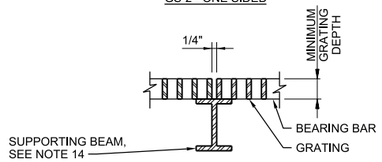
0559-026



GS-1



GS-2 - ONE SIDED



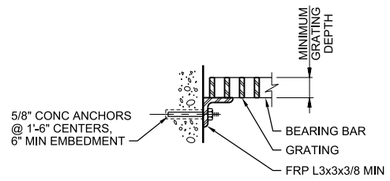
GS-2 - TWO SIDED

DETAIL 1 OF 3

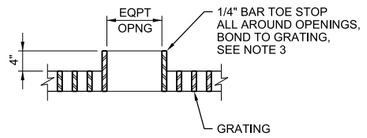
STANDARD FIBERGLASS GRATING

NTS

0682-030



GS-3



EQUIPMENT OPENINGS

DETAIL 2 OF 3

STANDARD FIBERGLASS GRATING

NTS

0682-030

GENERAL NOTES:

1. MOLDED FRP GRATING DETAILS SHOWN, PULTRUDED DETAILS SIMILAR.
2. EXTEND GRATING CONTINUOUSLY OVER GATE GUIDES AND GATES.
3. NOTCH GRATING AS REQUIRED FOR PENETRATIONS. FRP MANUFACTURER TO PROVIDE REINFORCEMENT AROUND OPENINGS TO ENSURE STRUCTURAL INTEGRITY.
4. BAND ALL EDGES, MOLDED GRATING ONLY.
5. GRATING SPAN ◄——► , SEE PLAN.
6. WIDTH OF GRATING SECTIONS SHALL NOT EXCEED 3'-0".
7. SHOP DRAWINGS BASED ON FIELD DIMENSIONS SHALL BE SUBMITTED TO THE ENGINEER PRIOR TO FABRICATION.
8. UNLESS OTHERWISE NOTED ON PLANS, MINIMUM GRATING THICKNESS SHALL BE AS TABULATED IN TABLE BELOW.
9. DESIGN LL = 100 PSF, UNLESS OTHERWISE NOTED.
10. PROVIDE GRATING FASTENERS AS SPECIFIED.
11. THE HORIZONTAL CLEARANCE BETWEEN THE GRATING AND GRATING SUPPORTS SHALL NOT BE LESS THAN 1/4" NOR GREATER THAN 1/2".
12. ALL GRATING SECTIONS, WHEN IN PLACE, SHALL BE ANCHORED TO THEIR SUPPORTS.
13. PROVIDE MINIMUM 1 1/2" BEARING FOR ALL FIBERGLASS GRATING.
14. SUPPORTING FRP MEMBERS AND CONNECTIONS THEREOF, SHALL BE DESIGNED AND DETAILED BY CONTRACTOR'S LICENSED DESIGN PROFESSIONAL, UNLESS OTHERWISE NOTED.

FOOT TRAFFIC

MAXIMUM SPAN	MINIMUM GRATING DEPTH	* GRATING TYPE
3'-6"	1 1/2"	M OR P
4'-0"	1 1/2"	M OR P
4'-6"	1 1/2"	M OR P
5'-0"	2"	P
5'-6"	2"	P

* M = MOLDED GRATING, P = PULTRUDED GRATING

DETAIL 3 OF 3

STANDARD FIBERGLASS GRATING

NTS

0682-030

NO.	DATE	REVISION	DR	CHK	APVD
DSGN	DR EVERSON	PA KARABAN		CW ANSON	DR EVERSON

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

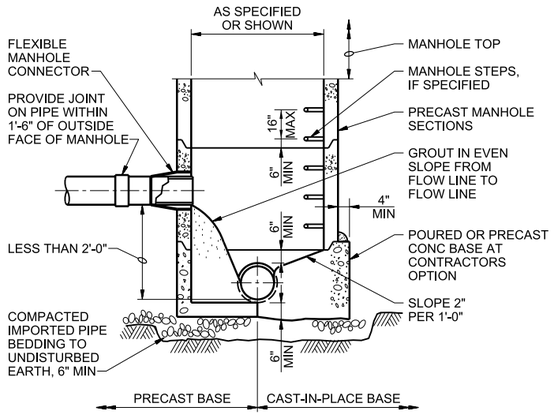
STRUCTURAL

STANDARD DETAILS

BID DOCUMENTS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

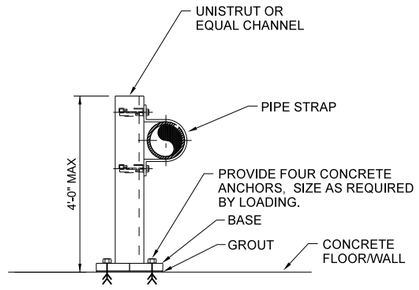
DATE	MARCH 2021
PROJ	D3403200
DWG	99-S-5008
SHEET	70 of 76



MANHOLE BASE SECTION

NTS

3305-710



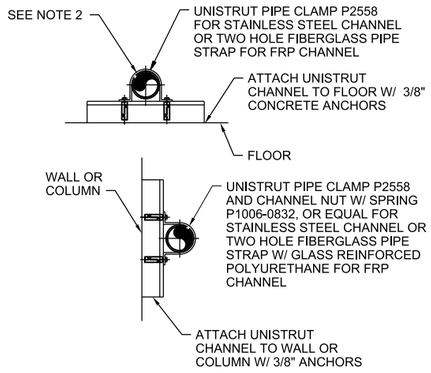
NOTES:

1. INCLUDE SAFETY CAP ON UNISTRUT. ADD GROUT BETWEEN BASEPLATE AND FLOOR SLAB.

PIPE SUPPORT

NTS

4005-495A



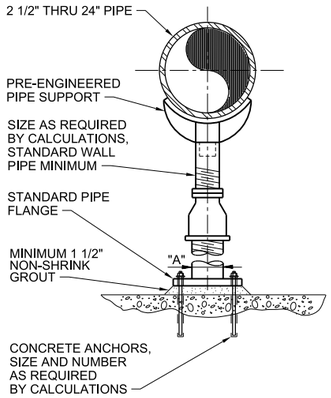
NOTES:

1. FOR MATERIALS OF CONSTRUCTION SEE SPECIFICATIONS SECTION 40 05 15.
2. FOR PVC PIPE USE UNICUSHION BETWEEN PIPE AND CLAMP.
3. TIGHTEN CLAMP SNUG TO PIPE.
4. ALL METAL UNISTRUT SHALL INCLUDE PVC END CAPS ON BOTH ENDS.

PIPE SUPPORT

NTS

4005-495C

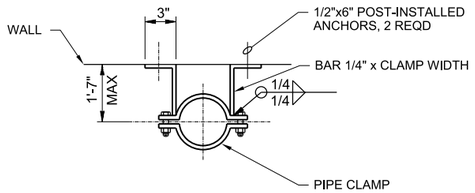


DIMENSION TABLE	
PIPE SIZE	"A" MINIMUM NOMINAL PIPE SIZE
2-1/2"	2-1/2"
3"	2-1/2"
4"	3"
6"	3"
8"	3"
10"	3"
12"	3"
14"	4"
16"	4"
20"	6"
24"	6"

SADDLE SUPPORT PEDESTAL TYPE - ADJUSTABLE

NTS

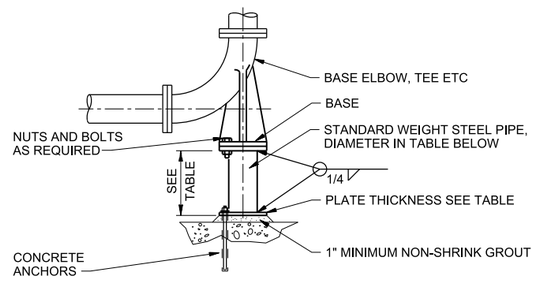
4005-500



TYPE B SWAY BRACE

NTS

4005-505



DIMENSION TABLE				
PIPE SIZE	SUPPORT DIAMETER	PLATE		ANCHOR BOLT DIAMETER
		DIAMETER	THICKNESS	
3"	1 1/2"	5"	3/8"	3/8"
4"	2"	6"	3/8"	3/8"
6"	3"	7"	3/8"	3/8"
8" and 10"	4"	9"	1/2"	1/2"
12" thru 16"	6"	11"	1/2"	1/2"
18" thru 24"	8"	13 1/2"	5/8"	5/8"
30"	10"	16"	5/8"	5/8"
36"	12"	19"	5/8"	5/8"
42"	16"	23 1/2"	3/4"	3/4"
48"	18"	25"	3/4"	3/4"
54"	20"	30"	3/4"	3/4" (USE 6)
60"	24"	32"	3/4"	3/4" (USE 6)

NOTES:

1. ALSO USE FOR SUPPORT OF HORIZONTALTEE OR CROSS.

BASE BEND

NTS

4005-518

NO.	DATE	REVISION	BY	APVD
DSGN	K WADDELL	DR	KL DIAZ	CHK
			K WADDELL	APVD
				R BOE

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

PROCESS MECHANICAL

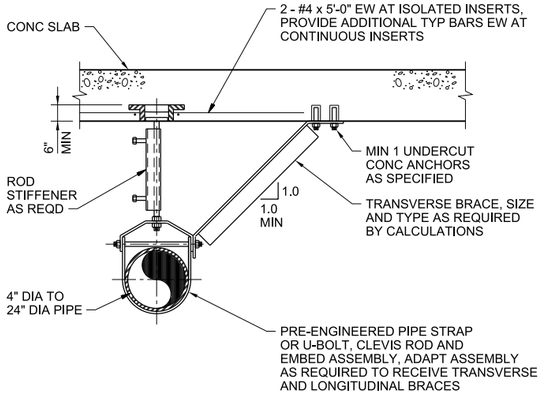
STANDARD DETAILS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

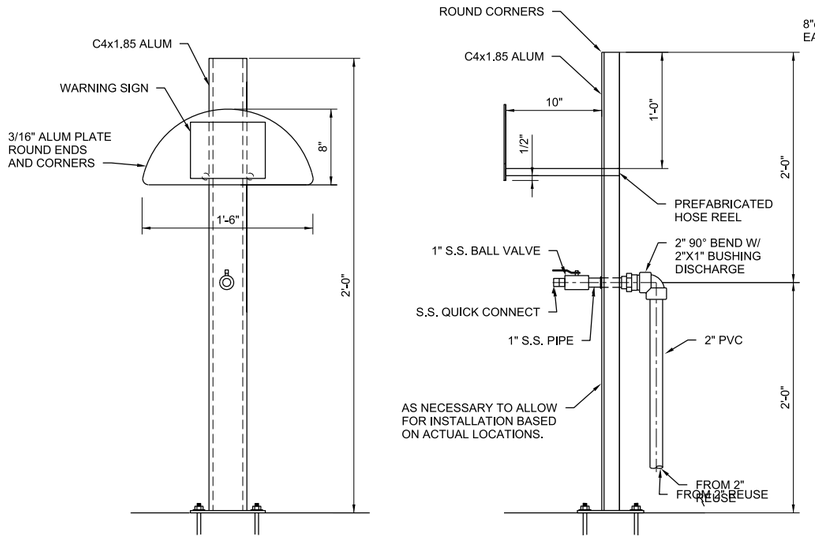
DATE	MARCH 2021
PROJ	D3403200
DWG	99-D-5001
SHEET	71 of 76

BID DOCUMENTS



OVERHEAD PIPE HANGER
NTS

4005-550



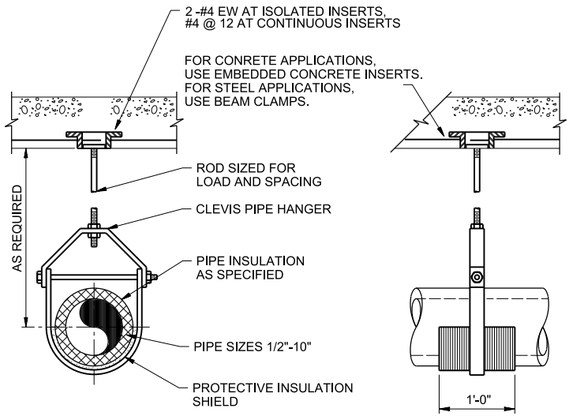
NOTE:
INCLUDE WITH EACH STATION A 50' 1" DIA. HOSE WITH A CAMLOCK QUICK CONNECT MATCHING THE HOSE RACK QUICK CONNECT. ALL HOSE BIB AND HOSE RACKS SHALL BE CONSTRUCTED PER DETAIL 4027-100A WITH HOSE BIB INTEGRAL TO THE RACK.

NOTE:
WARNING SIGN SHALL BE INCLUDED AT ALL RECLAIMED WATER HOSE BIBS AND ALL HOSE REELS. AT HOSE REELS, SIGN SHALL BE WALL MOUNTED ADJACENT TO HOSE REEL.

WARNING SIGN

REUSE WATER HOSE RACK AND WASHDOWN STATION
NTS

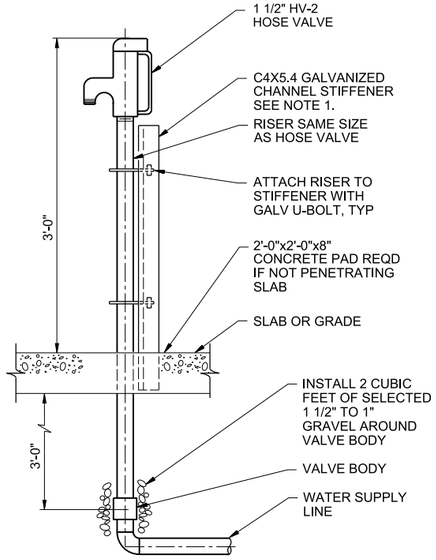
4027-100A



NOTES:
1. PIPE HANGERS SHALL BE OVERSIZED AS REQUIRED TO ACCOMMODATE THICKNESS OF INSULATION SPECIFIED. HANGER SHALL NOT COME INTO CONTACT WITH THE INSULATION DIRECTLY, EITHER AT THE VERTICAL YOKE OR AT THE POINT OF SUPPORT. FOR REQUIREMENTS ON INSULATION SHIELD USED WITH PIPE HANGERS, SEE SPECIFICATIONS.

PIPE HANGER
NTS

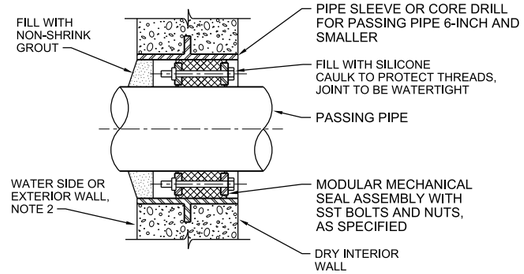
4005-557



NOTES:
1. CHANNEL STIFFENER AND RISER ATTACHMENT HARDWARE SHALL BE (A: GALVANIZED STEEL) (B: STAINLESS STEEL) (C: AS SPECIFIED).

NON-FREEZE POST HYDRANT
NTS

4027-154



NOTES:
1. WHERE EXISTING CONCRETE STRUCTURE IS TO BE CORE DRILLED, ULTRASONIC TEST OR X-RAY THE AREA FOR EMBEDDED ITEMS BEFORE CORE DRILLING. IF EMBEDDED ITEMS ARE FOUND, NOTIFY THE ENGINEER IMMEDIATELY.
2. WHERE PIPE PASSES THROUGH INTERIOR WALL, GROUT IS NOT REQUIRED.
3. COAT EXPOSED CONCRETE AND STEEL IN CORED OPENING IN ACCORDANCE WITH SPECIFICATION SECTION 09 90 00, PAINTING AND COATING.
4. FOR VERTICAL PIPE, FILL ANNULAR SPACE ABOVE MECHANICAL SEAL WITH GROUT. APPLY POLYURETHANE SEALANT TO PREVENT MOISTURE PENETRATION INTO CORED OPENING.

WALL PIPE PENETRATION SEAL
NTS

4027-607

NO.	DATE	DSGN	DR	CHK	APVD
REVISION		K WADDELL	KL DIAZ	R BOE	K WADDELL
				APVD	BY

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

PROCESS MECHANICAL
STANDARD DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-D-5002
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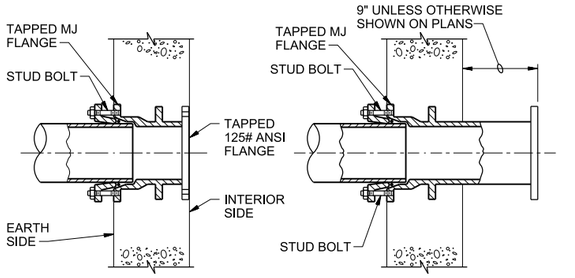
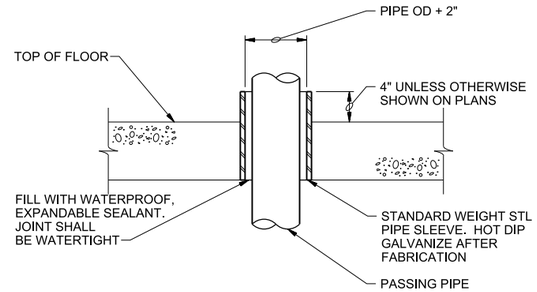
BID DOCUMENTS



DUCTILE IRON WALL PIPES
NTS

4027-609

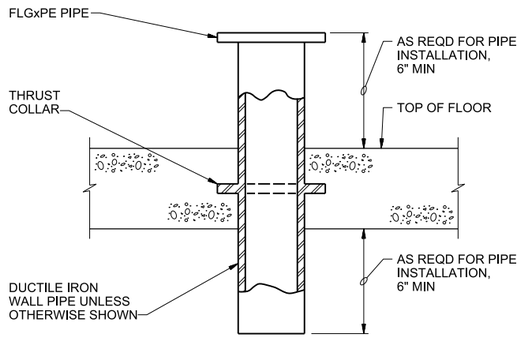


NOTES:

1. COAT FLOOR SLEEVE WITH SPECIFIED PAINT SYSTEM BEFORE CONCRETE PLACEMENT.

FLOOR SLEEVE
NTS

4027-620

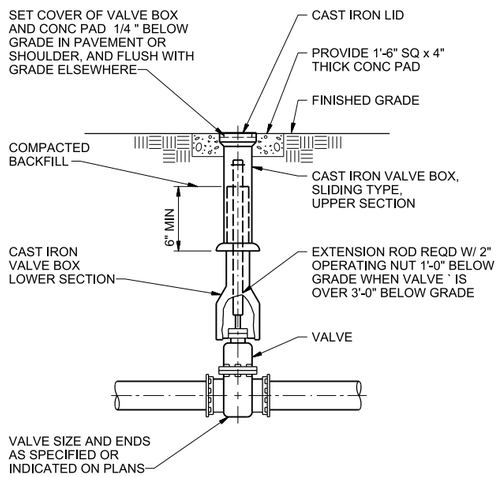


NOTES:

1. COAT FLOOR PIPE WITH SPECIFIED PAINT SYSTEM PRIOR TO CONCRETE PLACEMENT.

FLOOR PIPE
NTS

4027-622



BURIED VALVE BOX
NTS

4027-640

NO.	DATE	REVISION	BY	CHK	DR
DSGN	K WADDELL		APVD	R BOE	KL DIAZ
			APVD	K WADDELL	

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EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

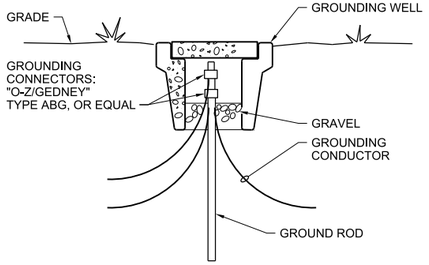
Jacobs

PROCESS MECHANICAL
STANDARD DETAILS

BID DOCUMENTS

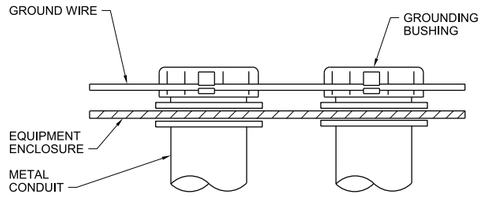
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-D-5003
SHEET	73 of 76



GROUND TEST WELL
NTS

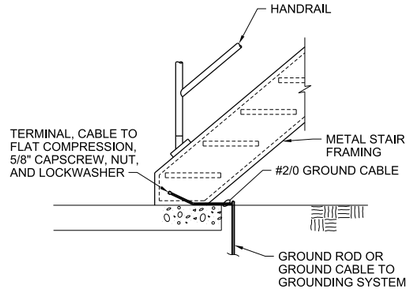
2605-202



NOTES:
1. THE ENDS OF ALL CONDUITS REQUIRED TO BE GROUNDED BY THE SPECIFICATIONS SHALL BE GROUNDED IN ACCORDANCE WITH THIS DETAIL.

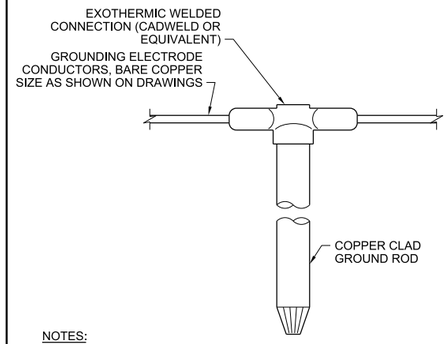
CONDUIT GROUNDING
NTS

2605-203



GROUNDING, GENERAL STAIRWAY
NTS

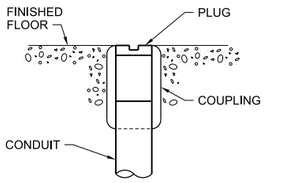
2605-207



NOTES:
1. TOP OF GROUND ROD SHALL BE SAND BEDDED 6" MIN BELOW GRADE.
2. CONNECTIONS TO EXISTING GROUNDING ELECTRODE CONDUCTORS SHALL BE CADWELD OR EQUIVALENT.

GROUND ROD CONNECTION
NTS

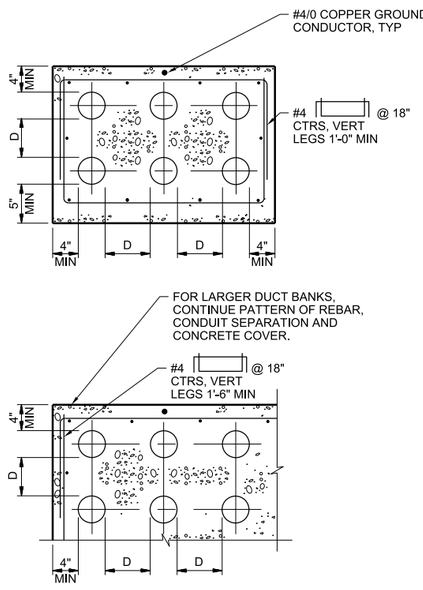
2605-235

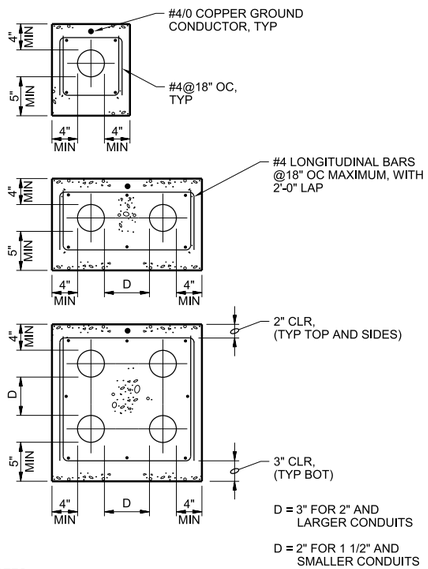


NOTES:
1. CONDUITS WHICH ARE STUBBED UP IN A CONCRETE SLAB FOR FUTURE EXTENSION SHALL BE INSTALLED IN ACCORDANCE WITH THIS DETAIL.

FLUSH CONDUIT STUB
NTS

2605-309

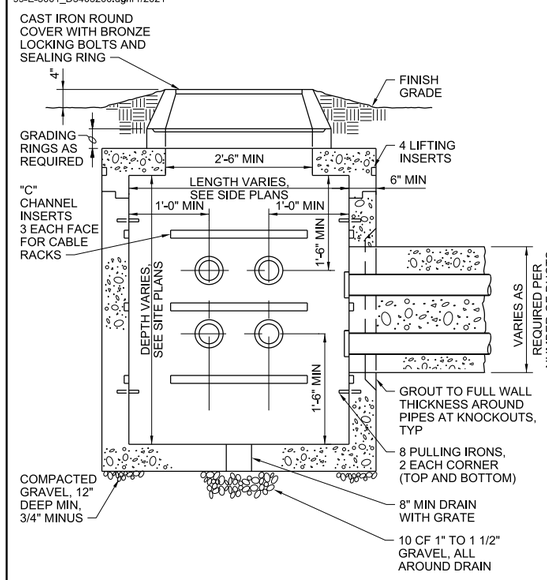




NOTES:
1. PROVIDE 6" MINIMUM COMPACTED GRAVEL, 3/4" MINUS, UNDER ALL CONCRETE ENCASED DUCT RUNS.

DUCT BANK
NTS

2605-400



SECTION

MANHOLE-WITHOUT GROUNDING
NTS

2605-442b

NO.	DATE	DSGN
	REVISION	
DR	CHK	BY
G MESSER	D NICHOLSON	APVD
KB HORTON	APVD	KB HORTON

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
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CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
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CRESTVIEW, FL

Jacobs

ELECTRICAL

STANDARD DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

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DWG	99-E-5001
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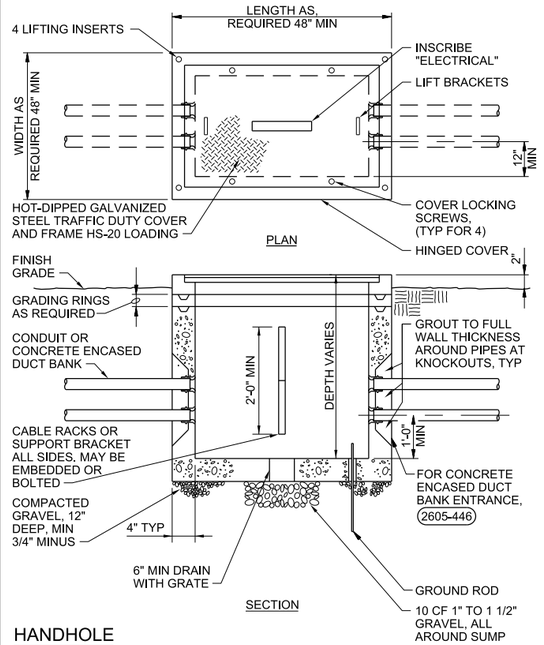
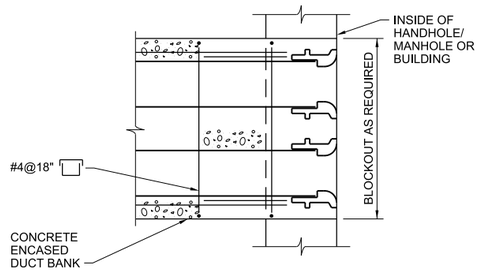
BID DOCUMENTS



HANDHOLE
NTS

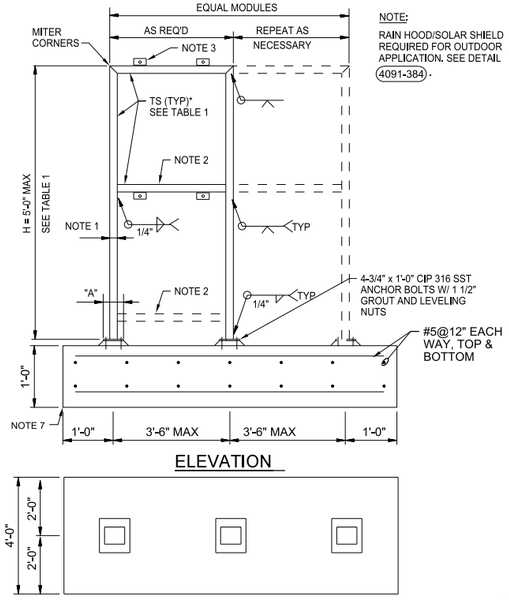
2605-444



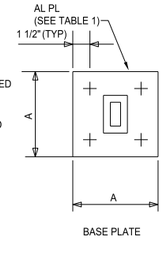
NOTES:
1. EXTEND REBAR A MINIMUM OF 2' BEYOND THE LIMIT OF EXCAVATION.

CONDUIT HANDHOLE/MANHOLE ENTRANCE
NTS

2605-446



NOTE:
RAIN HOOD/SOLAR SHIELD REQUIRED FOR OUTDOOR APPLICATION. SEE DETAIL 4091-384.



NOTES:
1. TOTAL WEIGHT OF PANEL(S) SHALL NOT EXCEED 750 LB IN EACH MODULE.
2. FOR PANELS WITH "H" GREATER THAN 4'-0", ONE HORIZONTAL MEMBER MUST BE LOCATED WITHIN THE MIDDLE THIRD OF THE FRAME HEIGHT. PROVIDE ADD'L MEMBERS AS NECESSARY FOR PANEL MOUNTING.
3. PROVIDE L 2 1/2"x 2 1/2"x 1/4"x 0'-3" WELD ALL AROUND TO TS: TYP AT EACH PANEL MOUNT.
4. GRIND ALL WELDS AND SHARP CORNERS SMOOTH.
5. THIS DETAIL APPLIES TO NON-FREE STANDING ELECTRICAL EQUIPMENT OVER 25 LB WHICH IS NOT MOUNTED ON A FREE STANDING FRAME OR IS NOT WALL MOUNTED.
6. PANEL OR INSTRUMENT FRONT FACES NORTH, UNLESS OTHERWISE NOTED.
7. PROVIDE REINFORCED PAD SHOWN EXCEPT WHERE THE RACK CAN BE MOUNTED ON SUITABLE EXISTING PAD.

TABLE 1			
	ALUMINUM FRAME		
HEIGHT "H"	TS (MIN SIZE)	BASE PLATE (IN)	
		A	t
5'-0" MAX.	TS 3 x 3 x.188	8	1/2

8. PROVIDE #6 BARE COPPER GROUND WIRE FROM EACH PANEL AND INSTRUMENT MOUNTED ON RACK TO GROUND STUD. CONNECTION TO GROUND GRID SPECIFIED UNDER DIVISION 26.

PANEL MOUNTING RACK WITH CONCRETE PAD
NTS

4091-402C

NO.	DATE	DSGN	DR	CHK	APVD	BY	REVISION
	KB HORTON	KB HORTON	G MESSER	D NICHOLSON	APVD	KB HORTON	

Jacobs
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CRESTVIEW, FL

ELECTRICAL

STANDARD DETAILS

BID DOCUMENTS

VERIFY SCALE
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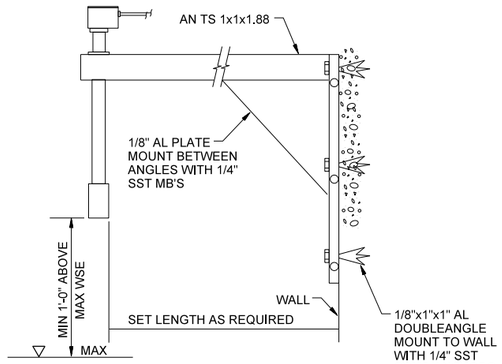


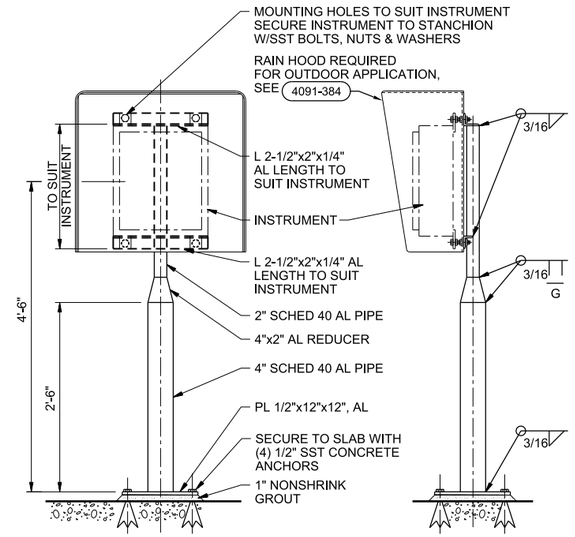
NOTES:

1. LOCATE BOTTOM OF TRANSDUCER NOT LESS THAN MFR'S RECOMMENDED DISTANCE FROM MAX LIQUID LEVEL.
2. LOCATE AWAY FROM WALLS AND OBSTRUCTIONS PER MFR'S RECOMMENDATION.

MICROWAVE LEVEL SENSOR INSTALLATION

NTS

4091-255G



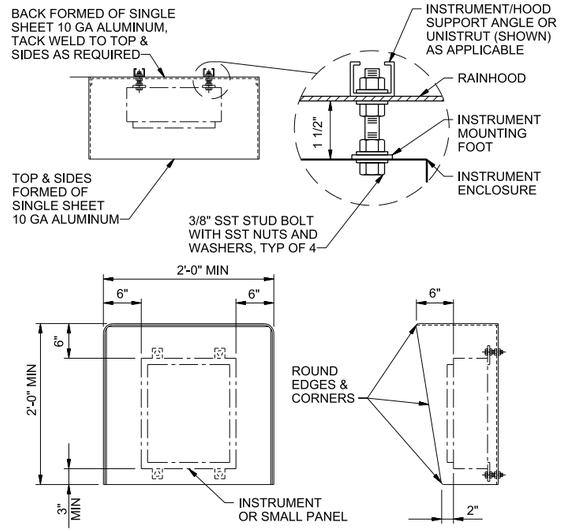
NOTES:

1. ROUND OFF ALL EXPOSED EDGES AND CORNERS.
2. PAINT ALUMINUM IN CONTACT WITH CONCRETE ACCORDING TO SPECIFICATIONS FOR PAINTING.

STANCHION SUPPORT FOR CASE MOUNTED INSTRUMENTS

NTS

4091-383



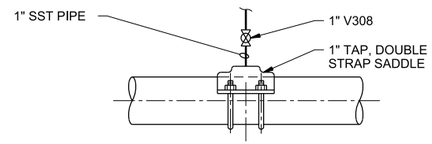
NOTES:

1. ALL EXPOSED EDGES TO BE GROUND SMOOTH AND BURR FREE.
2. MOUNT RAIN HOOD BETWEEN INSTRUMENT AND MOUNTING BRACKET. DRILL HOLES IN RAIN HOOD AS PER MOUNTING HOLES FOR INSTRUMENT, SEE 4091-383

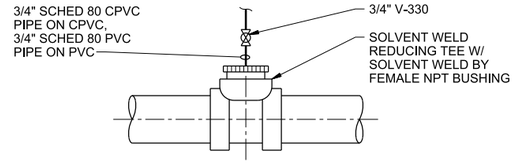
RAIN HOOD INSTALLATION

NTS

4091-384



CEMENT LINE STEEL PIPE, CAST IRON PIPE AND DUCTILE IRON PIPE



PVC AND CPVC PIPE

PRESSURE CONNECTION INSTALLATION

4091-305A

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
		C HARRIS	A PASTRANA	C SAHARKHIZ	APVD		C SAHARKHIZ

REVISION

25 W CEDAR STREET, SUITE 350
PENSACOLA, FLORIDA 32502
EB25861

CRESTVIEW WWTP
SOLIDS HANDLING IMPROVEMENTS
CITY OF CRESTVIEW
CRESTVIEW, FL

Jacobs

INSTRUMENTATION AND CONTROL

STANDARD DETAILS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	MARCH 2021
PROJ	D3403200
DWG	99-N-5001
SHEET	76 of 76

BID DOCUMENTS