# **PROJECT MANUAL**

# PURRYSBURG WTP EXPANSION TO 30 MGD-PHASE I

# Purrysburg, South Carolina

for

**BJWSA** 

**JUNE 25, 2019** 

Project Manual Bidding Documents

Prepared By



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GMC PROJECT NUMBER: CGRE180057







# **EXPANSION TO 30 MGD – PHASE 1**

# FOR

# BEAUFORT JASPER WATER AND SEWER AUTHORITY

# PURRYSBURG, SC

# GMC PROJECT NO. CGRE180057

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# SECTION 00020

# INVITATION FOR BIDS

# BJWSA Project No.: CIP-1366

Separate sealed bids for Purrysburg WTP Expansion to 30 MGD – Phase 1 project for the Beaufort – Jasper Water & Sewer Authority will be received by the Owner in the Beaufort-Jasper Water & Sewer Authority Office at 6 Snake Road, Okatie, South Carolina until 2:00 P.M. on July 11, 2019 and then at said place be publicly opened and read aloud.

A summary of the work to be done consists of furnishing all materials, equipment and labor necessary to complete the following items. This list is not inclusive of all contractual requirements and Bidders are implored to reference the Contract Drawings and Specifications for further details.

- Construction of one (1) 4.0 MG prestressed composite clearwell
- Surface preparation, crack repair and recoating of one (1) existing 4.0 MG clearwell
- Installation of 54", 48" and 18" yard piping and connections of new clearwell to existing plant yard piping system including new valves
- Extension of existing chemical feed lines from current feed point located at inlet of High Service Pumping Station to the new location downstream from the High Service Venturi Vault
- Construction of one (1) Contract Dewatering Area pad (including drains, pumping station, electrical building, dredge headers, fencing, paved access road and electrical service

A mandatory pre-bid conference and optional site visit will be conducted at 10:00 a.m., local time, on July 3, 2019, at Beaufort-Jasper Water & Sewer Authority, 6 Snake Road, Okatie, South Carolina. All bidders are required to attend the pre-bid conference.

# NOTE: FAILURE OF BIDDER TO ATTEND THE MANDATORY PRE-BID CONFERENCE WILL RESULT IN REJECTION OF THE BID.

Drawings, specifications and contract documents may be obtained from the office of Goodwyn Mills Cawood (contact Jim Vaughn at <u>jim.vaughn@gmcnetwork.com</u>). When requesting drawings, specifications or contract documents, provide the following information about your company: Contact name, mailing address; street (UPS) address; telephone number; and email.

Bidders must deposit security with all bids. Security shall be in the form of a certified check or bid bond made payable to the Owner, and shall be for an amount equal to not less than five percent (5%) of the amount of the bid. Provisions of the security shall be as described in the Information for Bidders.

No bid will be considered unless the bidder is legally qualified under the provisions of the South Carolina Contractor's Licensing Law (South Carolina Code of Laws as amended on April 1, 1999, Chapter 11, Sections 40-11-10 through 40-11-428). Contractors shall have a classification of WP.

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No bidder may withdraw the bid within 90 days after the actual date of the opening and thereof.

The Owner reserves the right to waive any informalities or to reject any or all bids.

ENGINEER Goodwyn Mills Cawood 35 Abercorn Street, Suite 210 Savannah, GA 31401 OWNER Beaufort Jasper Water & Sewer Authority 6 Snake Road Okatie, SC 29909

END OF SECTION

# SECTION 00100

# INFORMATION FOR BIDDERS

# 1. <u>RECEIPT AND OPENING OF BIDS</u>

The Beaufort Jasper Water & Sewer Authority (hereinafter called the "Owner"), invites bids on the Bid Form – Unit Price attached hereto, all blanks of which must be appropriately filled in. Bids will be received by the Owner in the Beaufort Jasper Water & Sewer Authority office at 6 Snake Road, Okatie, South Carolina, until 2:00 P.M. on July 11, 2019 at which time said bids will be publicly opened and read aloud. The envelopes containing your bid and Bid Bond only must be sealed, addressed to Beaufort Jasper Water & Sewer Authority with the sealed of the sealed of the Beaufort Jasper Water & Sewer Authority of the sealed of

The Owner may consider informal any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. 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 within 90 days after the actual date of the opening thereof.

# 2. <u>PREPARATION OF BID</u>

Each bid must be submitted on the Bid Form – Unit Price. All blank spaces for bid prices must be filled in, in ink or typewritten and a Bid Bond must be submitted with the bid.

Bids which are incomplete, unbalanced, conditional or obscure, or which contain additions not called for, erasures, alterations, or irregularities of any kind, or which do not comply with the Information for Bidders, may be rejected at the option of the Owner.

The correct total amount bid for the completed work is defined as the correct sum total of the amounts bid for the individual items in the Proposal. The correct amount bid for each unit price item is defined as the correct product of the quantity listed for the item by the unit price bid.

Each bid must be submitted in a sealed envelope bearing on the outside the name of the bidder, bidder's address, Contractor's License Number, and the name of the project for which the bid is submitted. If forwarded by mail, the sealed envelope containing the bid must be enclosed in another envelope addressed as specified above.

# 3. <u>SUBCONTRACTS</u>

The bidder is specifically advised that any person, firm or other party to whom it is proposed to award a subcontract under this contract must be approved by the Owner.

# 5. <u>METHOD OF BIDDING</u>

The Owner invites the following methods of bidding:

- a. Lump Sum
- b. Unit Price
- c. Allowance Item

\* All prices provided in the bid form represent a final contract price inclusive of any applicable

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taxes and freight

# 6. QUALIFICATION OF BIDDER

The Owner may make such investigations as is 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 contract and to complete the work contemplated therein. Conditional bids will not be acceptable.

# 7. <u>BID SECURITY</u>

Each bid must be accompanied by cash, certified check of the bidder, or a Bid Bond prepared on the form of bid bond attached hereto, duly executed by the bidder as principal and having as surety thereon a surety company approved by the Owner, in the amount of five percent (5%) of the bid. Cash or checks will be returned to all except the three lowest bidders within three days after the opening of bids, and the remaining cash or checks will be returned promptly after the Owner and the accepted bidder have executed the contract, or, if no award has been made within 90 days after the date of the opening of the bids, upon demand of the bidder at any time thereafter so long as bidder has not been notified of the acceptance of its bid.

# 8. LIQUIDATED DAMAGES FOR FAILURE TO ENTER INTO CONTRACT

The successful bidder, upon failure or refusal to execute and deliver the contract and bonds required within ten (10) days after they have received notice of the acceptance of their bid, shall forfeit to the Owner, as liquidated damages for such failure or refusal, the security deposited with the bid.

# 9. TIME OF COMPLETION AND LIQUIDATED DAMAGES

Bidder must agree to commence work on or before a date to be specified in a written "Notice to Proceed" of the Owner and to fully complete the project within the number of consecutive calendar days thereafter as indicated on the Bid Form. Bidder must agree also to pay as liquidated damages the sum indicated on the Bid Form for each consecutive calendar day thereafter as hereinafter provided in General Conditions.

# 10. CONDITIONS OF WORK

Each bidder must inform himself fully of the conditions relating to the construction of the project and the employment of labor thereon. Failure to do so will not relieve a successful bidder of the obligation to furnish all material and labor necessary to carry out the provisions of the contract. Insofar as possible, the Contractor in carrying out the work must employ such methods or means as will not cause any interruption of or interference with the work of any other contractor.

# 11. ADDENDA AND INTERPRETATIONS

No interpretation of the meaning of the plans, specifications or other pre-bid documents will be made to any bidder orally. Each request for such interpretation should be in writing or email, addressed to Mr. Jim Vaughn (jim.vaughn@gmcnetwork.com), Goodwyn Mills Cawood, 35 Abercorn Street, Suite 210, GA

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31401. To be given consideration, the request must be received at least **seven days prior to the date fixed for the opening of bids**. Any and all such interpretations and any supplemental instructions will be in the form of written addenda to the specifications which, if issued, will be mailed to all prospective bidders (at the respective addresses furnished for such purposes), no later than three days prior to the date fixed for the opening of bids. Failure of any bidder to receive any such addendum or interpretation shall not relieve such bidder from any obligation under its bid as submitted. All addenda so issued shall become part of the contract documents.

# 12. SECURITY FOR FAITHFUL PERFORMANCE

Simultaneously with bidders delivery of the executed contract, the Contractor shall furnish a surety bond or bonds as security for faithful performance of this contract (i.e. a performance bond) and for the payment of all persons performing labor on the project (i.e. a payment bond) under this contract in an amount necessary to fully secure the project, as specified in General Conditions included herein. The surety on such bond or bonds shall be a duly authorized surety company, bond shall be countersigned by an agent residing in South Carolina, and said surety shall be satisfactory to and approved by the Owner.

# 13. <u>POWER OF ATTORNEY</u>

Attorneys-in-fact who sign bonds or contract bonds must file with each bond a certified and effectively dated copy of their power of attorney.

# 14. LAWS AND REGULATIONS

The Bidder's attention is directed to the fact that all applicable laws of the State of South Carolina, relevant municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout, and they will be deemed to be incorporated in full and included in the contract the same as though repeated verbatim herein.

# 15. METHOD OF AWARD - LOWEST QUALIFIED BIDDER

If at the time this contract is to be awarded, the lowest base bid submitted by a responsible and qualified bidder does not exceed the amount of funds then estimated by the Owner as available to finance the contract, the contract will be awarded primarily on the base bid coupled with such other and necessary factors to insure a successful completion of the project. If such bid exceeds such amount, the Owner may reject all bids or may award the contract on the base bid combined with such deductible alternates applied in numerical order in which they are listed in the Form of Bid, as produces a net amount which is within the available funds. The Owner will decide which qualified bidder will be awarded the contract, and in determining such bidder, the following elements will be considered for each bidder:

- (a) Bid base.
- (b) Maintains a permanent place of business.
- (c) Has adequate plant equipment and personnel to perform the work properly, efficiently and expeditiously.
- (d) Has suitable financial status to meet obligations incident to the work to include required bonds and insurance.
- (e) Has appropriate technical/specialty experience.

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# 16. OBLIGATION OF BIDDER

At the time of the opening of bids, each bidder will be presumed to have inspected the site and to have read and be thoroughly familiar with the plans and contract documents, including all addenda in determining the estimate for their bid. The failure or omission of any bidder to examine any form, instrument or document shall in no way relieve any bidder from any obligation in respect to its bid.

# END OF SECTION

PURRYSBURG, SOUTH CAROLINA

# SECTION 00310

# **BID FORM**

# BEAUFORT-JASPER WATER & SEWER AUTHORITY

# Purrysburg WTP Expansion to 30 MGD – Phase 1

Location:	Beaufort County, SC
Date:	July 11, 2019
Project No.	<u>1366</u>

PROPOSAL OF \_\_\_\_\_\_, doing business as a corporation / a partnership / an individual (Strike out inapplicable terms), with its principal office in the City of \_\_\_\_\_\_, County of \_\_\_\_\_\_, State of \_\_\_\_\_\_, State of \_\_\_\_\_\_, (hereinafter called "Bidder").

TO: Beaufort-Jasper Water & Sewer Authority (hereinafter called "Owner"),

Bidders:

The Bidder, in compliance with your invitation for bids for the Purrysburg WTP Expansion to 30 MGD – Phase 1 having examined the plans and specifications with related documents and the site of the proposed work, and being familiar with all of the conditions surrounding the construction of the proposed project, including the availability of materials and labor, hereby proposes to furnish all labor, materials and supplies, and to construct the project in accordance with the Contract Documents, within the time set forth therein, and at the prices stated below. These prices are to cover all expenses incurred in performing the work required under the Contract Documents, of which this proposal is a part.

Bidder hereby agrees to commence work under this contract on or before a date to be specified in written "Notice to Proceed" of the Owner and to fully complete the project within 270 consecutive calendar days thereafter as stipulated in the specifications. The work associated with the Contract Dewatering Area must be substantially completed within 120 days. Bidder further agrees to pay as liquidated damages the sum of \$1000.00 for each consecutive calendar day thereafter as hereinafter provided in Paragraph 19 of the General Conditions.

The drawings, specifications and addenda are complementary of each other. What is called for by one shall be as binding as if called for by all. If a conflict between any of the above is discovered by the Contractor, the problem shall be referred to the Engineer as soon as possible for resolution by the Engineer. Should a conflict occur which is not resolved before bid time and/or is necessary to comply with mandatory requirements (i.e., codes, ordinances, etc.), it shall be the Contractor's responsibility to price and bid the more expensive method.

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Bidder acknowledges receipt of the following addendum:

No.	Dated	No.	Dated
No.	Dated	No.	Dated

## **BASE PROPOSAL:**

Bid	Description	Qty	Units	Unit Price	Extended
item					
1	Performing all of the Purrysburg WTP				
	Expansion to 30 MGD – Phase 1 work				
	including, but not limited to, 4.0 MG Clearwell,				
	chemical feed modifications and Contract	1	LS		
	Dewatering pad and support systems etc. all				
	as described in the specifications and on the				
	plans				
	Unsatisfactory soil excavation and				
2	disposal off-site and replacement with	800	CY		
	satisfactory soil material from off-site				
	Lump-Sum Allowance for instrumentation			<b>\$40,000,00</b>	<b>\$</b> 40,000,00
3	and SCADA integration associated with	1	LS	\$10,600.00	\$10,600.00
	the installation of the new 4.0 MG Clearwell				

TOTAL BASE BID, items 1 through 3 inclusive, the amount of:

Dollars (\$\_\_\_\_\_).

(Amount shall be shown in both words and figures. In case of discrepancy, the amount shown in words will govern.)

\* All prices provided in the bid form represent a final contract price inclusive of any applicable taxes and freight

The above prices shall include all labor, materials, bailing, shoring, removal, overhead, profit, insurance, etc. to cover the finished work of the several kinds called for. Changes shall be processed in accordance with Paragraph 17 of the General Conditions.

Bidder understands that the Owner reserves the right to reject any or all bids and to waive any informalities in the bidding.

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The Bidder agrees that this bid shall be good and may not be withdrawn for a period of 90 calendar days after the scheduled closing time for receiving bids.

Upon receipt of written notice of the acceptance of this bid, Bidder will execute the formal contract attached within 10 days and deliver a Surety Bond or Bonds as required by Paragraph 30 of the General Conditions.

The bid security attached in the sum of \_\_\_\_\_\_

Dollars and \_\_\_\_\_ Cents (\$\_\_\_\_\_) is to become

the property of the Owner in the event the contract and bond are not executed within the time above set forth, as liquidated damages for the delay and additional expense to the Owner caused thereby.

By submission of this bid, each bidder certifies, and in the case of a joint bid, each party thereto certifies as to its own organization, that this bid has been arrived at independently, without consultation, communication, or agreement as to any matter relating to this bid, with any other bidder or with any competitor.

[SEAL – (If bid is by a corporation)]

BY:

Respectfully submitted:

(Title)

(Business Address)

SC Contractors License

Classification(s)

PURRYSBURG, SOUTH CAROLINA

as Dringinal

# SECTION 00350

**BID BOND** 

# KNOW ALL MEN BY THESE PRESENTS: That we, the undersigned \_\_\_\_\_

		<u>,</u> as Filluipai,
and		as
Surety, are hereby held a the penal sum of	and firmly bound unto Beaufort Jasper W	ater and Sewer Authority as Owner, in
Dollars and which, well and truly to be	Cents (\$ made, we hereby jointly and severally b	), for the payment of ind ourselves, successors and assigns.
Signed this	day of	, 2019.

The condition of the above obligation is such that: Whereas, the Principal has submitted to Beaufort Jasper Water & Sewer Authority a certain Bid, attached hereto and by reference made a part hereof, to enter into a contract in writing for the Purrysburg WTP Expansion to 30 MGD – Phase 1.

# NOW, THEREFORE,

(a) If said BID shall be rejected, or

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

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by any extension of the time within which the OWNER may accept such BID, and said Surety does hereby waive notice of any such extension.

**IN WITNESS WHEREOF,** the Principal and 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.

PURRYSBURG WT	P BEAUFORT JASPER WATER AND SEWER AUTHORITY
EXPANSION TO 30	MGD-PHASE I PURRYSBURG, SOUTH CAROLINA
Principal	(Corporate Seal)
BY:	(L.S.)
Surety	(Corporate Seal)
BY:	(L.S.)
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 where the project is located.
NOTE:	Bond must be countersigned by a South Carolina resident agent.
	END OF SECTION

## SECTION 00500

## CONTRACT

THIS AGREEMENT mad	de this day of _	, 2019, by and
between Beaufort Jasper Water	& Sewer Authority, hereinafter calle	ed "Owner", and
	, doing business as a partne	ership / a corporation /an individual
(Strike out inapplicable terms), v	with its principal office in the City of	
, County of	, State of	, hereinafter called
"Contractor".		

**WITNESSETH:** That for and in consideration of the payments and agreements hereinafter mentioned, to be made and performed by the Owner, the Contractor hereby agrees with the Owner to commence and complete the construction described as follows: CIP-1366 Purrysburg WTP Expansion to 30 MGD – Phase 1, hereinafter called the "Project", for the sum of \_\_\_\_\_\_.

Contractor further agrees to commence and complete any and all extra work in connection therewith, under the terms as stated in the General and Special Conditions of the Contract; and at his (its or their) own proper cost and expense to furnish all the materials, supplies, machinery, equipment, tools, superintendents, labor, bonds, insurance and other accessories and services necessary to complete the said project in accordance with the conditions and prices stated in the Proposal and the General Conditions, Supplemental General Conditions and Special Conditions of the Contract, the plans, including all maps, plats, blueprints, and other drawings and printed or written explanatory matters thereof, the specifications and contract documents therefore as prepared by BJWSA, herein entitled the "Engineer", and as enumerated in Paragraph 1 of the Supplemental General Conditions, all of which are made a part hereof and collectively evidence and constitute the Contract.

The Contractor hereby agrees to commence work under the Contract on or before a date to be specified in written Notice to Proceed from the Owner and to fully complete the project within 270 (Two Hundred and Seventy) consecutive calendar days thereafter. The work associated with the Contract Dewatering Area must be substantially completed within 120 days. The Contractor further agrees to pay as liquidated damages the amount of \$1000.00 for each consecutive calendar day thereafter that the Contractor fails to complete the project, as hereinafter provided in Paragraph 19 of the General Conditions.

The Owner agrees to pay the Contractor in current funds for the performance of the Contract, subject to additions and deductions, as provided in the General Conditions of the Contract, and to make payments on account thereof as provided in Paragraph 25, "Payments to Contractor", of the General Conditions.

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**IN WITNESS WHEREOF**, the parties hereto have executed this contract in six counterparts, each copy of which shall be deemed an original, in the year and day first above mentioned.

	_	OWNER
(Seal)		
	By:	
	Title:	
ATTEST:	_	
Witness		
Witness		
(Corporate Seal)	_	CONTRACTOR
	By:	
	Title:	
ATTEST:		
Its Secretary		
Witness		CONTRACTOR'S ADDRESS:
	_	

PURRYSBURG, SOUTH CAROLINA

# SECTION 00501

# CONTRACTOR AFFIDAVIT SOUTH CAROLINA ILLEGAL IMMIGRATION REFORM ACT

In accordance with the requirements of the South Carolina Illegal Immigration Reform Act, \_

("Contractor") hereby certifies that it is currently in compliance with the requirements of Title 8, Chapter 14 of the S. C. Code Annotated and will remain in compliance with such requirements throughout the term of its contract with Beaufort Jasper Water and Sewer Authority.

The Contractor hereby acknowledges that in order to comply with requirements of S. C. Code Annotated Section 8-14-20 (B), it will:

(1) Register and participate in the federal work authorization program (E-verify) to verify the employment authorization of all new employees; and require agreement from its subcontractors, and through the subcontractors, the sub-subcontractors, to register and participate in the federal verification employment authorization of all new employees.

OR (2) Employ only workers who:

- (a) Possess a valid South Carolina driver's license or identification card issued by the S. C. Department of Motor Vehicles; or
- (b) Are eligible to obtain a South Carolina driver's license or identification card in that they meet the requirements set forth in S. C. Code Annotated Sections 56-1-40 through 56-1-90; or
- (c) Possess a valid driver's license or identification card from another state where the license requirements are at least as strict as those in South Carolina, as determined by the South Carolina Department of Motor Vehicles.

The Contractor agrees to provide to Beaufort Jasper Water and Sewer Authority upon request any documentation required to establish the applicability of the South Carolina Illegal Immigration Reform Act to the contractor, subcontractor or sub-subcontractor. The Contractor further agrees that it will upon request provide Beaufort Jasper Water and Sewer Authority any documentation required to establish that the contractor and any subcontractors or sub-subcontractors are in compliance with the requirements of Title 8, Chapter 14 of the S. C. Code Annotated.

Date:	_ By:
	(Contractor Authorized Signature)

(Contractor Print Name/Title)

(Name of Company)

PURRYSBURG, SOUTH CAROLINA

# SECTION 00600

# PERFORMANCE BOND

# KNOW ALL MEN BY THESE PRESENTS THAT

(Name of Contractor)

(Address of Contractor)

a (Corporation, Partnership or Individual), hereinafter called Principal, and

(Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto

Beaufort Jasper Water & Sewer Authority

(Name of Owner)

6 Snake Road, Okatie, SC 29909

(Address of Owner)

hereinafter called Owner, in the penal sum of \_\_\_\_\_\_ in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

**THE CONDITION OF THIS OBLIGATION** is such that whereas the Principal entered into a certain Contract with the Owner dated the day of

\_\_\_\_\_, 2019, a copy of which is hereto attached and made a part hereof for the rehab/replacement of:

CIP-1366 Purrysburg WTP Expansion to 30 MGD – Phase 1

**NOW, THEREFORE**, if the Principal shall well, truly and faithfully perform its duties, all the undertakings, covenants, terms, conditions and agreements of said Contract during the original term thereof, and any extensions thereof which may be granted by the Owner, with or without notice to the Surety, and if he shall satisfy all claims and demands incurred under such contract and fully indemnify and save harmless the Owner from all costs and damages which it may suffer by reason failure to do so, and shall reimburse and repay the Owner all outlay and expense which the Owner may incur in making good any default, then this obligation shall be void; otherwise to remain in full force and effect.

**PROVIDED FURTHER**, that the said Surety, for value received hereby stipulates and agrees that no change, extensions of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder or the specifications accompanying the same shall in any way affect its obligation on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work or to the specifications.

EXPANSION TO 30 MGD-PHASE I

# **BEAUFORT JASPER WATER AND SEWER AUTHORITY**

PURRYSBURG, SOUTH CAROLINA

**PROVIDED FURTHER**, that no final settlement between the Owner and the Contractor shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

**IN WITNESS WHEREOF**, this instrument is executed in six (6) counterparts, each one of which shall be deemed an original, this the \_\_\_\_\_ day of \_\_\_\_\_, 2019.

Signed, sealed and delivered in the presence of:

	By:	Principal – Contractor
As to Principal		Title
		Surety
	By:	
	-	Attorney-In-Fact
		(Power of Attorney to be Attached)
	By:	
		Resident Agent
As to Surety		Resident Agent Company Name
		Resident Agent Company Address

# NOTES:

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

# **BEAUFORT JASPER WATER AND SEWER AUTHORITY**

# **EXPANSION TO 30 MGD-PHASE I**

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

EXPANSION TO 30 MGD-PHASE I

PURRYSBURG, SOUTH CAROLINA

# SECTION 00601

# PAYMENT BOND

# KNOW ALL MEN BY THESE PRESENTS THAT

(Name of Contractor)

(Address of Contractor)

a (Corporation, Partnership or Individual), hereinafter called Principal, and

(Name of Surety)

(Address of Surety)

hereinafter called Surety, are held and firmly bound unto

Beaufort Jasper Water & Sewer Authority

(Name of Owner)

6 Snake Road, Okatie, SC 29909

(Address of Owner)

hereinafter called Owner, in the penal sum of \_\_\_\_\_\_ in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

**THE CONDITION OF THIS OBLIGATION** is such that whereas the Principal entered into a certain Contract with the Owner dated the \_\_\_\_\_\_ day of \_\_\_\_\_\_, 2019, a copy of which is hereto attached and made a part hereof for the rehab/replacement of:

CIP-1366 Purrysburg WTP Expansion to 30 MGD – Phase 1

**NOW, THEREFORE**, if the Principal shall promptly make payment to all persons, firms, subcontractors and corporations furnishing materials for or performing labor in the prosecution of the work provided for in such contract, and any authorized extension or modification thereof, including all amounts due for materials, lubricants, oil, gasoline, coal and coke, repairs on machinery, equipment and tools, consumed or used in connection with the construction of such work, and all insurance premiums on said work, and for all labor, performed in such work whether by subcontractor or otherwise, then this obligation shall be void; otherwise to remain in full force and effect.

**PROVIDED FURTHER**, that the said Surety, for value received hereby stipulates and agrees that no change, extensions of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder or the specifications accompanying the same shall in any way affect its obligation on this bond without notice and approval of such change, and if such notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the specifications

# EXPANSION TO 30 MGD-PHASE I

BEAUFORT JASPER WATER AND SEWER AUTHORITY

PURRYSBURG, SOUTH CAROLINA

is not given approved by said Surety, then only the original obligation of the Surety on this bond shall apply.

**PROVIDED FURTHER**, that no final settlement between the Owner and the Contractor shall abridge the right of any beneficiary hereunder, whose claim may be unsatisfied.

**IN WITNESS WHEREOF**, this instrument is executed in six (6) counterparts, each one of which shall be deemed an original, this the \_\_\_\_\_\_ day of \_\_\_\_\_\_, 2019.

Signed, sealed and delivered in the presence of:

•		
	-	Principal – Contractor
	By:	
As to Principal		Title
	-	Surety
	By:	
		Attorney-In-Fact (Power of Attorney to be Attached)
	By:	
		Resident Agent
As to Surety		Resident Agent Company Name
	-	Resident Agent Company Address
	-	
	-	Resident Agent Address

NOTES:

1. Date of Bond must not be prior to date of Contract.

# **EXPANSION TO 30 MGD-PHASE I**

# PURRYSBURG, SOUTH CAROLINA

- 2. If Contractor is a Partnership, all partners should execute bond.
- 3. Surety companies executing bonds must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the project is located.

**GMC PROJECT NO. CGRE180057** 

PURRYSBURG, SOUTH CAROLINA

00602 - 1 of 50

# SECTION 00602

# NOTICE OF AWARD

TO:

PROJECT DESCRIPTION: CIP-1366 Purrysburg WTP Expansion to 30 MGD - Phase 1

The Owner has considered the bid dated \_\_\_\_\_\_, 2019, submitted by you for the above described work in response to its Advertisement for Bids and its Information for Bidders.

You are hereby notified that your bid has been accepted in the amount of \$\_\_\_\_\_

You are required by the Information for Bidders to execute the Agreement and furnish the required Contractor's performance bond, payment bond and certificates of insurance within ten (10) calendar days from the date of this notice to you. If you fail to execute said agreement and to furnish said bonds and/or proof of insurance, to include naming Owner as an additional insured, within ten (10) days from the date of this notice, said Owner will be entitled to consider all your rights arising out of the Owner's acceptance of your bid as abandoned and as a forfeiture of your bid bond. The Owner will be entitled to such other rights as may be granted by law.

# You are required to return an acknowledged copy of this Notice of Award to the Owner.

Dated this	day of		, 2019.
		Beauf	ort Jasper Water & Sewer Authority
			Owner
			(Signature)
		By:	
			(Print Name)
		Title:	
	Ac	eptance of Notice	
Receipt of the abov	e Notice of Award is he	eby acknowledged by _	
, this the	day of		, 2019.
		Ву:	
		Title	

BEAUFORT JASPER WATER AND SEWER AUTHORITY

**EXPANSION TO 30 MGD-PHASE I** 

PURRYSBURG, SOUTH CAROLINA

# 00603

# CONTRACT CHANGE ORDER FORM

Date:	Project:	Purrysburg WTP Expansion to 30 MGD – Phase 1
Change Order #:	CIP # _	1366
	BJWSA PO # _	
Description of Work:		
Reason for the Scope Change:		
Itemization of Proposed Change and Original Contract Price Previous Change Orders This Change, (An Addition) (A Dedu Proposed Revised Contract Price	d Basis for Payme	<u>ent</u> \$ \$ <u>\$</u> \$
Extension of Contract Time Required: Revised Contract Completion Date:		Days.
This Change is Acceptable:		,
	Ву	(Contractor)
Design Engineer Approval of Change	Order:	,
	Ву	(BJWSA Design Engineer)
BJWSA Approval of Change Order:		,
	Ву	(BJWSA Project Manager)
GOODWYN, MILLS & CAWOOD, INC. GMC PROJECT NO. CGRE180057		CONTRACT CHANGE ORDER FORM 00603 - 1 of 50

**BEAUFORT JASPER WATER AND SEWER AUTHORITY** 

EXPANSION TO 30 MGD-PHASE I

PURRYSBURG, SOUTH CAROLINA

SECTION 00606

# NOTICE TO PROCEED

TO:

PROJECT DESCRIPTION: CIP-1366 Purrysburg WTP Expansion to 30 MGD – Phase 1

OWNER: Beaufort Jasper Water & Sewer Authority

You are hereby notified to commence WORK on or before \_\_\_\_\_\_, 2019, in accordance with the Agreement dated \_\_\_\_\_\_, 2019, and you are to complete the WORK within 270 consecutive calendar days thereafter.

The date of completion of all work is therefore: \_\_\_\_\_\_, 20\_\_\_\_\_,

Beaufort Jasper Water & Sewer Authority

By:

Title:

# Acceptance of Notice

Receipt of the above	NOTICE TO PROCEED	is hereby acknowledged by
this the	day of	, 2019.

Ву:

Title:
# PURRYSBURG, SOUTH CAROLINA

# SECTION 00700

# GENERAL CONDITIONS

1. <u>CONTRACT AND CONTRACT DOCUMENTS.</u> The plans, specifications and addenda, hereinafter enumerated in Paragraph 1 of Supplemental General Conditions, shall form part of this contract and the provisions thereof shall be as binding upon the parties hereto as if they were herein fully set forth. The table of contents titles, heading, running headlines and marginal notes contained herein and in said documents are solely to facilitate reference to various provisions of the contract documents and in no way affect, limit or cast light on the interpretations of the provisions to which they refer.

### Contents

- 1. Contract and Contract Documents
- 2. Definitions
- 3. Additional Instructions & Detail Drawings
- 4. Shop Drawings and Samples
- 5. Materials, Services & Facilities
- 6. Contractor's Title to Materials
- 7. Inspection and Testing of Materials
- 8. "Or Equal" Clause
- 9. Patents
- 10. Surveys, Laws and Regulations
- 11. Contractor's Obligations
- 12. Weather Conditions
- 13. Protection of Work and Property
- 14. Interpretations
- 15. Reports, Records and Data
- 16. Superintendence by Contractor
- 17. Changes in Work
- 18. Extras
- 19. Time for Completion & Liquidated Damages
- 20. Correction of Work
- 21. Subsurface Conditions Found Different
- 22. Claims for Extra Cost
- 23. Right of Owner to Terminate Contract
- 24. Construction Schedule & Periodic

Acceptance of Work and Final Payment
 Acceptance of Final Payment as Release

25. Payments to Contractor (Measurements)

- 28. Payments by Contractor
- 29. Insurance
- 30. Contract Security
- 31. Assignments
- 32. Mutual Responsibility of Contractors
- 33. Separate Contracts
- 34. Subcontracting
- 35. Engineer's Authority
- 36. Stated Allowances
- 37. Use of Premises and Removal of Debris
- 38. Quantities of Estimate
- 39. Rights-of-Way and Suspension of Work
- 40. One Year Warranty After Completion
- 41. Notice and Service Thereof
- 42. Required Provisions Deemed Inserted
- 43. Protection of Lives and Health
- 44. Wages and Overtime Compensation
- 45. Prohibited Interests
- 46. Conflicting Conditions
- 47. Indemnification (2 Attachments)
- 48. Project Close Out Requirements
- (1 Attachment)

### Estimates

- 2. <u>DEFINITIONS</u>. The following terms as used in this contract are respectively defined as follows:
  - (a) <u>Contractor</u>. A person, firm or corporation with whom the contract is made by the Owner.
  - (b) <u>Subcontractor</u>. A person, firm or corporation supplying labor and materials, or only labor, for work at the site of the project for and under separate contract or agreement with the Contractor.

#### PURRYSBURG WTP EXPANSION TO 30 MGD-PHASE I

#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

- (c) <u>Work on or at the Project</u>. Work to be performed at the location of the project, including the transportation of materials and supplies to or from the location of the project by employees of the Contractor and any Subcontractor.
- 3. <u>ADDITIONAL INSTRUCTIONS AND DETAIL DRAWINGS.</u> The Contractor will be furnished additional instructions and detail drawings as necessary to carry out the work included in the Contract. The additional drawings and instructions thus supplied to the Contractor will coordinate with the Contract Documents and will be so prepared that they can be reasonably interpreted as part thereof. The Contractor shall carry on the work in accordance with the additional detail drawings and instructions. The Contractor and the Engineer will prepare jointly:
  - (a) A schedule fixing the dates at which special detail drawings will be required; such drawings, if any, to be furnished by the Engineer in accordance with said schedule; and
  - (b) A schedule fixing the respective dates for the submission of shop drawings, the beginning of manufacture, testing and installation of materials, supplies, and equipment, and the completion of the various parts of the work; each such schedule to be subject to change from time to time in accordance with the progress of the work.
- 4. <u>SHOP DRAWINGS AND SAMPLES.</u> Submit to the Engineer for approval, in accordance with the requirement of Section 01340.
- 4.1 <u>Samples.</u> Contractor shall also submit to the Engineer for approval, all samples required by Section 01340. All samples will have been checked by and stamped with the approval of the Contractor, identified clearly as to material, manufacturer, any pertinent catalog numbers and the use for which intended.
- 4.2 <u>Deviations.</u> At the time of each submission, Contractor shall in writing call the Engineer's attention to any deviations that the Shop Drawings or samples may have from the requirements of the Contract Document. Any such deviation(s) shall be prominently and readily identified and displayed in a conspicuous manner.
- 4.3 <u>Engineer's Review.</u> Engineer will review and approve with reasonable promptness Shop Drawings and samples, but his review and approval shall be only for conformance with the design concept of the project and for compliance with the information given in the Contract Documents. The approval of a separate item as such will not indicate approval of the assembly in which the item functions. Contractor shall make any corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and resubmit new samples until approved. Contractor shall direct specific attention in writing or on resubmitted Shop Drawings to revisions other than the corrections called for by Engineer on previous submissions. Contractor's stamp of approval on any Shop Drawing or sample shall constitute a representation to Owner and Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers and similar data or he assumes full responsibility for doing so, and that he has reviewed or coordinated each Shop Drawing or sample with the requirements of the work and Contract Documents.
- 4.4 <u>Contractor's Records.</u> Where a Shop Drawing or sample submission is required by the Specifications, no related work shall be commenced until the submission has been approved by

#### EXPANSION TO 30 MGD-PHASE I

#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

Engineer. A copy of each approved shop drawing and each approved sample shall be kept in good order by Contractor at the site and shall be available to Engineer.

- 4.5 <u>Contractor's Responsibility.</u> Engineer's approval of Shop Drawings or sample shall not relieve Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless Contractor has in writing called the Engineer's attention to such deviation at the time of submission and Engineer has given written approval to the specific deviation, nor shall any approval by Engineer relieve Contractor from responsibility for errors or omissions in the Shop Drawings.
- 5. <u>MATERIALS, SERVICES AND FACILITIES</u> shall be furnished by the Contractor.
  - (a) It is understood that except as otherwise specifically stated in the Contract Documents, the Contractor shall provide and pay for all materials, labor, tools, equipment, water, gas lights, power, transportation, superintendence, taxes, bonds, insurance, temporary construction of every nature, and all other services and facilities of every nature whatsoever necessary to execute, complete and deliver the work within the specified time.
  - (b) Any work necessary to be performed after regular working hours, on Sundays, or legal holidays, shall be performed without additional expense to the Owner.
- 6. <u>CONTRACTOR'S TITLE TO MATERIALS.</u> No materials or supplies for the work shall be purchased by the Contractor or by any subcontractor subject to any chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller. The Contractor warrants that he has good title to all materials and supplies used by him in the work, free from all liens, claims or encumbrances.
- 7. <u>INSPECTION AND TESTING OF MATERIALS.</u> Unless otherwise specifically provided for in the specifications, the inspection and testing of material and finished articles to be incorporated in the work at the site shall be made by bureaus, laboratories, or agencies approved by the Owner. The cost of such inspection and testing shall be paid by the Contractor.
- 7.1 <u>Certification by Contractor.</u> Where the detailed specifications call for certified copies of mill or shop tests to establish conformance of certain materials with the specifications, it shall be the responsibility of the Contractor to assure delivery of such certifications to the Owner. No materials or finished articles shall be incorporated in the work until such materials and finished articles have passed the required tests. The Contractor shall promptly segregate and remove rejected material and finished articles from the site of the work.
- 7.2 <u>Guaranty.</u> The testing and approval of materials by the laboratory, or laboratories, shall not relieve the Contractor of any of his obligations to fulfill his contract and guarantee of workmanship and materials as called for in paragraph entitled "General Warranty for One Year After Completion of Contract" herein. The Contractor may, at his option and at his own expense, cause such other tests to be conducted as he may deem necessary to assure suitability, strength and durability of any material or finished article.
- 8. <u>"OR EQUAL" CLAUSE.</u> The phrase "or equal" shall be construed to mean that material or equipment will be acceptable only when, in the judgment of the Engineer, they are composed of

#### EXPANSION TO 30 MGD-PHASE I

#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

parts of equal quality, or equal workmanship and finish, designed and constructed to perform or accomplish the desired result as efficiently as the indicated brand, pattern, grade, class, make or model. Written approval will be obtained from the Engineer prior to installation of any "or equal" material or equipment.

- 9. PATENTS. The Contractor shall hold and save the Owner and its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the contract, including its use by the Owner, unless otherwise specifically stipulated in the Contract Documents. If the Contractor uses any design, device or material covered by letter, patent, or copyright, he shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device or material. It is mutually agreed and understood that, without exception, the contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringements by reason of the use of such patented or copyrighted design, device or materials or any trademark or copyright in connection with work agreed to be performed under this contract, and shall indemnify the Owner for any cost, expense or damage which it may be obliged to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.
- 10. <u>SURVEYS, LAWS AND REGULATIONS.</u> The Contractor shall comply with the following:
- 10.1 <u>Construction staking</u> shall be in accordance with the requirements of Section 01050 entitled "Field Engineering".
- 10.2 Laws and Regulations. The Contractor shall keep himself fully informed of all laws, ordinances and regulations of State, City and County in any manner affecting those engaged or employed in the work, or the materials used in the work, or in any way affecting the conduct of the work, and of all orders and decrees of bodies or tribunals having any jurisdiction or authority over same. If any discrepancy or inconsistency should be discovered in this contract, or in the drawings or specifications herein referred to, in relation to any such law, ordinance, regulation, order or decree, he shall forthwith report the same in writing to the Owner. He shall, at all times, himself observe and comply with all such existing and future laws, ordinances and regulations (to the extent that such requirements do not conflict with Federal laws or regulations) and shall protect and indemnify the Owner and its agents against any claims or liability arising from or based on the violation of any such law, ordinance, regulation, order or decree, whether by himself or by his employees.
- 11. <u>CONTRACTOR'S OBLIGATIONS.</u> The Contractor shall, in good workmanlike manner, do and perform all work and furnish all supplies and materials, machinery, equipment, facilities and means, except as herein otherwise expressly specified, necessary or proper to perform and complete all the work required by this contract, within the time herein specified, in accordance with provisions of this contract and said specifications, and in accordance with the plans and drawings covered by this contract and any and all supplemental plans and drawings and in accordance with the directions of the Engineer as given from time to time during the progress of

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the work. He shall furnish, erect, maintain and remove such construction plant and such temporary works as may be required. The Contractor shall observe, comply with, and be subject to all terms, conditions, requirements and limitation of the contract and specifications, and shall do, carry on and complete the entire work to the satisfaction of the Engineer and the Owner.

- 12. <u>WEATHER CONDITIONS.</u> In the event of temporary suspension of work or during inclement weather, or whenever the Engineer shall direct, the Contractor will, and will cause his subcontractors to, protect carefully his and their work and materials against damage or injury from the weather. If, in the opinion of the Engineer, any work or materials shall have been damaged or injured by reason of failure on the part of the Contractor or any of his Subcontractors to so protect its work, such materials shall be removed and replaced at the expense of the Contractor.
- 13. PROTECTION OF WORK AND PROPERTY, EMERGENCY. The Contractor shall at all times safely guard the Owner's property from injury or loss in connection with this contract. He shall at all times safely guard and protect his own work and that of adjacent property from damage. The Contractor shall replace or make good any such damage, loss or injury unless such be caused directly by errors contained in the contract or by the Owner or by his duly authorized representatives, employees or subcontractors. In case of emergency which threatens loss or injury of property and/or safety of life, the Contractor will be allowed to act, without previous instructions from the Engineer, in a diligent manner. He shall notify the Engineer immediately thereafter. Any claim for compensation by the Contractor due to such emergency work shall be promptly submitted to the Engineer for approval. Where the Contractor has not taken action but has notified the Engineer of an emergency threatening injury to persons or damage to the work of any adjoining property, he shall act as instructed or authorized by the Engineer. The amount of reimbursement claimed by the Contractor on account of any emergency action shall be determined in the manner provided in paragraph entitled "Changes in Work" of these specifications.
- 14. <u>INTERPRETATIONS.</u> If any person contemplating submitting a bid for the proposed contract is in doubt as to the true meaning of any part of these proposed contract documents, he may submit to the Engineer a written request for an interpretation thereof. The person submitting the request will be responsible for its prompt and actual delivery. Any interpretation of such documents will be made only by addendum duly issued, and a copy of such addendum will be mailed or delivered to each person receiving a set of such documents. The Owner will not be responsible for any other explanation or interpretation of such documents which anyone presumes to make on behalf of the Owner before expiration of the ultimate time set for the receipt of bids.
- 15. <u>REPORTS RECORDS AND DATA.</u> The Contractor shall submit to the Owner such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as the Owner may request concerning work performed or to be performed under this contract.
- 16. <u>SUPERINTENDENCE BY CONTRACTOR.</u> The Contractor shall employ only competent and skilled employees for the work on this project. The Contractor shall have competent Superintendent or Foreman present at all times when the work is in progress, who shall have full authority to act for the Contractor. It is understood that such representative shall be acceptable

#### EXPANSION TO 30 MGD-PHASE I

#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

to the Engineer and shall be one who will remain in that capacity for the particular project involved unless he ceases to be on the Contractor's payroll. The Contractor shall, upon demand from the Engineer, immediately remove any superintendent, foreman or workman whom the Engineer may consider incompetent or undesirable.

- 17. <u>CHANGES IN WORK.</u> No changes in the work covered by the approved contract documents shall be made without having prior written approval of the Owner. Charges or credits for the work covered by the approved change shall be determined by one or more, or a combination of, the following methods in advance:
  - (a) Unit bid prices previously approved.
  - (b) An agreed lump sum.
  - (c) The actual cost of:
    - 1. Labor, including foremen.
    - 2. Materials entering permanently into the work.
    - 3. The ownership or rental cost of construction plant and equipment during the time of use on the extra work.
    - 4. Power and consumable supplies for the operation of power equipment.
    - 5. Insurance.
    - 6. Social security and unemployment contributions.

To the cost under (c) there shall be added a fixed fee to be agreed upon but not to exceed 15 percent of the estimated cost of the work. The fee shall be compensation to cover the cost of supervision, overhead, bond, profit and any other general expenses.

- 18. <u>EXTRAS.</u> Without invalidating the contract, the Owner may order extra work or make changes by altering, adding to or deducting from the work, the contract sum being adjusted accordingly, and the consent of the surety being first obtained where necessary or desirable. All the work of the kind bid upon shall be paid for at the price stipulated in the proposal, and no claims for any extra work or materials shall be allowed unless the work is performed pursuant to a written change order approved by the Owner, or the Engineer acting officially for the Owner, and the price is stated in such order. Extra work shall be performed only upon the execution of authorized change orders as set forth in the preceding paragraph.
- 19. <u>TIME FOR COMPLETION AND LIQUIDATED DAMAGES.</u> It is hereby understood and mutually agreed by and between the Contractor and the Owner that the date of beginning and the time for completion as specified in the contract of the work to be done hereunder are essential conditions of this contract; and it is further mutually understood and agreed that the work embraced in this contract shall be commenced on a date to be specified in the Notice to Proceed.
- 19.1 <u>Regular Prosecution of Work.</u> The Contractor agrees that said work shall be prosecuted regularly, diligently and uninterruptedly at such rate of progress as will insure full completion thereof within the time specified. It is expressly understood and agreed, by and between the Contractor and the Owner, that the time for completion of the work described herein is a reasonable time for completion of same, taking into consideration the average climatic range and usual industrial conditions prevailing in this locality.

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#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

- 19.2 <u>Liquidated Damages.</u> If the Contractor shall neglect, fail, or refuse to complete the work within the time herein specified, or any proper extensions thereof granted by the Owner, then the Contractor does hereby agree, as a part consideration for the awarding of this contract, to pay to the Owner the amount specified in the contract not as a penalty but as liquidated damages for such breach of contract as hereinafter set forth, for each and every calendar day that the Contractor shall be in default after the time stipulated in the contract for completing the work. The said amount is fixed and agreed upon by and between the Contractor and the Owner because of the impracticality and extreme difficulty of fixing and ascertaining the actual damages the Owner would in such event sustain, and said amount is agreed to be the amount of damages which the Owner would sustain and said amount shall be retained from time to time by the Owner from current periodical estimates.
- 19.3 <u>Extensions of Time for Completion.</u> It is further agreed that time is of the essence of each and every portion of this contract and of the specifications wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where under the contractor an additional time is allowed for the completion of any work, the new time limit fixed by such extension shall be of the essence of this contract. Provided, that the Contractor shall not be charged with liquidated damages or any excess cost when the delay in completion of the work is due:
  - (a) To any preference, priority or allocation order duly issued by the Government.
  - (b) To unforeseeable cause beyond the control and without the fault or negligence of the Contractor including, but not restricted to, acts of the public enemy, acts of another contractor in the performance of a contract with the Owner; fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, hurricanes, tornadoes; and
  - (c) To any delays of subcontractors or suppliers occasioned by any of the causes specified in subsections (a) and (b) of this article.

Provided, further that the Contractor shall, within seven (7) days from the beginning of such delay, unless the Owner shall grant a further period of time prior to the date of final settlement of the contract, notify the Owner in writing of the causes of delay, who shall ascertain the facts and extent of delay and notify the Contractor within a reasonable time of its decision in the matter, and grant such extension of time as the Owner shall deem suitable and just.

Normal weather conditions for the project area are taken into consideration in the time for completion of the contract; therefore, no extension of time will be extended for normal weather conditions.

20. <u>CORRECTION OF WORK.</u> All work, all materials, whether incorporated in the work or not, all processes of manufacturer, and all methods of construction, shall be at all times and places subject to the inspection of the Engineer, who shall be the final judge of the quality and suitability of the work, materials, processes of manufacture, and methods of construction of the purposes for which they are used. Should they fail to meet his approval, they shall be forthwith reconstructed, made good, replaced and/or corrected by the Contractor at his own expense. Rejected material shall immediately be removed from the site. If, in the opinion of the Engineer, it is undesirable to require the Contractor to replace any defective or damaged materials or to reconstruct or correct any portion of the work injured or not performed in accordance with the

#### EXPANSION TO 30 MGD-PHASE I

contract documents, the compensation to be paid to the Contractor hereunder shall be reduced by such amount as determined by the Engineer.

- 21. <u>SUBSURFACE CONDITIONS FOUND DIFFERENT.</u> Should the Contractor encounter subsurface and/or latent conditions at the site materially differing from those shown on the plans or indicated in the specifications, he shall immediately give notice to the Engineer of such conditions before they are disturbed. The Engineer will thereupon promptly investigate the conditions, and if he finds that they materially differ from those shown on the plans or indicated in the specifications, he will at once make such changes in the plans and/or specifications as he may find necessary; any increase or decrease of cost resulting from such changes to be adjusted in the manner provided in paragraph 17 of these specifications.
  - (a) Where no specific subsurface conditions are indicated or specified, no increase in cost will be considered in regards to subsurface conditions encountered.
- 22. <u>CLAIMS FOR EXTRA COSTS.</u> No claim for extra work or cost shall be allowed unless the same was done pursuant to a written change order of the Engineer and that the claim for extra work and/or costs is presented with a copy of the original estimate after the changes or extra work is done. When work is performed under the terms of subparagraph 17(c) of these specifications, the Contractor shall furnish satisfactory bills payrolls and vouchers covering all items of cost and when requested by the Owner, give the Owner access to accounts relating thereto and in no instance will the claims for the extra work or costs based on subparagraph 17(c) exceed 15% of the cost of the estimated work.
- 23. RIGHT OF OWNER TO TERMINATE CONTRACT. In the event that any of the provisions of this contract are violated by the Contractor or by any of his subcontractors, the Owner may serve written notice upon the Contractor and the Surety of its intention to terminate the contract, such notices to contain the reasons for such intention to terminate the contract, and unless within 10 days after the serving of such notice upon the Contractor, such violation or delay shall cease and satisfactory arrangement or correction be made, the contract shall, upon the expiration of said 10 days, cease and terminate. In the event of any such termination, the Owner shall immediately serve notice thereof upon the Surety and the Contractor, and the Surety shall have the right to take over and perform the contract; provided, however, that if the Surety does not commence performance thereof within 10 days from the date of the mailing to such Surety of notice of termination, the Owner may take over the work and prosecute same to completion by the contract at the expense of the Contractor, and the Contractor and his Surety shall be liable to the Owner for any excess or additional costs occasioned thereby, and in such event the Owner may take possession of and utilize in completion the work such materials, appliances and plant as may be on the site of the work and necessary to complete such work. If the Contractor should die, be declared an incompetent, be declared bankrupt or insolvent, make an assignment for the benefit of creditors during the term of his contract, the Owner may terminate the contract in the manner and under the procedure set forth above with the exception that no notices to the Contractor shall be required, but in lieu thereof the Owner must make a reasonable effort to notify the estate of the Contractor, his guardian, assignee, or legal representative of the intention to terminate and

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### PURRYSBURG, SOUTH CAROLINA

fact of termination, if there is any such guardian, assignee, or legal representative at the time the Owner desires to terminate.

- 24. <u>CONSTRUCTION SCHEDULE AND PERIODIC ESTIMATES.</u> Immediately after execution and delivery of the contract and before the first partial payment is made, the Contractor shall deliver to the Owner an estimated construction progress schedule in form satisfactory to the Owner, showing the proposed dates of commencement and completion of each of the various subdivisions of work required under the contract documents and the anticipated amount of each monthly payment that will become due the Contractor in accordance with the progress schedule.
- 24.1 <u>Contractor's Estimate.</u> The Contractor shall also furnish:
  - (a) A detailed estimate, giving a complete breakdown of the contract price, including unit prices for materials; and
  - (b) Periodic itemized estimates of work completed for the purpose of making partial payments thereon. The costs employed in making up any of these schedules will be used only for determining the basis of partial payments and will not be considered as fixing a basis for addition to or deductions from the contract price.
- 24.2 <u>Equipment Delivery Schedule.</u> The Contractor shall also prepare a schedule of anticipated shipping dates for materials and equipment. It is intended that equipment and materials be so scheduled as to arrive at the job site just prior to time for installation to prevent excessive materials on hand for inventory and the necessity for extensive storage facilities at the job site.
- 25. <u>PAYMENTS TO CONTRACTOR</u> shall be made according to the following:
  - (a) Payments to the Contractor will be made within thirty (30) days upon receipt of a duly certified approved estimate of the work performed during the preceding calendar month under this contract, but to insure the proper performance of this contract, the Owner will retain a portion of each estimate until final completion and acceptance of all work covered by this contract in accordance with the following:
    - 1) Retention of up to 10% of payment claimed until construction is complete, or as follows;
    - 2) After construction is 50% complete, 10% of the 50% completion portion will be retained and no additional retainage will be withheld, provided that the contractor is making satisfactory progress and there is no specific cause for greater withholding.
    - 3) When the project is substantially complete as determined by the Engineer or applicable codes enforcement personnel when necessary (operational or beneficial occupancy), the retained amount may be further reduced to only that amount necessary to assure completion.

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- 4) The Owner may reinstate up to ten (10) percent retainage if the Owner determines, at its discretion, that the contractor is not making satisfactory progress or there is other specific cause for such retainage.
- (b) In preparing estimates, the material delivered on the site and preparatory work done may be taken into consideration.
- (c) All material and work covered by partial payments shall thereupon become the sole property of the Owner, but this provision shall not be construed as relieving the Contractor from the sole responsibility for the care and protection of materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the Owner to require the fulfillment of all the terms of the contract.
- 25.1 Owner's Right to Withhold Certain Amounts and Make Application Thereof. The Contractor agrees that he will indemnify and save the Owner harmless from all claims growing out of the lawful demands of subcontractors, laborers, workmen, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, power tools, and all supplies, including commissary, incurred in the furtherance of the performance of this contract. The Contractor shall, at the Owner's request, furnish satisfactory evidence that all obligations of the nature hereinabove designated have been paid, discharged, or waived. If the Contractor fails so to do, then the Owner may, after having served written notice on the contractor, either pay unpaid bills, of which the Owner has written notice, direct, or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to the Contractor shall be resumed in accordance with the terms of this contract, but in no event shall the provisions of this sentence be construed to impose any obligations upon the Owner to either the Contractor or his Surety. In paying any unpaid bills of the Contractor, the Owner shall be deemed the agent of the Contractor, and any payment so made by the Owner shall be considered as a payment made under the contract by the Owner to the Contractor, and the Owner shall not be liable to the Contractor for any such payment made in good faith.
- 25.2 Measurement and Payment. Measurements of the completed work shall be in accordance with, and by instruments and devices calibrated to United States Standard Measures and the units of measurement for payment, and the limits thereof, shall be made as shown on the Plans, Specifications, General Requirements, and Supplementary Conditions.

Each item for which payment will be made is listed in the Bid. Work specified or shown on the Drawings for which the Bid does not provide a separate lump sum or unit price, or which is incidental, is not separately paid. Costs for such work are compensated in the prices bid for other work items.

The Bid Amounts for each Bid Item will be used for comparative bid analysis. The Bid amounts will also form the basis of monthly progress payments. Bid items are not intended to be exclusive descriptions of work categories and the Contractor shall determine and include in its pricing all

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materials, labor, and equipment necessary to complete each Bid Item (work phase) as shown and specified.

25.3 <u>Methods of Measurement.</u> Measure quantities in accordance with standard industry practice, and as specified herein.

Units of measurement are indicated on the Bid for each unit price item of work. Payment shall be made by multiplying the quantities measured by the unit price bid for the item of work. The costs for performing each item of work shall be included in the price bid for the item in which the work is required.

Payments for lump sum items will be made in accordance with a well-balanced, detailed apportionment of the lump sum, prepared by the Contractor and approved by the Engineer.

Measurements of allowance-based items shall be on the basis of allowable documented costs, as specified herein, for labor, equipment, materials and services, and subcontracts as submitted by the Contractor in the form of time-cards, and invoices.

- 26. <u>ACCEPTANCE OF WORK AND FINAL PAYMENT.</u> Before final acceptance of the work and payment to the Contractor of the percentage retained by the Owner, the following requirements shall be complied with:
  - (a) <u>Final Inspection.</u> Upon notice from the Contractor that his work is completed, the Engineer or the applicable codes enforcement personnel where necessary will make a final inspection of the work and shall notify the Contractor of all instances where his work fails to comply with the contract drawings and specifications, as well as any defects he may discover. The Contractor, at his sole expense, shall immediately make such alterations as are necessary to make the work comply with the contract drawings and specifications, and to the satisfaction of the Engineer.
  - (b) <u>Operating Test.</u> After the alterations for compliance with the contract drawings and specifications have been made, and before acceptance of the whole or any part of the work, it shall be subjected to test to determine that it is in accordance with the contract drawings and specifications. The Contractor shall maintain all work in first class condition for a thirty (30) day operating period after the work has been completed as a whole, the final inspection has been made, and the Engineer has notified the Contractor in writing that the work has been finished to his satisfaction. The retained percentage as provided herein will not become due or payable to the Contractor until after the thirty (30) day operating period.
  - (c) <u>Cleaning Up.</u> Before the work is considered as complete, all rubbish and unused material due to or connected with the construction must be removed and the premises left in a condition satisfactory to the Owner. Streets, curbs, crosswalks, pavements, sidewalks, fences and other public and private property disturbed or damaged should be restored to their former condition. Final acceptance will be withheld until such work is finished.
  - (d) <u>Liens.</u> Final acceptance of the work will not be granted and the retained percentage will not be due or payable until the Contractor has furnished the Owner proper and satisfactory

evidence under oath that all claims for labor and material employed or used in the construction of the work under this contract have been settled, and that no legal claims can be filed against the Owner for such labor or material.

- (e) <u>Final Estimate.</u> Upon completion of all cleaning up, alterations and repairs required by the final inspection or operating test, the satisfactory completion of the operating test, and upon submitting proper and satisfactory evidence to the Owner that all claims have been settled, the Contractor shall then prepare his final estimate. After review and approval of the final estimate by the Engineer and the Owner, the payment shall then become due.
- 27. <u>ACCEPTANCE OF FINAL PAYMENT AS RELEASE.</u> The acceptance by the Contractor of final payment shall be and shall operate as a release to the owner of all claims and all liability to the Contractor for all things done or furnished in connection with this work and for every act and neglect of the Owner and others relating to or arising out of this work. No payment, final or otherwise, shall operate to release the Contractor or his sureties from any obligations under this Contract or his sureties from any obligations under this contract or the performance and payment bond.
- 28. PAYMENTS BY CONTRACTOR. The Contractor shall pay:
  - (a) For all transportation and utility services not later than the 20th day of the calendar month following that in which services are rendered;
  - (b) For all materials, tools, and other expendable equipment to the extent of ninety (90) percent of the cost thereof not later than the 20th day of the calendar month following that in which such materials, tools, and equipment are delivered at the site of the project, and the balance of the cost thereof not later than the 30th day following completion of that part of the work in or on which such materials, tools, and equipment are incorporated or used; and
  - (c) To each of his subcontractors not later than the 5th day following each payment to the Contractor, the respective amounts allowed the Contractor on account of the work performed by his subcontractors to the extent of each subcontractor's interest therein.
- 29. <u>INSURANCE.</u> The Contractor shall procure and shall maintain during the life of this contract, whether such operation be by himself or by a subcontractor or anyone directly or indirectly employed by either of them, such insurance as required by statute and/or ordinance to adequately protect the Owner from any claims or damages, including bodily injury or death, which may arise from them during operations under this contract. The Contractor or any approved subcontractor or sub-subcontractor shall name Owner as an Additional Insured on every required policy of insurance and shall provide the Owner with a copy of the necessary Certificate of Insurance which reflects the designation of the Owner as on Additional Insured under the policy. Contractor shall also provide, upon request, a copy of the Declarations Page of the applicable policy also noting the Owner as an Additional Insured under the policy.
- 29.1 <u>Limits of Liability.</u> Insurance shall be obtained for not less than the limits of liability as specified in Section 00800 entitled Supplemental General Conditions.

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- 29.2 <u>Certificates of Insurance.</u> The Contractor shall furnish the Owner certificates showing the type, amount, class of operations covered, effective dates and dates of expiration of the policies. Such certificates shall contain substantially the following statement: "The insurance covered by this certificate will not be cancelled or materially altered except after 30 days written notice has been received by the Owner". The Certificate of Insurance must also reflect the designation of the Owner as an Additional Insured under the policy as is required under the terms of this contract.
- 30. <u>CONTRACT SECURITY-Payment and Performance Bonds Required.</u> The Contractor shall furnish a 100 percent performance bond and a 100 percent payment bond as security for the faithful performance of this contract, as security for the payment of all persons performing labor on the project under this contract and furnishing materials in connection with this contract. The performance bond and payment bond shall be in separate instruments. Before the final acceptance, each bond must be approved by the Owner.
- 31. <u>ASSIGNMENTS.</u> The Contractor shall not assign the whole or any part of this contract or any moneys due or to become due hereunder without written consent of the Owner. In case the Contractor assigns all or any part of any moneys due or to become due under this contract, the instrument of assignment shall contain a clause substantially to the effect that is agreed that the right of the assignee in and to any moneys due or to become due to the Contractor shall be subject to prior claims of all persons, firms and corporations for services rendered or materials supplied for the performance of the work called for in this contract.
- 32. <u>MUTUAL RESPONSIBILITY OF CONTRACTORS.</u> If through acts of neglect on the part of the Contractor, any other contractor, subcontractor or sub-subcontractor shall suffer loss or damage on the work, the Contractor agrees to resolve the dispute with such other contractor or subcontractor by agreement or arbitration. If such other contractor or subcontractor shall assert any claim against the Owner on account of any damage alleged to have been sustained, the Owner shall notify the Contractor, who shall indemnify and save harmless the Owner against any such claim.
- 33. <u>SEPARATE CONTRACTS.</u> The Contractor shall coordinate his operations with those of other contractors. Cooperation will be required in the arrangement for the storage of materials and in the detailed execution of the work. The Contractor, including his subcontractor, shall keep informed of the progress and the detail work of other contractors and shall notify the Engineer immediately of lack of progress or defective workmanship on the part of other contractors. Failure of a contractor to keep informed of the work progressing on the site and failure to give notice of lack of progress or defective workmanship by others shall be construed as acceptance by him of the status of the work as being satisfactory for proper coordination with his own work.
- 34. <u>SUBCONTRACTING</u> shall comply with the following:
  - (a) The Contractor may utilize the services of specialty contractors on those parts of the work that under normal contracting practices are performed by specialty subcontractors with the written approval of the Owner.

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#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

- (b) The Contractor shall not award any work to any subcontractor without prior written approval of the Owner, which approval will not be given until the Contractor submits to the Owner a written statement concerning the proposed award to the subcontractor, which statement shall contain such information as the Owner may require to include but not limited to any required licenses and insurance information.
- (c) The Contractor shall be as fully responsible to the Owner for the acts and omissions of his subcontractors and any sub-subcontractors, and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons employed by him and shall indemnify and hold harmless the Owner for any acts or omissions undertaken by its subcontractors or sub-subcontractors
- (d) The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractors and any sub-subcontractors to the Contractor by the terms of the General Conditions, Supplemental General Conditions and such other contract documents insofar as applicable to the work of subcontractors or subsubcontractors and to give the Contractor the same power as regards terminating any subcontract that the Owner may exercise over the Contract under any provisions of the contract documents.
- (e) Nothing contained in this contract shall create any contractual relation between any subcontractor and the Owner or any sub-subcontractor and the Owner.
- (f) The contractor and all covered subcontractors shall abide by the requirements of 29 CFR Part 741, 41 CFR § 60-1.4(a), Appendix A to Subpart A, 60-300.5(a) and 60-741.5(a). These regulations prohibit discrimination against qualified individuals based on their status as protected veterans or individuals with disabilities, and prohibit discrimination against all individuals based on their race, color, religion, sex, sexual orientation, gender identity, or national origin. Moreover, these regulations require that covered prime contractors and subcontractors take affirmative action to employ and advance in employment individuals without regard to race, color, religion, sex, sexual orientation, gender identity.
- 35. <u>ENGINEER'S AUTHORITY.</u> The Engineer shall determine the amount, quality, acceptability and fitness of the several kinds of work and materials which are to be paid for under this contract and shall decide all questions which may arise in relation to said work and the construction thereof. The Engineer's estimates and decisions shall be final and conclusive, except as herein otherwise expressly provided. In case any question shall arise between the parties hereto relative to said contract or specifications, the determination or decision of the Engineer shall be a condition precedent to the right of the Contractor to receive any money or payment for work under this contract affected in any manner or to any extent by such question.
- 35.1 <u>Interpretation of Drawings and Specifications.</u> The Engineer shall decide the meaning and intent of any portion of the specifications and of any plans or drawings where the same may be found obscure or be in dispute. Any differences or conflicts in regard to their work that may arise

#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

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between the Contractor under this contract and other contractors performing work for the Owner shall be adjusted and determined by the Engineer.

- 36. <u>STATED ALLOWANCES.</u> The Contractor shall include in his proposal the bid allowances stated in Section 01021. The Contractor shall purchase the "Allowed Equipment" as listed in Section 01021, or equal equipment as defined and subject to the conditions stated in the equipment specification section(s). If the actual price for purchasing the "Allowed Equipment" is less than the "Bid Allowance", the contract price shall be adjusted accordingly. The adjustment in contract price shall be made on the basis of the purchase price without additional charges for overhead, profit, insurance or any other incidental expenses. The cost of installation of the "Allowable Equipment" shall be included in the applicable sections of the contract specifications covering this work.
- 37. <u>USE OF PREMISES AND REMOVAL OF DEBRIS.</u> The Contractor expressly undertakes at his own expense:
  - (a) To take every precaution against injuries to persons or damage to property.
  - (b) To store his apparatus, materials, supplies and equipment in such orderly fashion at the site of the work as will not unduly interfere with the progress of his work or the work of any other contractors.
  - (c) To place upon the work or any part thereof only such loads as are consistent with the safety of that portion of the work.
  - (d) To clean up frequently all refuse, rubbish, scrap materials, and debris caused by his operations, to the end that at all times the site of the work shall present a neat, orderly and workmanlike appearance.
  - (e) Before final payment to remove all surplus material, false work, temporary structures, including foundations thereof, plant of any description and debris of every nature resulting from his operations, and to put the site in a neat, orderly condition.
  - (f) To effect all cutting, fitting or patching of his work required to make the same conform to the plans and specifications, and, except with the consent of the Engineer, not to cut or otherwise alter the work of any other contractor.
- 38. <u>QUANTITIES OF ESTIMATE.</u> The estimated quantities of work to be done and materials to be furnished under this contract, shown in any of the documents, including the proposal, are given for use in comparing bids, and the right is especially reserved except as herein otherwise specifically limited, to increase or diminish them as may be deemed reasonably necessary or desirable by the Owner to complete the work contemplated by this contract, and such increase or diminution shall in no way vitiate this contract, nor shall any such increase or diminution give cause for claims or liability for damages.
- 39. <u>RIGHT-OF-WAY AND SUSPENSION OF WORK.</u> The Owner shall furnish all land and rights-ofway necessary for the carrying out of this contract and the completion of the work herein contemplated, and will use due diligence in acquiring said land and rights-of-way as speedily as possible. But it is possible that all lands and rights-of-way may not be obtained as herein

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#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

contemplated before construction begins, in which event the Contractor shall begin his work upon such land and rights-of-way as the Owner may have previously acquired, and no claim for damages whatsoever will be allowed by reason of the delay in obtaining the remaining lands and rights-of-way.

Should the Owner be prevented or enjoined from proceeding with the work, or from authorizing its prosecution, either before or after the commencement, by reason of any litigation or by reason of its ability to procure any lands or rights-of-way for said work, the Contractor shall not be entitled to make or assert claim for damage by reason of said delay or to withdraw from the contract except by consent of the Owner; but time for completion of the work will be extended to such time as the Owner determines will compensate for the time lost by such delay, such determination to be set forth in writing.

- 40. <u>GENERAL WARRANTY FOR ONE YEAR AFTER COMPLETION OF CONTRACT.</u> For a period of at least one year after the completion of the contract, the Contractor warrants the fitness and soundness of all work done and materials and equipment put in place under the contract, and neither the final certificate of payment nor any provision in the Contract Documents nor partial or entire occupancy of the premises by the Owner shall constitute an acceptance of work not done in accordance with the Contract Documents or relieve the Contractor of liability in respect to any express warranties or responsibility for faulty materials or workmanship. The Contractor shall remedy any defects in the work and pay for any damage to other work resulting there from, which shall appear within a period of one year from the date of final acceptance of the work, unless a longer period is specified. The Owner will give notice of observed defects with reasonable promptness.
- 41. <u>NOTICE AND SERVICE THEREOF.</u> Any notice to any Contractor from the Owner relative to any part of this contract shall be in writing and considered delivered and the service thereof completed, when said notice is posted by registered mail to said Contractor or his authorized representative on the work, or is deposited in the regular United States Mail in a sealed, postage prepaid envelope and the receipt thereof is acknowledged by the Contractor.
- 41.1 <u>Owner's Notice.</u> All papers required to be delivered to the Owner shall be delivered as indicated in Section 00800 entitled Supplemental General Conditions.
- 42. <u>REQUIRED PROVISIONS DEEMED INSERTED.</u> Each and every provision of law and clause required by law to be inserted in this contract shall be deemed to be inserted herein, and the contract shall be read and enforced as though it were included herein, and if through mistake or otherwise any such provision is not inserted or is not correctly inserted, then upon the application of either party the contract shall forthwith by physically amended to make such insertion or correction.
- 43. <u>PROTECTION OF LIVES AND HEALTH.</u> In order to protect the lives and health of his employees under the contract, the Contractor shall comply with all pertinent provisions of the "Manual of Accident Prevention in Construction" issued by the Associated General Contractors of America, Inc., and shall maintain an accurate record of all cases of death, occupational disease, and injury requiring medical attention or causing loss of time from work, arising out of and in the course of

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#### BEAUFORT JASPER WATER AND SEWER AUTHORITY PURRYSBURG, SOUTH CAROLINA

employment on work under the contract. The Contractor alone shall be responsible for the safety, efficiency and adequacy of his plant, appliances and methods, and for any damage that may result from their failure or their improper construction, maintenance or operation.

- 44. <u>WAGES AND OVERTIME COMPENSATION.</u> The Contractor and each of his subcontractors shall comply with all applicable State and local laws or ordinances with respect to the hours worked by laborers and mechanics engaged in work on the project and with respect to compensation for overtime.
- 45. <u>PROHIBITED CONFLICTS OF INTERESTS.</u> No official of the Owner, who is authorized in such capacity and on behalf of the Owner to negotiate, make, accept or approve or to take part in negotiating, making, accepting, or approving any architectural, engineering, inspection, construction, or material supply contract or any subcontract in connection with the construction of the project, shall become directly or indirectly interested personally in this contract or in any part hereof. No officer, employee, architect, attorney, engineer, or inspector of and on behalf of the Owner to exercise any legislative, executive, supervisory or other similar functions in connection with the construction of the project shall become directly or indirectly interested personally in this contract or in any part hereof, any material supply contract, subcontract, insurance contract, or any other contract pertaining to the project.
- 46. <u>CONFLICTING CONDITIONS.</u> Any provisions in any of the Contract Documents which may be in conflict or inconsistent with any of the paragraphs in these General Conditions shall be void to the extent of such conflict or inconsistency.

### 47. INDEMNIFICATION

- 47.1 The CONTRACTOR will indemnify and hold harmless the OWNER, the ENGINEER and their agents and employees from and against all claims, damages, losses and expenses including attorney's fees arising out of or resulting from the performance of the WORK, provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property including the loss of use resulting there from; and is caused in whole or in part by any negligent or willful act of omission of the CONTRACTOR and SUBCONTRACTOR OR SUB-SUBCONTRACTOR, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.
- 47.2 In any and all claims against the OWNER or the ENGINEER, or any of their agents or employees, by an employee of the CONTRACTOR, any SUBCONTRACTOR, anyone directly employed by any of them, or anyone for whose acts any of them may be liable, the indemnification obligation of the CONTRACTOR shall not be limited in any way by limitation on the amount or type of damages, compensation, insurance limits or benefits payable by or for the CONTRACTOR or any SUBCONTRACTOR under workmen's compensation acts, disability benefit acts or other employee benefits acts.
- 47.3 The obligation of the CONTRACTOR under this paragraph shall not extend to the liability of the ENGINEER, its agents or employees arising out of the preparation or approval of maps, drawings, opinions, reports, surveys, change orders, design or specifications.

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PURRYSBURG, SOUTH CAROLINA

Attachment 1

Date:\_\_\_\_\_

General Manager Beaufort-Jasper Water and Sewer Authority 6 Snake Road Okatie, SC 29909

Re: Certificate of Non-Litigation/Lien Waiver for Project Name: CIP: 1366 Purrysburg WTP Expansion to 30 MGD – Phase 1

Dear Sir:

This is to certify that there are <u>no pending</u> or threatened actions at law that will affect the fee simple dedication of the *water and sewer utilities* for the above referenced project. I further certify that all contractors, sub-contractors, material suppliers, engineers, attorneys, or other persons, firms or corporations retained for the purpose of designing, planning, and constructing the *water and sewer utilities on the* referenced project have been paid in full.

 Witness
 Name of Contractor (please print)

 Witness
 Signature of Contractor

 Witness
 Name of Engineer (please print)

 Witness
 Signature of Engineer

**EXPANSION TO 30 MGD-PHASE I** 

Attachment 2

### CONTRACTOR GUARANTY

WHEREAS, Beaufort-Jasper Water and Sewer Authority, as ultimate owner and operator of the Purrysburg WTP Expansion to 30 MGD – Phase 1 (project name) water and/or sewer utility systems, located at 10314 Purrysburg Rd, Hardeeville, SC, 29927, requires tangible assurance as to the quality of materials and workmanship used on the aforementioned project; and,

WHEREAS, TBD as duly licensed and responsible contractor having constructed and/or supervised the construction of the aforementioned project, desires to assure the Beaufort-Jasper Water and Sewer Authority that the quality of materials and workmanship meet published standards governing the construction of such utilities work.

THERFORE, it is hereby agreed that neither final payment by the developer nor any provision in the contract with the developer, no partial or entire use of the constructed utility improvements by the Beaufort-Jasper Water and Sewer Authority or the public shall constitute an acceptance of work not performed in accordance with approved plans or relieve the contractor of liability or responsibility for faulty materials or workmanship or of its obligation and duty to indemnify and hold harmless the Owner. It is further agreed that the contractor shall promptly remedy any defects in the work, with the exception of damages construed as acts of God, at his own expense, and pay for any damage to other work resulting therefrom which shall appear within a period to twelve (12) months from the date the Permit to Operate is issued by SC DHEC.

THEREFORE, the contractor hereby certifies that all work described or shown on the construction documents was performed. If it can be demonstrated that work was not performed, then the contractor shall remedy the oversight at his own expense or reimburse the Authority for the cost plus twenty (20%) percent for administrative costs. This clause shall be in effect indefinitely.

IN WITNESS WHEREOF, this instrument of GENERAL GUARANTY is hereby executed.

Attest:	(Authorized signature of contractor)					
For:	(Company Name)					
	(Address)					
Submitted and sworn to before me this	day of, 2019					
Ву:						
	Notary Public for state of					
	My commission expires					

EXPANSION TO 30 MGD-PHASE I

PURRYSBURG, SOUTH CAROLINA

END OF SECTION

### 48. PROJECT CLOSE OUT

Attachment 1

### BJWSA

### CIP PROJECT CLOSE OUT REQUIREMENTS

Date: \_\_\_\_\_

**CIP Project number: 1366** 

### CIP Project name: Purrysburg WTP Expansion to 30 MGD – Phase 1

Final service authorization will be provided upon acceptance of the water and/or sewer system by BJWSA. If required, a service authorization letter shall be provided to the engineer and/or contractor after acceptance.

To receive service authorization necessary to allow the establishments to receive water and/or sewer service, the items checked below must be completed.

\*\*\*NOTE\*\*\* Items checked below must be received before payment of the final invoice:

- **1.** \_\_\_\_\_ All punch list items as determined by a BJWSA Field Inspector.
- **2.** \_\_\_\_\_ The certification letter, to include certification that the air test, pressure test, etc. have been satisfactorily performed, and a copy of the bacteriological test.
- **3.** \_\_\_\_\_ Executed Certification of Non-Litigation/LIEN WAIVER (Attachment I). Unless covered by the contract.
- **4.** \_\_\_\_\_ Executed Contractors Guaranty for not less than one year after receiving service authorization (Attachment II).
- **5.** \_\_\_\_\_ Final record drawings/red lines have been received and approved by BJWSA. (Refer to record drawing standards). 911 addresses are to be placed on the as-built drawings.
- 6. \_\_\_\_\_ Department of Health and Environmental Control approval. Temporary verbal or partial approval may be arranged for but must be followed in a timely manner by written approval from DHEC.
- 7. \_\_\_\_\_ Executed Cost Certificate if applicable. (Attachment III).
- 8. \_\_\_\_\_ Release by other agencies such as State, County, SCDOT or others applicable to encroachment permits or other liabilities.
- **9.** \_\_\_\_\_ Execution of all easements and deeds necessary for the conveyance of the water/or sewer facilities to be maintained and owned by BJWSA.
- **10.** \_\_\_\_\_ All *original paperwork* shall be delivered to the attention of the CIP Project Manager.
- **11.** \_\_\_\_\_ Notify Purchasing to return bid bond to contractor.

END OF SECTION

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### SECTION 00800

### SUPPLEMENTAL GENERAL CONDITIONS

### 1. ENUMERATION OF PLANS, SPECIFICATIONS AND ADDENDA

1.1 The plans, specifications and addenda which form a part of this contract as set forth in Paragraph 1 of the General Conditions, Contract and Contract Documents are enumerated in the Project Manual Table of Contents.

### 2. CONTRACTOR'S AND SUBCONTRACTOR'S INSURANCE

- 2.1 As required under Paragraph 29 of the General Conditions, the CONTRACTOR shall not commence WORK under this Contract until he has obtained all the insurance required under this paragraph and such insurance has been approved by the OWNER, nor shall the CONTRACTOR allow any SUBCONTRACTOR to commence WORK on his Subcontract until all similar insurance required of the SUBCONTRACTOR has been so obtained and approved.
- 2.2 Unless otherwise specified in this Contract, the CONTRACTOR shall, at its sole expense, maintain in effect at all times, during the performance of WORK, insurance coverage with limits not less than those set forth below with insurers and under forms of policies satisfactory to OWNER.
- 2.3 The CONTRACTOR shall deliver Certificates of Insurance to the ENGINEER no later than ten (10) days after award of the Contract but in any event, prior to execution of the Contract by the OWNER and prior to commencing WORK on the site as evidence that policies providing such coverage and limits of insurance are in full force and effect.

(a) Certificates shall provide that not less than thirty (30) days advance notice will be given in writing to the OWNER prior to cancellation, termination or material alteration of said policies of insurance.

(b) Certificates shall identify on their faces the PROJECT NAME and the ENGINEER'S PROJECT NUMBER.

- 2.4 Additional Insured: The Commercial General Liability, Excess Liability (Umbrella) and Comprehensive Automobile Liability insurance policies shall be endorsed to include the OWNER and ENGINEER as additional insured for ongoing and completed operations. Such insurance shall be primary and not be contributory with any other insurance maintained by the OWNER or ENGINEER.
- 2.5 The OWNER AND ENGINEER are not maintaining any insurance on behalf of the CONTRACTOR covering against loss or damage to the WORK or to any other property of the CONTRACTOR unless otherwise specifically stated herein and as may be described by appendix hereto. In the event the CONTRACTOR maintains insurance against physical loss or damage to the CONTRACTOR'S construction equipment and tools, such insurance shall include an insurer's waiver of rights of subrogation in favor of OWNER AND THE ENGINEER.

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- 2.6 Provide only insurance carrier(s) with an "A" rating.
- 2.7 The CONTRACTOR shall fully and completely indemnify and hold harmless the OWNER and the ENGINEER as stated in Part 47 of Section 00700.

### 2.8. Insurance Requirements:

(a) **Commercial General Liability Insurance:** The CONTRACTOR shall take out and maintain during the life of the Contract such commercial general liability insurance as shall protect him from claims for damage for bodily injury, including accidental death, as well as from claims for property damage, to include completed operations coverage, which may arise from operations under this contract whether such operations are by himself or by any SUBCONTRACTOR or by anyone directly or indirectly employed by either of them. The amount of such insurance shall be not less than the following:

General Aggregate	\$2,000,000.00			
Products - Complete/Operations Aggregate	\$2,000,000.00			
Personal and Advertising Injury	\$1,000,000.00			
Each Occurrence	\$1,000,000.00			
Fire Damage (Any one fire)	\$50,000.00			
Medical Expenses (Any one person)	\$5,000.00			

(1) The General Aggregate listed above shall be for this project only.

- (2) **Special Hazards:** The CONTRACTOR'S and his SUB-CONTRACTOR'S General Liability Insurance shall provide adequate protection against use of explosives, collapse, and underground hazards. Each detonation of blasting shall be considered a single occurrence.
- (3) Provide Waiver of Subrogation in favor of the Owner.

### (b) **Comprehensive Automobile Liability Insurance:**

- (1) Includes coverage for all owned, hired and non-owned automobiles.
- (2) The combined single limit of liability shall not be less than the following:

Any One Accident or Loss	\$1,000,000.00

(3) Provide Waiver of Subrogation in favor of the Owner.

### (c) Excess Liability (Umbrella) Insurance:

(1) CONTRACTOR shall carry and maintain Combined Excess Liability (Umbrella) insurance for a limit not less than the following:

Each Occurrence	\$5,000,000.00
Aggregate	\$5,000,000.00

(2) Provide Waiver of Subrogation in favor of the Owner.

(d) **Worker's Compensation:** The insurance required by this Section shall be written for not less than the following or greater if required by law:

- (1) Statutory benefits as provided by South Carolina Law.
- (2) Employers' Liability:

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Each Accident	\$500,000.00
Disease - Policy Limit	\$500,000.00
Disease - Each Employee	\$500,000.00

(c) Provide Waiver of Subrogation in favor of the Owner.

(e) **Builders Risk Insurance:** The CONTRACTOR shall purchase and maintain an "all risk" or special perils form builder's risk policy issued in the name of the CONTRACTOR, OWNER and all SUBCONTRACTORS for the full contract value of the insurable portions of the WORK. This policy shall contain a provision that in the event of payment of any loss or damage, the insurer will have no rights of recovery against any of the parties named as insureds or additional insureds.

(f) **Flood Insurance:** The CONTRACTOR is required to carry flood insurance for projects located in designated flood hazard areas in which Federal Flood Insurance is available.

(g) **Earthquake Insurance**: The CONTRACTOR is required to carry earthquake insurance for the full contract value of insurable portions of the WORK.

(h) **OWNER'S Protective Liability Insurance:** The CONTRACTOR shall purchase and maintain an OWNER'S Protective Liability policy issued in the name of the OWNER with a combined single limit of liability of not less than the following:

Each Occurrence	\$2,000,000.00
Aggregate	\$2,000,000.00

(i) **WORK SAFETY**: The CONTRACTOR shall provide and enforce a safe work environment as prescribed in the Occupational Safety and Health Act of 1970 as amended – The CONTRACTOR will provide such safety equipment, training and supervision as may be required by BJWSA and/or applicable law. The CONTRACTOR shall ensure its subcontractors provide a similar provision. The CONTRACTOR shall attend BJWSA mandated safety meetings.

### 3. ABBREVIATIONS AND DEFINITIONS

3.1 Abbreviations used in these Specifications refer to the following:

OWNER: Beaufort Jasper Water & Sewer Authority

ENGINEER: Beaufort Jasper Water & Sewer Authority

3.2 Definitions: Wherever in the specifications or upon the drawings the words "directed", "required", "permitted", "ordered", "designated", "prescribed", or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation or prescription of the OWNER is intended; and similarly, the words "approved", "acceptable", "satisfactory", or words of like import shall mean approved by, or acceptable to, or satisfactory to the OWNER, unless otherwise expressly stated.

#### 4. **PHOTOGRAPHS OF PROJECT**

4.1 Periodic photographs of the project by the contractor will be required. Photographs shall be made available on a monthly basis.

### 5. <u>SCHEDULE OF OCCUPATIONAL CLASSIFICATIONS AND MINIMUM HOURLY WAGE</u> <u>RATES</u>

5.1 Not applicable.

### 6. NOTICE AND SERVICE THEREOF

6.1. All papers required to be delivered to the OWNER shall, unless otherwise specified in writing to the CONTRACTOR, be delivered to the OWNER'S representative as indicated below, and any notice to or demand upon the OWNER shall be sufficiently given if delivered to the office of said representative, or if deposited in the United States Mail, in a sealed postage prepaid envelope, or delivered with charges prepaid to any telegraph company for transmission, in each case addressed to the OWNER'S representative as indicated below, or to such other representative of the OWNER, or to such other address as the OWNER may subsequently specify in writing to the CONTRACTOR for such purposes. The OWNER'S representative is as follows:

Shawn Flood Capital Projects Manager Beaufort Jasper Water & Sewer Authority 6 Snake Road Okatie, SC 29910

### 7. CORRELATION OF PLANS AND SPECIFICATIONS

7.1 The contract, plans and specifications are to be interpreted as mutually explanatory or supplementary, and therefore any features shown in one and not in the other shall have the same force and effect as if shown by both, and shall be fully executed. Prior to execution of the WORK, the CONTRACTOR shall check all drawings and specifications, and shall immediately report to the ENGINEER all errors, discrepancies, conflicts and omissions discovered therein. All such errors, discrepancies, conflicts and omissions will be adjusted by the ENGINEER, and adjustment by the CONTRACTOR without prior approval shall be at his own risk. The settlement of any complications arising from such adjustments shall be made by the CONTRACTOR at his own expense and to the satisfaction of the OWNER.

### 8. OWNERSHIP OF DRAWINGS

- 8.1 All drawings, specifications and memoranda relating to the WORK are the property of the OWNER and are to be carefully used and returned to the OWNER upon completion or cessation of the WORK from any cause.
- 8.2 Plans and specifications to be furnished: Five (5) sets of specifications and plans will be furnished to the CONTRACTOR without charge. Additional sets can be secured from the ENGINEER upon request at cost of reproduction. The CONTRACTOR shall have available on the project site at all times one (1) copy of each of said plans and specifications.

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### 9. ORDER OF WORK

9.1 The prosecution, order or sequence of the WORK shall be as approved by the ENGINEER, which approval, however, shall in no way affect the responsibility of the CONTRACTOR.

### 10. PHYSICAL DATA

10.1 The drawings, which accompany and form a part of the contract, have been prepared on the basis of surveys and observations of the site, and are intended to present an essentially accurate indication of the physical conditions at the site. However, this shall not relieve the CONTRACTOR of the necessity for familiarizing himself with physical conditions at the site, and any discrepancies found in the drawings shall not be grounds for claims by the CONTRACTOR against the OWNER, or for non-performance of WORK specifically provided for under the contract.

### 11. ORGANIZATION, PLANT AND PROGRESS

11.1 The following is supplemental to Paragraph 16 of the General Conditions:

(a) The CONTRACTOR shall give his personal superintendence to the WORK, or shall have a competent superintendent with authority to act for him, to the satisfaction of the ENGINEER, on the job at all times during the progress of the WORK.

(b) The CONTRACTOR shall employ an ample force of properly experienced persons and provide construction plant properly adapted to the WORK and of sufficient capacity and efficiency to accomplish the WORK in a safe and workmanlike manner at a rate of progress satisfactory to the OWNER. All plants shall be maintained in good working order and provision shall be made for immediate emergency repairs. No reduction in the capacity of the plant employed on the WORK shall be made except by written permission of the OWNER. The measure of the capacity of the plant shall be its actual performance on the WORK to which these specifications apply. Award of this contract shall not be construed as a guaranty by the OWNER that plant listed by the CONTRACTOR for use on this contract is adequate for the performance of the WORK.

(c) Should the CONTRACTOR fail to maintain a rate of progress which, in the opinion of the OWNER, will complete WORK within the time limit specified, the OWNER may require that additional persons working, if necessary, during additional periods or shifts, or additional plant, or both, be placed on the WORK; or a reorganization of plant layout be effected in order that the progress of the WORK be brought up to schedule and so maintained. Should the CONTRACTOR refuse or neglect so to increase the number of employees, working period, or plant, or to reorganize the plant layout in the manner satisfactory to the OWNER, the latter may proceed under the provisions of the Contract to rectify the conditions.

### 12. ENGINEER'S REVIEW AND CONTRACTOR'S INSPECTION

12.1 The WORK shall be periodically reviewed by the ENGINEER's representatives, but the presence of the ENGINEER's representatives shall not relieve the CONTRACTOR or his responsible agent of responsibility for the proper execution of the WORK.

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- 12.2 The CONTRACTOR will be required to furnish at his expense such labor, organization and materials which form a part of the ordinary and usual equipment and crew of the CONTRACTOR as may be reasonably necessary in inspecting and supervising the WORK. Should the CONTRACTOR refuse, neglect or delay compliance with this requirement, the specified facilities may be furnished and maintained by the OWNER and the cost thereof will be deducted from any amounts due, or to become due, the CONTRACTOR.
- 12.3 Except as specified in this paragraph, or otherwise provided for in these specifications, all expense of inspection will be borne by the CONTRACTOR.
- 12.4 It is understood that any instruction or decision given by the ENGINEER through the Resident ENGINEER is to be considered the instruction or decision of the OWNER, in all cases where, under the terms of this contract, decision rests with the ENGINEER.
- 12.5 The ENGINEER or his authorized representative shall have access to the WORK at all times.

### 13. STANDARD TESTS, QUALITY AND GUARANTEES

13.1 Standard tests, quality and guarantees shall comply with the following:

(a) All materials, supplies and parts and assemblies thereof, entering into the WORK to be performed under these specifications, shall be tested as specified herein or otherwise required, in conformity with the contract and according to the best modern approved methods for the particular type and class of WORK.

(b) Unless waived in writing by the ENGINEER, all tests and trials shall be made in the presence of a duly authorized representative of the ENGINEER. When the presence of the inspector is so waived, sworn statements in duplicate of the tests made and results thereof shall be furnished to the ENGINEER by the CONTRACTOR as soon as possible after completion of tests.

(c) Unless otherwise authorized, directed or specified, where standard published specifications of recognized authorities and organizations are mentioned, the latest revision of such specification current at the time when the WORK is executed shall govern.

(d) All materials and equipment used in the construction of the project shall be subject to adequate inspection and testing in accordance with accepted standards. The laboratory or inspection agency shall be selected by the OWNER. The OWNER will pay for all laboratory inspection service direct and not as a part of the contract.

(e) Materials of construction, particularly those upon which the strength and durability of the structure may depend, shall be subject to inspection and testing to establish conformance with specifications and suitability for uses intended.

(f) In accordance with the Contract, all materials, parts and equipment furnished and incorporated in the WORK shall be high grade, free from defects and imperfections, of recent manufacture and unused. Workmanship shall be of the highest grade and in accordance with the best modern standard practice.

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### 14. STANDARD PRODUCTS

14.1 All materials supplied and articles furnished shall, wherever specified and otherwise wherever practicable, be the standard products of recognized, reputable manufacturers. The standard products of manufacturers other than those specified will be accepted when it is proven to the satisfaction of the ENGINEER, in accordance with the Contract, that they are equal in strength, durability, usefulness and convenience for the purpose intended. Any changes required in the details and dimensions indicated on the drawings, or the substitution of standard products other than those provided for, shall be properly made as approved by the ENGINEER and at the expense of the CONTRACTOR.

### END OF SECTION

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Project information.
  - 2. Work covered by Contract Documents.
  - 3. Phased construction.
  - 4. Contractor-furnished.
  - 5. Access to site.
  - 6. Coordination with occupants.
  - 7. Work restrictions.
  - 8. Specification and drawing conventions.
  - 9. Miscellaneous provisions.
- B. Related Requirements:
  - 1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

#### 1.3 **PROJECT INFORMATION**

- A. Project Identification: Purrysburg WTP –Expansion to 30 MGD Phase 1
  - 1. Project Location: Purrysburg, SC
- B. Owner: Beaufort Jasper Water and Sewer Authority
  - 1. Owner's Representative(s): Shawn Flood, Capital Projects Manager
- C. Engineer:
  - Goodwyn Mills & Cawood (ATTN: Jim Vaughn, PE); 35 Abercorn Street, Suite 210; Savannah, GA 31401
- D. Engineer's Consultants: The Engineer has retained the following design professionals who have prepared designated portions of the Contract Documents:
  - 1. Structural: Weatherford & Day Engineers; Montgomery, AL

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E. Contractor: TBD.

### 1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
  - 1. The construction and modifications consist of the following:
    - a. Clearing and grubbing, civil/site work, etc.
    - b. Construction of new 4.0 MG prestressed composite clearwell.
    - c. Surface Preparation, Crack repair and recoating of the existing 4.0 MG clearwell.
    - d. Installation of 48" and 54" yard piping and connections of new clearwell to existing plant yard piping system including new valves
    - e. Extension of existing chemical feed lines from current feed point located at inlet of High Service Pumping Station to the new location downstream from the High Service Venturi Vault.
    - f. Installation of new 18" plant drain from the new clearwell to a connection point at the existing drain manhole located east of Clearwell No. 1.
    - g. Construction of new access road to the proposed Contract Dewatering Area
    - h. Installation of new water main and electrical service to serve the proposed Contract Dewatering Area.
    - i. Construction of Contract Dewatering Area pad, drains, pumping station and electrical building.
    - j. Construct dredge header from the existing Process Water Lagoon to the Contract Dewatering Area.
    - k. Miscellaneous site improvements associated with the work.
- B. Type of Contract:
  - 1. Project will be constructed as a design-bid-build contract.

#### 1.5 CONTRACTOR-FURNISHED AND INSTALLED PRODUCTS

A. Contractor shall furnish all products indicated in the bid documents. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.

#### 1.6 WORK BY OWNER

A. General: Cooperate fully with Owner so that work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

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#### 1.7 CONTRACTOR-FURNISHED AND INSTALLED PRODUCTS

A. Contractor shall furnish all products indicated in the bid documents. The Work includes unloading, handling, storing, and protecting Contractor-furnished products as directed and turning them over to Owner at Project closeout.

#### 1.8 ACCESS TO SITE

- A. General: Contractor shall have full access to Project site for construction operations during construction period. Contractor's use of Project site is limited by the requirements of the Owner to operate the existing facilities on the site and the Owner's right to perform work or to retain other Contractors on portions of Project.
- B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
  - 1. Driveways, Walkways and Entrances: Keep driveways and loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
    - a. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

### 1.9 COORDINATION WITH OCCUPANTS

- A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
  - 1. Engineer will prepare a Certificate of Substantial Completion for each specific phase of the project.
  - 2. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.

#### 1.10 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
  - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Working hours shall be generally limited to 7am to 5pm; Contractor shall contact the Engineer/Owner when working hours are extended beyond normal business hours or when weekend construction is expected to occur.

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- C. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to neighbors with the Owner.
  - 1. Obtain Engineer's written permission before proceeding with disruptive operations.
- D. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.

#### 1.11 ADVERSE WEATHER

- A. General
  - 1. Notice of rain delay days with the documentation of the aforementioned sources herein and on-site records must be submitted by the Contractor to the Inspector/Engineer on the first working day of every month for the previous month or at the monthly construction meeting as determined at the preconstruction meeting.
- B. Definition
  - 1. Adverse weather is defined as the occurrence of a condition that prevents construction activity exposed to weather conditions or access to the site for more than four (4) hours in a day.
  - 2. Adverse weather may also include, if appropriate, "dry-out" or "mud" days.
  - 3. Adverse weather includes days that temperature does not rise above the required temperature for a construction activity.
- C. Qualifications
  - 1. Adverse weather conditions having a <u>direct</u> effect due to precipitation are as follows:
    - a. Precipitation of 0.10 inch or more for a city within a 100-mile radius of the project's location.
      - 1) If the 100-mile radius overlaps with a nearby city, then the city with the shortest radius from the project location shall be used.
      - 2) If the project location does not fall within a 100-mile radius, the following schedule shall be used as the default:

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
5	5	5	4	6	8	8	9	5	4	3	6
(Data from NOAA, > 0.10" Daily Precipitation, January 2007 – December 2017, Hardeeville, SC											

- b. Precipitation of 0.10 inches or more shall be determined by the precipitation gauge on-site and both logged and confirmed by the Owner/Inspector.
- 2. Adverse weather conditions having an <u>indirect</u> effect due to precipitation are as follows:
  - a. Precipitation that occurs beyond the standard baseline which results in "dry-out" or "mud" days.

- 1) The standard baseline is based on the NOAA's Point Precipitation Frequency (PPF) Estimate for the construction area using the latitude and longitude for a 1-year average recurrence interval and a 60-min time period. This can be found at <u>http://dipper.nws.noaa.gov/hdsc/pfds/</u>.
- 3. Adverse weather conditions due to temperature are as follows:
  - 1) Cold Weather concreting shall be per ACI 306.
    - a) The Contractor shall have a calibrated thermometer onsite which is logged by the inspector and Contractor prior to any concrete pours during cold weather.
- 4. Adverse weather conditions due to wind speeds are as follows:
  - a. Wind speeds exceeding those permissible to use equipment or to perform certain tasks safely, including but not limited to operating crane(s) or other aerial equipment for construction or erection of a building structure.
    - 1) The Contractor shall have a calibrated wind speed gauge on-site.
- 5. Adverse weather conditions resulting in compromised project site conditions are as follows:
  - a. Project site conditions such as mud, pooling of water, ice, or standing snow subsequent to the actual precipitation days, prevent the performance of activities such as, but not limited to, mass grading, building pad grading, foundations, piping, excavations, backfill, concrete, masonry, etc. operations.
- D. Weather Delay Days
  - 1. Adverse weather delay day may be counted if adverse weather prevents work on the project during an event where:
    - a. Precipitation days for a specific month is greater than the recorded monthly average for a project location indicated above.
      - 1) The number of average rain days shall be subtracted from the number of recorded rain days and the difference shall be the allotted time.
    - b. Precipitation for a given day is greater than the NOAA's PFF estimate indicated above.
      - 1) One (1) day for each day or consecutive days of precipitation that exceeds the standard baseline.
    - c. Precipitation of 3.0 inches over a 24-hour period.
      - 1) The number of allotted days shall be at the discretion of the Engineer/Owner based on site conditions, working conditions, and type of construction.
      - 2) Temperature per ACI 306.

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### E. Exceptions

- 1. The Contractor shall take into account that certain construction activities are more affected by adverse weather and seasonal conditions than other activities, and that "dry-out" or "mud" days are not eligible to be counted as an Adverse Weather Delay Day until the standard baseline is exceeded. Hence, the Contractor should allow for an appropriate number of additional days associated with the Standard Baseline days in which such applicable construction activities are expected to be prevented and suspended.
- F. Record Keeping
  - 1. All Adverse Weather events shall be recorded by the on-site management team.
  - 2. On-site records of daily rain and/or temperature readings shall be kept by the Contractor and may be accepted to verify weather and/or temperature variations which prevent earthwork, foundation and slabs, and/or roofing materials installation. The Inspector shall also be required to maintain on-site records of daily rain and/or temperature.

# 1.12 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
  - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
  - 2. Abbreviations: Materials and products are identified by abbreviations.

# 1.13 WARRANTIES

- A. Warranties shall conform to the requirements of the General Conditions.
- B. All equipment supplied by the Contractor under these Specifications shall be warranted by the Contractor and the equipment manufacturers for a period of one (1) year. Warranty period shall commence on the date of Substantial Completion.

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- C. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail due to workmanship, design and materials during the warranty period, it shall be replaced by the Contractor and the unit(s) restored to service at no expense to the Owner.
- D. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining equipment warranties from each of the respective suppliers or manufacturers for all the equipment specified.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00
# SECTION 01 21 00 - ALLOWANCES

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
  - 1. Lump-sum allowances.

### 1.3 DEFINITIONS

A. Allowance is a quantity of work or dollar amount established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

# 1.4 SELECTION AND PURCHASE

A. Purchase products and systems selected by Engineer from the designated supplier.

### 1.5 ACTION SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

# 1.6 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

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## 1.7 LUMP-SUM ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Engineer under allowance and shall include taxes, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Engineer under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
  - 1. If requested by Engineer, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

## 1.8 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
  - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
  - 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.
  - 3. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit-cost allowances.
  - 4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
  - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
  - 2. No change to Contractor's indirect expense is permitted for selection of higher- or lowerpriced materials or systems of the same scope and nature as originally indicated.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

## 3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

## 3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Lump-Sum Allowance: Include the sum of \$10,600 for instrumentation and SCADA integration associated with the installation of the new 4.0 MG Clearwell.
  - 1. This allowance includes integrators field devices and SCADA integration, and Contractor overhead and profit.

END OF SECTION 01 21 00

SECTION 01 22 00 - UNIT PRICES

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

# 1.2 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

## 1.3 DEFINITIONS

A. Unit price is an amount incorporated into the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

### 1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

# 3.1 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.
  - 1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, according to Section 31 20 00 "Earth Moving."
  - 2. Unit of Measurement: Cubic yard of soil excavated, based on in-place surveys of volume before and after removal.

END OF SECTION 01 22 00

# SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
  - 1. Division 1 General Requirements

## 1.3 MINOR CHANGES IN THE WORK

A. Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

## 1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.
    - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
    - e. Quotation Form: Use forms acceptable to Engineer.

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- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Engineer.
  - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
  - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
  - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
  - 4. Include costs of labor and supervision directly attributable to the change.
  - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
  - 6. Proposal Request Form: Use form acceptable to the Engineer.

# 1.5 CHANGE ORDER PROCEDURES

- A. Change Order Procedures shall conform to the requirements of the General Conditions.
- B. A change in the project work that is consistent with the objective of the project and outside the scope of the project requires the execution and approval of a Change Order.
- C. On Owner's approval of a Work Changes Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on form included in the bid documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

# SECTION 01 29 00 - PAYMENT PROCEDURES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
  - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
  - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

### 1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

### 1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
  - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
    - a. Application for Payment forms with continuation sheets.
    - b. Submittal schedule.
    - c. Items required to be indicated as separate activities in Contractor's construction schedule.
  - 2. Submit the schedule of values to Engineer at earliest possible date, but no later than 14 days before the date scheduled for submittal of initial Applications for Payment.
  - 3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.

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- 4. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section where a submittal is required.
  - 1. Identification: Include the following Project identification on the schedule of values:
    - a. Project name and location.
    - b. Name of Architect.
    - c. Architect's project number.
    - d. Contractor's name and address.
    - e. Date of submittal.
  - 2. Arrange schedule of values consistent with format of Contract Documents used (EJCDC, AIA, etc.).
  - 3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
    - a. Related Specification Section or Division.
    - b. Description of the Work.
    - c. Name of subcontractor.
    - d. Name of manufacturer or fabricator.
    - e. Name of supplier.
    - f. Change Orders (numbers) that affect value.
    - g. Dollar value of the following, as a percentage of the Contract Sum to nearest onehundredth percent, adjusted to total 100 percent.
      - 1) Labor.
      - 2) Materials.
      - 3) Equipment.
  - 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
    - a. Include separate line items under contractor and principal subcontracts for Project closeout requirements in an amount totaling no less than 2.5% of the Contract Sum and subcontract amount.
  - 5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
  - 6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
    - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

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- 7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
- 8. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
- 9. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
  - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
- 10. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

# 1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by engineer and contractor and paid for by Owner.
  - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Times: Submit Application for Payment to Architect by the 25<sup>th</sup> day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
  - 1. Submit draft copy of Application for Payment five days prior to due date for review by Engineer.
- D. Application for Payment Forms: Use form consistent with Contract Documents (EJCDC, AIA, etc.) for Applications for Payment.
- E. Application for Payment Forms: Use forms provided by Owner for Applications for Payment. Sample copies are included in Project Manual.
- F. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor.
  - 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

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- 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
- 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- G. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
  - 1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
  - 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
  - 3. Provide summary documentation for stored materials indicating the following:
    - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- H. Transmittal:
  - 1. Deliverable:
    - a. Hard Copy: Submit three (3) signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
    - b. Digital: Submit one (1) signed and notarized copy of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
  - Contractor's Affidavit of Payment to Subcontractors

     Shall be submitted with each Application for Payment.
  - 3. Contractor Progress Lien Waivers Specification Section 012900A
    - a. Shall be submitted with each Application for Payment after No. 1.
  - 4. Subcontractor/Supplier Lien Waivers Specification Section 012900B
    - a. Shall be submitted with each Application for Payment after No. 1.
  - 5. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
  - 1. List of subcontractors.
  - 2. Schedule of values.
  - 3. Contractor's construction schedule (preliminary if not final).

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- 4. Products list (preliminary if not final).
- 5. List of Contractor's staff assignments.
- 6. Copies of building and other local/state permits.
- 7. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
- 8. Report of preconstruction conference.
- 9. Certificates of insurance and insurance policies.
- 10. Performance and payment bonds.
- 11. Data needed to acquire Owner's insurance.
- J. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
  - 1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
  - 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- K. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
  - 1. Evidence of completion of Project closeout requirements.
  - 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
  - 3. Updated final statement, accounting for final changes to the Contract Sum.
  - 4. "Contractor's Affidavit of Payment of Debts and Claims."
  - 5. "Contractor's Affidavit of Release of Liens."
  - 6. "Consent of Surety to Final Payment."
  - 7. Evidence that claims have been settled.
  - 8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
  - 9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

# SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Startup construction schedule.
  - 2. Contractor's construction schedule.
  - 3. Construction schedule updating reports.
  - 4. Weekly construction reports.
  - 5. Material location reports.
  - 6. Site condition reports.
  - 7. Special reports.
  - 8. Preconstruction photographs.
  - 9. Periodic construction photographs.
  - 10. Final completion construction photographs.
  - 11. Preconstruction video recordings.
  - 12. Periodic construction video recordings.
  - 13. Web-based construction photographic documentation.
- B. Related Requirements:
  - 1. Section 01 33 00 "Submittal Procedures" for submitting schedules and reports.
  - 2. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.
  - 3. Section 01 70 00 "Execution and Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.
  - 4. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
  - 1. PDF electronic file.
- B. Startup construction schedule.

- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
- D. Construction Reports: Submit, at minimum, monthly intervals.
- E. Material Location Reports: Submit at monthly intervals.
- F. Site Condition Reports: Submit at time of discovery of differing conditions.
- G. Special Reports: Submit at time of unusual event.

# PART 2 - PRODUCTS

- 2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL
  - A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
    - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
  - B. Activities: Treat each process or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
    - 1. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
    - 2. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
    - 3. Startup and Testing Time: Include no fewer than 30 for startup and testing.
    - 4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
    - 5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
  - C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
    - 1. Phasing: Arrange list of activities on schedule by phase.
    - 2. Work Restrictions: Show the effect of the following items on the schedule:
      - a. Coordination with existing construction.
      - b. Limitations of continued occupancies.
      - c. Uninterruptible services.
      - d. Partial occupancy before Substantial Completion.

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- e. Use of premises restrictions.
- f. Environmental control.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- E. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

# 2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for the Notice to Proceed. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
  - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10% percent increments within time bar.

## 2.3 REPORTS

- A. Monthly Construction Reports: Prepare a Monthly construction report recording the following information concerning events at Project site:
  - 1. List of subcontractors at Project site.
  - 2. List of separate contractors at Project site.
  - 3. Approximate count of personnel at Project site.
  - 4. Equipment at Project site.
  - 5. Material deliveries.
  - 6. High and low temperatures and general weather conditions, including presence of rain or snow.
  - 7. Accidents.
  - 8. Meetings and significant decisions.
  - 9. Unusual events (see special reports).
  - 10. Stoppages, delays, shortages, and losses.
  - 11. Emergency procedures.
  - 12. Orders and requests of authorities having jurisdiction.
  - 13. Change Orders received and implemented.
  - 14. Work Directives received and implemented.
  - 15. Services connected and disconnected.
  - 16. Equipment or system tests and startups.
  - 17. Partial completions and occupancies.
  - 18. Substantial Completions authorized.

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- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
  - 1. Material stored prior to previous report and remaining in storage.
  - 2. Material stored prior to previous report and since removed from storage and installed.
  - 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

## 2.4 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within two day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

# PART 3 - EXECUTION

### 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule two days before each regularly scheduled progress meeting.
  - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  - 2. As the Work progresses, indicate final completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

# 3.2 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

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- 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
  - 1. Date and Time: Include date and time in file name for each image.
  - 2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Engineer.
- C. Preconstruction Photographs: Before starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Engineer.
  - 1. Flag construction limits before taking construction photographs.
  - 2. Take photographs to show existing conditions adjacent to property before starting the Work.
  - 3. Take photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
  - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Periodic Construction Photographs: Take photographs at necessary intervals with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- E. Engineer-Directed Construction Photographs: From time to time, Engineer will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.
- F. Final Completion Construction Photographs: Take color photographs after date of Substantial Completion for submission as project record documents. Retain subparagraph below if date stamp is not required.
  - 1. Do not include date stamp.

END OF SECTION 01 32 00

# SECTION 01 33 00 - SUBMITTAL PROCEDURES

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
  - 1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
  - 2. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
  - 3. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
  - 4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
  - 5. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

### 1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

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## 1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.
  - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
  - 2. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
    - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
  - 3. Format: Arrange the following information in a tabular format:
    - a. Scheduled date for submittal.
    - b. Specification Section number and title.
    - c. Submittal category: Action; informational.
    - d. Name of subcontractor.
    - e. Description of the Work covered.
    - f. Scheduled date for Engineer's final release or approval.
    - g. Scheduled date of fabrication.
- B. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.
  - 1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and record documents.
    - a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
    - b. Digital Drawing Software Program: The Contract Drawings are available in Revit and CAD files.
- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  - 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

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- a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
  - 1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  - 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  - 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
  - 4. Sequential Review: Where sequential review of submittals by Engineer's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
- E. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
  - 1. Indicate name of firm or entity that prepared each submittal on label or title block.
  - 2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
  - 3. Include the following information for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name of Engineer.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Name of subcontractor.
    - g. Name of supplier.
    - h. Name of manufacturer.
    - i. Submittal number or other unique identifier, including revision identifier.
      - 1) Submittal number shall use Specification Section number followed by a decimal and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
    - j. Number and title of appropriate Specification Section.
    - k. Drawing number and detail references, as appropriate.
    - 1. Location(s) where product is to be installed, as appropriate.
    - m. Other necessary identification.
  - 4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
    - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.

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- 5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form.
  - a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
    - 1) Project name.
    - 2) Date.
    - 3) Destination (To:).
    - 4) Source (From:).
    - 5) Name and address of Engineer.
    - 6) Name of Construction Manager.
    - 7) Name of Contractor.
    - 8) Name of firm or entity that prepared submittal.
    - 9) Names of subcontractor, manufacturer, and supplier.
    - 10) Category and type of submittal.
    - 11) Submittal purpose and description.
    - 12) Specification Section number and title.
    - 13) Specification paragraph number or drawing designation and generic name for each of multiple items.
    - 14) Drawing number and detail references, as appropriate.
    - 15) Indication of full or partial submittal.
    - 16) Transmittal number
    - 17) Submittal and transmittal distribution record.
    - 18) Remarks.
    - 19) Signature of transmitter.
- F. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
  - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
  - 2. Name file with submittal number or other unique identifier, including revision identifier.
    - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
  - 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
  - 4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Name of firm or entity that prepared submittal.

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- g. Names of subcontractor, manufacturer, and supplier.
- h. Category and type of submittal.
- i. Submittal purpose and description.
- j. Specification Section number and title.
- k. Specification paragraph number or drawing designation and generic name for each of multiple items.
- 1. Drawing number and detail references, as appropriate.
- m. Location(s) where product is to be installed, as appropriate.
- n. Related physical samples submitted directly.
- o. Indication of full or partial submittal.
- p. Transmittal number.
- q. Submittal and transmittal distribution record.
- r. Other necessary identification.
- s. Remarks.
- 5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
  - a. Project name.
  - b. Number and title of appropriate Specification Section.
  - c. Manufacturer name.
  - d. Product name.
- G. Options: Identify options requiring selection by Engineer.
- H. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- I. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
  - 1. Note date and content of previous submittal.
  - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  - 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
- J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- K. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

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### 1.5 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
  - 1. Submit electronic submittals via email as PDF electronic files.
    - a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
  - 2. Action Submittals: Submit one paper copies of each submittal unless otherwise indicated. Engineer will not return copies.
  - 3. Informational Submittals: Submit one paper copies of each submittal unless otherwise indicated. Engineer will not return copies.
  - 4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
    - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  - 4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams showing factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  - 5. Submit Product Data before or concurrent with Samples.
  - 6. Submit Product Data in the following format:

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- a. PDF electronic file.
- b. One paper copies of Product Data unless otherwise indicated. Engineer will not return paper copies.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Engineer's digital data drawing files is otherwise permitted.
  - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
  - 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
  - 3. Submit Shop Drawings in the following format:
    - a. PDF electronic file.
    - b. One opaque (bond) copies of each submittal.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
  - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  - 2. Identification: Attach label on unexposed side of Samples that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of manufacturer.
    - c. Sample source.
    - d. Number and title of applicable Specification Section.
    - e. Specification paragraph number and generic name of each item.
  - 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
  - 4. Disposition: Maintain sets of approved Samples at Project site, available for qualitycontrol comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.

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- b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- 5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  - a. Number of Samples: Submit 1 set of samples to the Engineer and Owner for review.
    - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
    - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- F. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- G. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017000 "Execution and Closeout Procedures."
- J. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.
- L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

- M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - 1. Name of evaluation organization.
  - 2. Date of evaluation.
  - 3. Time period when report is in effect.
  - 4. Product and manufacturers' names.
  - 5. Description of product.
  - 6. Test procedures and results.
  - 7. Limitations of use.
- T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- V. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- W. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads.

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Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

### 1.6 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

# PART 2 - PRODUCTS (NOT USED)

# PART 3 - EXECUTION

# 3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017000 "Execution and Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

## 3.2 ENGINEER'S ACTION

A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

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- B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 01 33 00

## SECTION 01 40 00 - QUALITY REQUIREMENTS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

# A. Section includes:

- 1. Quality control.
- 2. Testing and inspection services.
- 3. Manufacturers' field services.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
  - 2. Specified tests, inspections, and related actions do not limit Contractor's other qualityassurance and -control procedures that facilitate compliance with the Contract Document requirements.
  - 3. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
  - 4. Specific test and inspection requirements are not specified in this Section.

### 1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

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- D. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- E. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
  - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- I. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

# 1.4 INSPECTION AND TESTING LABORATORY SERVICES

- A. Owner will employ and pay for the services of a Resident Project Representative (RPR)
- B. Owner will employ and pay for the services of an independent testing laboratory to perform all specified services and testing related to the design of mixes, products and equipment, to Engineer's review of proposed materials and equipment before, during and after incorporation in the Work and to retest materials and equipment which fail original tests.
  - 1. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the Work of the Contract.
  - 2. Retesting or re-inspection required because of nonconformance with specified or indicated requirements shall be performed by same independent firm on instructions from Engineer. Payment for retesting or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

# 1.5 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

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### 1.6 ACTION SUBMITTALS

1. Indicate manufacturer and model number of individual components.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
  - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Engineer.
  - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Engineer.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
  - 1. Specification Section number and title.
  - 2. Entity responsible for performing tests and inspections.
  - 3. Description of test and inspection.
  - 4. Identification of applicable standards.
  - 5. Identification of test and inspection methods.
  - 6. Number of tests and inspections required.
  - 7. Time schedule or time span for tests and inspections.
  - 8. Requirements for obtaining samples.
  - 9. Unique characteristics of each quality-control service.

# 1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

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- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
  - 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
  - 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
  - 3. Owner-performed tests and inspections indicated in the Contract Document.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

# 1.9 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address, and telephone number of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making tests and inspections.
  - 6. Description of the Work and test and inspection method.
  - 7. Identification of product and Specification Section.
  - 8. Complete test or inspection data.
  - 9. Test and inspection results and an interpretation of test results.
  - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
  - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  - 12. Name and signature of laboratory inspector.
  - 13. Recommendations on retesting and reinspection.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

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- 1. Name, address, and telephone number of technical representative making report.
- 2. Statement on condition of substrates and their acceptability for installation of product.
- 3. Statement that products at Project site comply with requirements.
- 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
- 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
- 6. Statement whether conditions, products, and installation will affect warranty.
- 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
  - 1. Name, address, and telephone number of factory-authorized service representative making report.
  - 2. Statement that equipment complies with requirements.
  - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  - 4. Statement whether conditions, products, and installation will affect warranty.
  - 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

# 1.10 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

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- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
  - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
  - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
  - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
  - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  - 3. Notify testing agencies at least 48 hours in advance of time when Work that requires testing or inspecting will be performed.
  - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  - 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  - 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- K. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including

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service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

- L. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- M. Retesting/Reinspection: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspection, for construction that replaced Work that failed to comply with the Contract Documents.
- N. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
  - 1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  - 6. Do not perform any duties of Contractor.
- O. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
- P. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- Q. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar qualitycontrol services required by the Contract Documents as a component of Contractor's quality-

control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
  - 1. Date test or inspection was conducted.
  - 2. Description of the Work tested or inspected.
  - 3. Date test or inspection results were transmitted to Engineer.
  - 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

## 3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 70 00 "Execution and Closeout Requirements."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00
# SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
  - 1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

## 1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to Engineer, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Sewer service use charges shall be by the Contractor utilizing portable facilities.
- C. Water Service: Water-service use charges for water used by all entities for construction operations shall be by the Contractor.
- D. Electric Power Service: Electric-power-service use charges for electricity used by all entities for construction operations shall be by the Contractor.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction (DHEC), whichever is more stringent.
- C. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.

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- 1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
- 2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
- 3. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

# 1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

## 1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

# PART 2 - PRODUCTS

# 2.1 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Engineer and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
  - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
  - 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4 foot square tack and marker boards.
  - 3. Drinking water and private toilet.
  - 4. Coffee machine and supplies.
  - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
  - 6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

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- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
  - 1. Store combustible materials apart from building.

## 2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
  - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with fourstage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

# 3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
  - 1. Connect temporary sewers to system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

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- E. Heating and Cooling Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
  - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
    - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
    - b. Maintain negative air pressure within work area using HEPA-equipped airfiltration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
  - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dustproducing equipment. Isolate limited work within occupied areas using portable dustcontainment devices.
  - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filterequipped vacuum equipment.
- G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
  - 1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- H. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
  - 1. Install electric power service overhead or underground or as indicated.
- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- J. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel.
  - 1. At each telephone, post a list of important telephone numbers.
    - a. Police and fire departments.
    - b. Ambulance service.
    - c. Contractor's home office.

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- d. Contractor's emergency after-hours telephone number.
- e. Engineer's office.
- f. Engineers' offices.
- g. Owner's office.
- h. Principal subcontractors' field and home offices.
- 2. Provide superintendent with cellular telephone for use when away from field office.

# 3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
  - 1. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Final Completion.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
  - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
  - 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
  - 2. Prepare subgrade and install subbase and base for temporary roads.
  - 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
  - 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Section 32 12 16 "Asphalt Paving."
- D. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
  - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- E. Parking: Provide temporary parking areas for construction personnel.
- F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted. Subcontractors are not authorized to have signage.
  - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
  - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

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- a. Provide temporary construction signs as required by funding agencies.
- b. Provide temporary, directional signs for construction personnel and visitors.
- 3. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 70 00 "Execution and Closeout Requirements."
- H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
- I. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
  - 1. Do not load elevators beyond their rated weight capacity.
  - 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
- J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- K. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
  - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.
- L. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

# 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

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- 1. Comply with work restrictions specified in Section 01 10 00 "Summary."
- C. Temporary Erosion and Sedimentation Control: Comply with authorities having jurisdiction, and requirements specified in Section 31 25 00 "Erosion and Sedimentation Controls."
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.
- F. Site Enclosure Fence: Before construction operations begin furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
  - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
- G. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- I. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- J. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
  - 2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
  - 3. Insulate partitions to control noise transmission to occupied areas.
  - 4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
  - 5. Protect air-handling equipment.
  - 6. Provide walk-off mats at each entrance through temporary partition.

# 3.5 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

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- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
  - 1. Protect porous materials from water damage.
  - 2. Protect stored and installed material from flowing or standing water.
  - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
  - 4. Remove standing water from decks.
  - 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
  - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
  - 2. Keep interior spaces reasonably clean and protected from water damage.
  - 3. Periodically collect and remove waste containing cellulose or other organic matter.
  - 4. Discard or replace water-damaged material.
  - 5. Do not install material that is wet.
  - 6. Discard, replace, or clean stored or installed material that begins to grow mold.
  - 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
  - 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
  - 2. Use permanent HVAC system to control humidity.
  - 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
    - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
    - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Engineer.
    - c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

# 3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Maintenance: Maintain facilities in good operating condition until removal.
  - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

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- B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
  - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
  - 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 70 00 "Execution and Closeout Requirements."

END OF SECTION 01 50 00

## SECTION 01 60 00 - PRODUCT REQUIREMENTS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

## 1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

## 1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

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- 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
- 2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
  - a. Form of Approval: As specified in Section 01 33 00 "Submittal Procedures."
  - b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

# 1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.
  - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

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- 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
- 6. Protect stored products from damage and liquids from freezing.

## 1.7 PRODUCT WARRANTIES

A. Warranty requirements shall conform with the General Conditions followed by Specification Section 01 10 00.

## 1.8 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
  - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  - 4. Where products are accompanied by the term "as selected," Engineer will make selection.
  - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
  - 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
  - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - 3. Products:
    - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.
  - 4. Manufacturers:
    - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with

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requirements. Comparable products or substitutions for Contractor's convenience will be considered,

- 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

# 1.9 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:
  - 1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  - 3. Evidence that proposed product provides specified warranty.
  - 4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
  - 5. Samples, if requested.
  - 6. The Contractor shall also include in the price bid the modifications necessary for the comparable product to be utilized. This includes but is not limited to, electrical and mechanical changes, engineering time to assess the changes, modifications to buildings, programmable controls and structural modifications.

PART 2 - EXECUTION (Not Used)

END OF SECTION 01 60 00

## SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section includes:
  - 1. Field engineering.
  - 2. Closeout procedures.
  - 3. Starting of systems.
  - 4. Demonstration and instructions.
  - 5. Testing, adjusting, and balancing.
  - 6. Project record documents.
  - 7. Operation and maintenance data.
  - 8. Manual for materials and finishes.
  - 9. Manual for equipment and systems.
  - 10. Spare parts and maintenance products.
  - 11. Product warranties and product bonds.
  - 12. Examination.
  - 13. Preparation.
  - 14. Execution.
  - 15. Cutting and patching.
  - 16. Protecting installed construction.
  - 17. Final cleaning.
- B. Related Requirements:
  - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
  - 2. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.

# 1.2 FIELD ENGINEERING

- A. Employ land surveyor registered in state of South Carolina acceptable to Engineer.
- B. Locate protect survey control and reference points. Promptly notify Architect/Engineer of discrepancies discovered.
- C. Control datum for survey is indicated on Drawings.
- D. Verify setbacks and easements; confirm Drawing dimensions and elevations.
- E. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.
- F. Submit copy of certificate signed by land surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

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- G. On completion of foundation walls and major Site improvements, prepare certified survey illustrating dimensions, locations, angles, and elevations of construction and site work
- H. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.
- I. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect/Engineer.

# 1.3 CLOSEOUT PROCEDURES

- A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:
  - 1. Submit operation and maintenance manuals, Project record documents, and other similar final record data in compliance with this Section.
  - 2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
  - 3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
  - 4. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
  - 5. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
  - 6. Make final change-over of locks and transmit keys directly to Owner. Advise Owner's personnel of change-over in security provisions.
  - 7. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
  - 8. Perform final cleaning according to this Section.
- B. Substantial Completion Inspection:
  - 1. When Contractor considers Work to be substantially complete, submit to Engineer:
    - a. Written certificate that Work, or designated portion, is substantially complete.
    - b. List of items to be completed or corrected (initial punch list).
  - 2. Within seven days after receipt of request for Substantial Completion, Engineer will make inspection to determine whether Work or designated portion is substantially complete.
  - 3. Should Engineer determine that Work is not substantially complete:
    - a. Engineer will promptly notify Contractor in writing, stating reasons for its opinion.
    - b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Engineer.
    - c. Engineer will re-inspect Work.

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- d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer and Owner's inspection.
- 4. When Engineer finds that Work is substantially complete, Engineer will:
  - a. Prepare Certificate of Substantial Completion on EJCDC C-625 Certificate of Substantial Completion accompanied by Contractor's list of items to be completed or corrected as verified and amended by Architect/Engineer and Owner (final punch list).
  - b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.
- 5. After Work is substantially complete, Contractor shall:
  - a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
  - b. Complete Work listed for completion or correction within time period stipulated.
- C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.
  - 1. When Contractor considers Work to be complete, submit written certification that:
    - a. Contract Documents have been reviewed.
    - b. Work has been examined for compliance with Contract Documents.
    - c. Work has been completed according to Contract Documents.
    - d. Work is completed and ready for final inspection.
  - 2. Submittals: Submit following:
    - a. Final punch list indicating all items have been completed or corrected.
    - b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
    - c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
    - d. Accounting statement for final changes to Contract Sum.
    - e. Contractor's affidavit of payment of debts.
    - f. Contractor affidavit of release of liens.
    - g. Consent of surety to final payment.
  - 3. Perform final cleaning for Contractor-soiled areas according to this Section.
- D. Final Completion Inspection:
  - 1. Within seven days after receipt of request for final inspection, Owner and Engineer will make inspection to determine whether Work or designated portion is complete.
  - 2. Should Engineer consider Work to be incomplete or defective:
    - a. Engineer will promptly notify Contractor in writing, listing incomplete or defective Work.

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- b. Contractor shall remedy stated deficiencies and send second written request to Work is complete.
- c. Engineer will re-inspect Work.
- d. Redo and Inspection of Deficient Work: Repeated until Work passes inspection.

# 1.4 STARTING OF SYSTEMS

- A. Coordinate schedule for startup of various equipment and systems.
- B. Notify Engineer and owner seven days prior to startup of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to manufacturer's instructions.
- G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.
- H. Submit a written report that equipment or system has been properly installed and is functioning correctly, as well as a certificate/field report from the manufacturer from his inspection of the installation.

# 1.5 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel as equipment becomes available for use and not later than 14 days prior to date of Substantial Completion.
- B. Demonstrate Project equipment and instruct in classroom environment located at the facility. Class shall be instructed by qualified manufacturer's representative who is knowledgeable about the Project.
- C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at designated location.
- E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

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## 1.6 TESTING, ADJUSTING, AND BALANCING

- A. Contractor with Engineer approval will appoint and employ services of independent firm to perform testing, adjusting, and balancing. Contractor shall pay for services.
- B. Reports will be submitted by independent firm to Architect/Engineer indicating observations and results of tests and indicating compliance or noncompliance with requirements of Contract Documents.

# 1.7 PROJECT RECORD DOCUMENTS

- A. Maintain on Site one set of the following record documents; record actual revisions to the Work:
  - 1. Drawings.
  - 2. Specifications.
  - 3. Addenda.
  - 4. Change Orders and other modifications to the Contract.
  - 5. Reviewed Shop Drawings, product data, and Samples.
  - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:
  - 1. Manufacturer's name and product model and number.
  - 2. Product substitutions or alternates used.
  - 3. Changes made by Addenda and modifications.
- F. Record Drawings: Legibly mark each item to record actual construction as follows:
  - 1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
  - 2. Include locations of concealed elements of the Work.
  - 3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
  - 4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
  - 5. Identify and locate existing buried or concealed items encountered during Project.
  - 6. Measured depths of foundations in relation to finish floor datum.
  - 7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - 8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
  - 9. Field changes of dimension and detail.

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- 10. Details not on original Drawings.
- G. Submit marked-up paper copy documents to Architect/Engineer with claim for final Application for Payment.

## 1.8 OPERATION AND MAINTENANCE DATA

- A. See Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manuals.
- PART 2 PRODUCTS Not Used

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual Specification Sections.
- D. Verify that utility services are available with correct characteristics and in correct locations.

# 3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

#### 3.3 EXECUTION

- A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until completion of construction.
- B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

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- C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.
- D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
  - 1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
  - 2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
  - 3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Architect/Engineer for final decision.
- E. Allow for expansion of materials and building movement.
- F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.
  - 1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
  - 2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.
- G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.
  - 1. Refer questionable mounting heights choices to Architect/Engineer for final decision.
  - 2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.
- H. Adjust operating products and equipment to ensure smooth and unhindered operation.
- I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

# 3.4 CUTTING AND PATCHING

- A. Employ skilled and experienced installers to perform cutting and patching.
- B. Submit written request in advance of cutting or altering elements affecting:
  - 1. Structural integrity of element.
  - 2. Integrity of weather-exposed or moisture-resistant elements.
  - 3. Efficiency, maintenance, or safety of element.
  - 4. Visual qualities of sight-exposed elements.
  - 5. Work of Owner or separate contractor.
- C. Execute cutting, fitting, and patching including excavation and fill to complete Work and to:
  - 1. Fit the several parts together, to integrate with other Work.
  - 2. Uncover Work to install or correct ill-timed Work.

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- 3. Remove and replace defective and nonconforming Work.
- 4. Remove samples of installed Work for testing.
- 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.
- E. Cut masonry and concrete materials using masonry saw or core drill.
- F. Restore Work with new products according to requirements of Contract Documents.
- G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
- H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- I. At penetrations of fire-rated walls, partitions, ceiling, or floor construction, completely seal voids with fire-rated material to full thickness of penetrated element.
- J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.
- K. Identify hazardous substances or conditions exposed during the Work to Architect/Engineer for decision or remedy.

# 3.5 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual Specification Sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

# 3.6 FINAL CLEANING

- A. Execute final cleaning prior to final Project assessment.
  - 1. Employ experienced personnel or professional cleaning firm.

- B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces, and vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.
- D. Clean filters of operating equipment.
- E. Clean debris from roofs, gutters, downspouts, and drainage systems.
- F. Clean Site; sweep paved areas, rake clean landscaped surfaces.
- G. Remove waste and surplus materials, rubbish, and construction facilities from Site.

END OF SECTION 01 70 00

# SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory.
  - 2. Emergency manuals.
  - 3. Operation manuals for systems, subsystems, and equipment.
  - 4. Product maintenance manuals.
  - 5. Systems and equipment maintenance manuals.
- B. Related Requirements:
  - 1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

#### 1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
  - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.

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- a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
- b. Enable inserted reviewer comments on draft submittals.
- 2. Two paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.
  - 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.

# PART 2 - PRODUCTS

# 2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
  - 1. List of documents.
  - 2. List of systems.
  - 3. List of equipment.
  - 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

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## 2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  - 1. Title page.
  - 2. Table of contents.
  - 3. Manual contents.
- B. Title Page: Include the following information:
  - 1. Subject matter included in manual.
  - 2. Name and address of Project.
  - 3. Name and address of Owner.
  - 4. Date of submittal.
  - 5. Name and contact information for Contractor.
  - 6. Name and contact information for Construction Manager.
  - 7. Name and contact information for Engineer.
  - 8. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
  - 9. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
  - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
  - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
  - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

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- 1. Binders: Heavy-duty, three-ring, vinyl-covered, binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch and 11 x 17 paper (Z folded); with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
  - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary, to provide essential information for proper operation or maintenance of equipment or system.
  - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
- 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
- 3. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
  - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
  - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

# 2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
  - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  - 2. Performance and design criteria if Contractor has delegated design responsibility.
  - 3. Operating standards.
  - 4. Operating procedures.
  - 5. Operating logs.
  - 6. Wiring diagrams.
  - 7. Control diagrams.
  - 8. Piped system diagrams.
  - 9. Precautions against improper use.
  - 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
  - 1. Product name and model number. Use designations for products indicated on Contract Documents.
  - 2. Manufacturer's name.
  - 3. Equipment identification with serial number of each component.

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- 4. Equipment function.
- 5. Operating characteristics.
- 6. Limiting conditions.
- 7. Performance curves.
- 8. Engineering data and tests.
- 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
  - 1. Startup procedures.
  - 2. Equipment or system break-in procedures.
  - 3. Routine and normal operating instructions.
  - 4. Regulation and control procedures.
  - 5. Instructions on stopping.
  - 6. Normal shutdown instructions.
  - 7. Seasonal and weekend operating instructions.
  - 8. Required sequences for electric or electronic systems.
  - 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

# 2.4 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
  - 1. Inspection procedures.
  - 2. Types of cleaning agents to be used and methods of cleaning.
  - 3. List of cleaning agents and methods of cleaning detrimental to product.

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- 4. Schedule for routine cleaning and maintenance.
- 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 1. Include procedures to follow and required notifications for warranty claims.

# 2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
  - 1. Standard maintenance instructions and bulletins.
  - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  - 3. Identification and nomenclature of parts and components.
  - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
  - 1. Test and inspection instructions.
  - 2. Troubleshooting guide.
  - 3. Precautions against improper maintenance.
  - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - 5. Aligning, adjusting, and checking instructions.
  - 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
  - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.

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- 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 1. Include procedures to follow and required notifications for warranty claims.

# PART 3 - EXECUTION

## 3.1 MANUAL PREPARATION

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
  - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
  - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
  - 1. Do not use original project record documents as part of operation and maintenance manuals.

## BEAUFORT JASPER WATER AND SEWER AUTHORITY

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- PURRYSBURG, SOUTH CAROLINA
- 2. Comply with requirements of newly prepared record Drawings in Section 01 78 n39 "Project Record Documents."
- E. Comply with Section 01 70 00 "Execution and Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

## SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
  - 4. Miscellaneous record submittals.
- B. Related Requirements:
  - 1. Section 01 70 00 "Execution and Closeout Procedures" for general closeout procedures.
  - 2. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit one set(s) of marked-up record prints.
  - 2. Number of Copies: Submit copies of record Drawings as follows:
    - a. Final Submittal:
      - 1) Submit one paper-copy set(s) of marked-up record prints.
      - 2) Submit PDF electronic files of scanned record prints and one set(s) of prints.
      - 3) Print each drawing, whether or not changes and additional information were recorded.
- B. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous recordkeeping requirements and submittals in connection with various construction activities.

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## PART 2 - PRODUCTS

# 2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued. Contractor shall maintain a set of marked up prints on the job site for review prior to pay request approval.
  - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.
    - c. Record data as soon as possible after obtaining it.
    - d. Record and check the markup before enclosing concealed installations.
    - e. Cross-reference record prints to corresponding archive photographic documentation.
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations below first floor.
    - d. Locations and depths of underground utilities.
    - e. Revisions to routing of piping and conduits.
    - f. Revisions to electrical circuitry.
    - g. Actual equipment locations.
    - h. Duct size and routing.
    - i. Locations of concealed internal utilities.
    - j. Changes made by Change Order or Work Change Directive.
    - k. Changes made following Engineer's written orders.
    - 1. Details not on the original Contract Drawings.
    - m. Field records for variable and concealed conditions.
    - n. Record information on the Work that is shown only schematically.
  - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
  - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

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- 1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
- 2. Format: Annotated PDF electronic file with comment function enabled.
- 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
- 4. Identification: As follows:
  - a. Project name.
  - b. Date.
  - c. Designation "PROJECT RECORD DRAWINGS."
  - d. Name of Engineer.
  - e. Name of Contractor.

## 2.2 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.
  - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

# PART 3 - EXECUTION

### 3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

END OF SECTION 01 78 39

## SECTION 01 79 00 - DEMONSTRATION AND TRAINING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
  - 1. Demonstration of operation of systems, subsystems, and equipment.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. Furnish demonstration and training instruction time as a subsidiary obligation of the price bid.

### 1.3 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training.

# 1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Engineer.

PURRYSBURG, SOUTH CAROLINA

## PART 2 - PRODUCTS

# 2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  - 2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Operations manuals.
    - c. Maintenance manuals.
    - d. Project record documents.
    - e. Identification systems.
    - f. Warranties and bonds.
    - g. Maintenance service agreements and similar continuing commitments.
  - 3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.
    - c. Shutdown instructions for each type of emergency.
    - d. Operating instructions for conditions outside of normal operating limits.
    - e. Sequences for electric or electronic systems.
    - f. Special operating instructions and procedures.
  - 4. Operations: Include the following, as applicable:
    - a. Startup procedures.
    - b. Equipment or system break-in procedures.
    - c. Routine and normal operating instructions.
    - d. Regulation and control procedures.
    - e. Control sequences.

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- f. Safety procedures.
- g. Instructions on stopping.
- h. Normal shutdown instructions.
- i. Operating procedures for emergencies.
- j. Operating procedures for system, subsystem, or equipment failure.
- k. Seasonal and weekend operating instructions.
- 1. Required sequences for electric or electronic systems.
- m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
  - a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.

# PART 3 - EXECUTION

# 3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.
#### PURRYSBURG WTP

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#### 3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
  - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
  - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Schedule training with Owner, through Engineer with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Cleanup: Restore systems and equipment to condition existing before initial training use.

#### END OF SECTION 01 79 00

#### **EXPANSION TO 30 MGD-PHASE I**

PURRYSBURG, SOUTH CAROLINA

#### SECTION 018100 – GEOTECHNICAL DATA

PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

A. Report of explorations and tests of subsurface conditions at the site.

#### 1.2 RELATED SECTION

- A. Section 312000 Earth Moving
- B. Section 312319 Dewatering

#### 1.3 INVESTIGATION

- A. Soil and subsurface investigations were conducted at the site, the results of which are to be found in the report titled "Report of Geotechnical Exploration" issued by Goodwyn, Mills and Cawood (GMC)., dated April 30, 2019 GMC Project Number GGRE180005.
- B. The GMC Geotechnical Report provides Owner's information for Bidders' convenience and is intended to supplement rather than serve in lieu of Bidders' own investigations. It is made available for Bidders' convenience and information, but is not a warranty of existing conditions.
- C. Bidders are urged to examine soils investigation data and to make their own investigation of the site before bidding.

#### 1.4 INTERPRETATION

- A. Soil investigation data is provided only for information and the convenience of bidders.
- B. Owner and Engineer disclaim all responsibility for the accuracy, true location, and extent of the soils investigation that has been prepared by others. They further disclaim responsibility for interpretations of that data by bidders, as in projecting soil-bearing values, rock profiles, soil stability and the presence, level, and extent of underground water.
- C. Owner and Engineer disclaim all responsibility for the existence of other soil and subsurface investigations previously prepared for Owner, Engineer, or others. It is the sole responsibility of the Bidder to obtain other soil and subsurface investigations that may be available for interpretation, at no additional cost to the Owner.
- D. Bidders are urged to examine Report Limitations of the GMC Geotechnical Report that addresses the purpose, basis, and warranties relevant to that report.

#### EXPANSION TO 30 MGD-PHASE I

PURRYSBURG, SOUTH CAROLINA

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 018100

### PURRYSBURG WATER TREATMENT PLANT IMPROVEMENTS

Purrysburg, Jasper County, South Carolina

April 30, 2019

REPORT OF GEOTECHNICAL EXPLORATION

Prepared By



Goodwyn, Mills and Cawood, Inc. 101 East Washington Street Suite 200 Greenville, SC 29601 T: 864.527.0460 www.gmcnetwork.com

**GMC PROJECT NUMBER:** GGRE180005



Goodwyn Mills Cawood April 30, 2019

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T (864) 527-0460

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Mr. Jim Vaughn Goodwyn, Mills and Cawood, Inc. 35 Abercorn Street Suite 210 Savannah, GA 31401

RE:

#### REPORT OF GEOTECHNICAL EXPLORATION PURRYSBURG WTP IMPROVEMENTS PURRYSBURG, JASPER COUNTY, SOUTH CAROLINA GMC PROJECT NO. GGRE180005

Dear Mr. Vaughn,

Goodwyn, Mills and Cawood, Inc. (Geotechnical & Construction Services Division) is pleased to provide this report of geotechnical exploration performed for the above referenced project. This report includes the results of field and laboratory testing, general site preparation recommendations based on specific site conditions, and recommendations for foundation design.

We appreciate the opportunity to perform this study on this phase of the project for you and look forward to continued participation during the construction phase of this project. If you have any questions pertaining to this report, or if we may be of further service, please do not hesitate to call us.

Sincerely,

GOODWYN, MILLS, AND CAWOOD, INC.

enh W. Walos

Kevin W. Wales Executive Vice President

Michael J. McNeill Senior Geotechnical Professional

Cc: Mr. Mitch Freeman, PE – GMC Mr. Jim Vaughn, PE – GMC Mr. Tony Reid, PE - GMC





stiller,

Patrick O'Leary, PE Project Engineer Licensed South Carolina





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APPENDIX: Site Location Map Boring Location Plan Subsurface Diagrams Soil Classification Chart Boring Records Summary of Laboratory Results Liquefaction Analysis Field and Laboratory Procedures

#### **1.0** PROJECT INFORMATION AND SCOPE OF WORK

#### 1.1 Existing Site

A geotechnical exploration has been conducted for the proposed improvements at the Purrysburg Water Treatment Plant (WTP) on Purrysburg Road in Purrysburg, SC. The project area for the improvements will generally be in the east and south portion of the existing WTP. The project area currently consists of open areas of grass and bare earth.



View of site on January 4, 2019

#### 1.2 Planned Construction

The proposed construction will consist of the following structures:

- A PAC contactor tank approximately 31' x 62' with 24' tall walls (maximum 22' water height) bearing at or near existing grade
- A static mix basin attached to the PAC
- Flocculation/sedimentation basins at or near existing grade, matching the existing structures
- Filters with a bearing depth approximately 5 to 10 feet below grade, matching the existing structures
- An expansion to the control building
- A 140-foot diameter above ground clearwell

At the time this report was prepared, no structural loading information was available. Based on our experience with similar types of structures, we anticipate area loading to be less than 3 kips per square foot, and wall loads to be less than 2 kips per linear foot.

GMC was provided with previous geotechnical reports for the plant site for our review and information:

- Geotechnical Investigation Purrysburg WTP dated 11/26/01 by Geo-Systems Design & Testing, Inc.
- Geotechnical Investigation 250,000 Gallon Elevated Water Tank dated 5/24/02 by Geo-Systems Design & Testing, Inc.

#### 1.3 Scope of Work

The purpose of this exploration was to characterize the subsurface soil conditions at the site, and to provide the following:

- A brief summary of our test procedures and the results of all field and laboratory testing
- A review of the site conditions and geologic setting
- A review of subsurface soil stratigraphy including the individual Boring Records, Subsurface Diagrams, and a Boring Location Plan
- General recommendations for site preparation, excavation considerations, preparation of existing soils for proposed construction activities, and construction of compacted fills
- Information regarding groundwater conditions, along with recommendations for controlling groundwater in excavations during construction
- Soil liquefaction potential/considerations
- IBC seismic site class
- Design and construction recommendations for foundations, including foundation bearing capacities, bearing depths, and installation recommendations
- Estimated settlements
- Lateral earth pressure parameters
- Recommendations for design and construction of concrete slabs-on-grade

The scope of services for the geotechnical exploration did not include any environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements, if any, in this report or on the boring records regarding odors, colors, or unusual or suspicious items or conditions are strictly for the information of the client.

#### 2.0 FIELD EXPLORATION AND LABORATORY TESTING

#### 2.1 Field Exploration

The site subsurface conditions were explored by drilling a total of nine (9) soil test borings to depths ranging from 46 to 100 feet below existing ground surface at the approximate locations shown in Figure 1 below and on the Boring Location Plan in the Appendix. The borings had a planned termination depth of 50 feet, except for boring B-7, which had a planned termination depth of 100 feet. The boring locations were selected by GMC and were located in the field by GMC personnel estimating distances from existing structures. The ground surface elevations shown on the boring records were approximated from previous borings drilled at the site near the approximate locations of GMC's borings and are considered approximate. Field-testing employed by GMC was in general accordance with ASTM standards or generally accepted methods. The borings, structural areas, and termination or auger refusal depths are in the following table.

Boring No.	Structure	Termination or Auger Refusal (AR) Depth (feet)
B-1, B-2	PAC contactor tank	50
B-3	Flocculation/sedimentation basins	50
B-4	Flocculation/sedimentation basins	50
B-5	Filters	50
B-6	Control building expansion	50
B-7	Clearwell	100
B-8	Clearwell	47 (AR)
B-9	Clearwell	46 (AR)



Figure 1: Approximate Boring Locations on Google Earth Aerial Imagery date 3/12/2018

The borings were performed between January 17<sup>th</sup> and February 8<sup>th</sup>, 2019, using a truck-mounted drill rig equipped with a rotary head and mud rotary drilling methods. Soils were sampled using a two-inch outside diameter split barrel sampler driven with an automatic hammer. Split-spoon sampling and standard penetration testing were conducted at standard intervals in the borings. The retrieved samples were identified according to project number, boring number and depth, and were placed in polyethylene plastic bags to protect against moisture loss. Bulk soil samples were collected from auger cuttings within the upper 10 feet of the ground surface at borings B-1 and B-4. Two (2) undisturbed Shelby (UD) tube samples were attempted but the soil sample slid out of the tube during retrieval. Soil sampling and drilling was performed in general accordance with the procedures for "Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM 1586) and corrected to N<sub>60</sub> values based on the energy efficiency of the hammer.

#### 2.2 Laboratory Analyses

The laboratory-testing program included visual classification of all soil samples and laboratory testing of selected samples. Grain size analyses, Atterberg limits, and natural moisture content tests were performed on selected splitspoon samples and the bulk samples. In addition, two (2) modified Proctor tests were performed on the bulk samples. The triaxial shear testing and one-dimensional consolidation testing proposed for the UD tubes were not performed due to the UD tubes not able to be collected. The laboratory-testing program was conducted in general accordance with applicable ASTM standards and the results are summarized in the Appendix.



#### **3.0 SUBSURFACE CONDITIONS**

#### 3.1 Site Geology

Published geologic information indicates that the site is underlain by the Coastal Plain Unit. The Coastal Plain Unit is bounded on the west by the Piedmont Unit. The common boundary between the Piedmont Unit and the Coastal Plain Unit is the "Fall Line". The Coastal Plain Unit is a compilation of wedge-shaped formations that begin at the "Fall Line" and dip towards the Atlantic Ocean with ground surface elevations typically less than 300 feet. The Coastal Plain is underlain by Mesozoic/Paleozoic basement rock. This wedge of sediment is comprised of numerous geologic formations that range in age from late Cretaceous period to Recent. The sedimentary soils of these formations consist of unconsolidated sand, clay, gravel, marl, cemented sands, and limestone that were deposited over the basement rock. The marl and limestone are considered in geotechnical engineering as an IGM. The basement rock consists of granite, schist, and gneiss similar to the rocks of the Piedmont Unit. The thickness of the Coastal Plain sediments varies from zero at the "Fall Line" to more than 4,000 feet at the southern tip of South Carolina near Hilton Head Island. The thickness of the Coastal Plain sediments along the Atlantic coast varies from ~1300 feet at Myrtle Beach to ~4000 feet at Hilton Head Island.

The area is formed of older, generally well-consolidated layers of sands, silts, or clays that were deposited by marine or fluvial action during a period of retreating ocean shoreline. Predominantly, sediments lie in nearly horizontal layers; however, erosional episodes occurring between depositions of successive layers are often expressed by undulations in the contacts between the formations. Due to their age, sediments exposed at the ground surface are often heavily eroded. Ridges and hills are either capped by terrace gravels or wind-deposited sands. Younger alluvial soils may mask these sediments in swales or stream valleys.

#### 3.2 Subsurface Conditions

The descriptions given below are for materials that were encountered in the specific boring locations during the course of the fieldwork. The subsurface descriptions contained herein are of a generalized nature to highlight the major soil stratification features and soil characteristics. The boring records included in the Appendix should be reviewed for specific information as to specific boring locations. The stratification shown on the boring records and subsurface profiles represent conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. In addition, the stratifications represent the approximate boundary between subsurface materials, and the transition may be gradual. The results of laboratory tests, consisting of Atterberg limits, grain size, and natural moisture contents performed on selected soil samples, are contained in the Appendix.



The borings generally encountered four main soil strata:

Strata	Soil Type	Approx. depth to bottom of strata from existing grade (feet)	Range of SPT N <sub>60</sub> Values (bpf)	Relative Density / Consistency	Borings encountered
1	Lean and fat sandy CLAY (CL/CH) / Clayey SAND (SC)	9 to 11	8-34	Loose to dense/ Medium to hard	All borings
2	Poorly graded fine SAND (SP) / Fine SAND with silt (SP- SM)	28.5 to 31	4-25	Very loose to medium	All borings
3	Fat CLAY (CH)	21 to 31	10-19	Stiff to very stiff	B-3 and B-6
4	Elastic Silt (MH) with sand	28.5 to 100	9-50+	Stiff to hard	All borings

#### 3.3 Groundwater Information

Groundwater was encountered in the borings at depths of about 8 to 9 feet below existing grade during drilling and at a depth of about 5 feet after 24 hours. The borings were backfilled at the end of the drilling operations. The groundwater information presented in this report is based on conditions at the time of our field activities. Groundwater levels may vary due to seasonal conditions and recent rainfall. Excavations below this depth will need to account for groundwater and the likelihood of flowing sands below this depth.

#### 3.4 Seismic Characteristics

Areas of South Carolina, mainly along the coastal areas between Charleston and Savannah, Georgia, are at a higher risk of seismic activity. From a geotechnical standpoint, a seismic event could result in a condition called liquefaction occurring at this site. Liquefaction is caused by a build-up of excess pore water pressures in saturated granular soils during vibrational loadings (earthquake). The resulting damage to structures bearing over these soils are large settlements and displacements. Submerged sands, such as those at this site generally below 9 feet from the ground surface, are the most susceptible.

A liquefaction analysis was performed using the following parameters taken from Seismicmaps.org/U.S. Seismic Design Maps:



Design Code Reference Document: IBC-2015 Risk Category: III Site Class: D - Stiff Soil

Туре	Value	Description
Ss	0.36	MCER ground motion. (for 0.2 second period)
S <sub>1</sub>	0.133	MCER ground motion. (for 1.0s period)
S <sub>MS</sub>	0.544	Site-modified spectral acceleration value
S <sub>M1</sub>	0.301	Site-modified spectral acceleration value
S <sub>DS</sub>	0.363	Numeric seismic design value at 0.2 second SA
S <sub>D1</sub>	0.201	Numeric seismic design value at 1.0 second SA
S <sub>DC</sub>	D	Seismic design category
Fa	1.512	Site amplification factor at 0.2 second
Fv	2.269	Site amplification factor at 1.0 second
PGA	0.191	MCEG peak ground acceleration
F <sub>PGA</sub>	1.418	Site amplification factor at PGA
PGA <sub>M</sub>	0.271	Site modified peak ground acceleration
ΤL	8	Long-period transition period in seconds
SsRT	0.36	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.432	Factored uniform-hazard (2% probability of exceedance in 50 years)
		spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.133	Probabilistic risk-targeted ground motion. (1.0 second)
<u>с111</u> Ц	0 159	Factored uniform-hazard (2% probability of exceedance in 50 years)
31011	0.155	spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C <sub>RS</sub>	0.834	Mapped value of the risk coefficient at short periods
C <sub>R1</sub>	0.832	Mapped value of the risk coefficient at a period of 1 s

#### 4.0 RECOMMENDATIONS

#### 4.1 General

Based on the information provided for the new structures, we understand the proposed grade of the site will remain at or near the existing grades and the structures will be founded at similar depths to the existing structures. The proposed structures will be above grade structures and will be at or near grade with the exception of the filters, which will be founded 5 to 10 feet below grade. The main considerations that will need to be addressed at this site and during construction include:

- 1. The presence of fat clays (CH) and high moisture soils in the upper 5 feet of the borings;
- 2. Groundwater levels at or above proposed foundation bearing depths for the filters and other utility excavations;
- 3. Liquefaction of the sand strata below 10 feet across the site and the resulting settlement potential; and
- 4. Consolidation settlement of the loose sands below the clearwell and PAC structure.

#### 4.2 Site Preparation

Surface vegetation and deleterious materials in the planned construction area should be completely removed. Based on our observations, we recommend 6 inches of stripping be budgeted to remove organics and root zones in the areas adjacent to the existing structure on the site. It should be noted that deeper depths of organics may be present in lower lying areas of the site or in drainage features.

#### PAC Contactor

Borings B-1 and B-2 drilled in this area encountered an upper 6 to 8 feet of moderate to highly plastic sandy clay (CH) with natural moisture contents ranging from 21% and 26%. These soils will likely be difficult to manage during construction. We recommend that the upper 3 feet of material below the proposed subgrade elevation be removed and replaced with select off-site borrow material. The subgrade soils may need to be scarified and recompacted prior to the first lift of fill being placed. The select material should be compacted to 95% of the soils modified Proctor density (ASTM D-1557) and within +/-2 percentage points of its optimum moisture content (OMC).

#### Flocculation/Sedimentation Basins and Clearwell

Borings B-3, B-4, and B-7 through B-9 were drilled in these areas and encountered an upper 6 to 8 feet of clayey sand (SC) with some zones of highly plastic sandy clay (CH) with natural moisture contents ranging from 14% and 25%. We recommend that once the area is excavated to the planned subgrade elevation, the subgrade should be proofrolled with a loaded dump truck to verify the existing subgrade soils are suitable for slab support. Proofrolling consists of repeated passes with a loaded dump truck to locate areas of soft soil. Areas that rut or pump excessively will indicate those soils that will need remediation. If the layer of soft/pumping soils is relatively thin, less than about 1 foot, an attempt can be made to scarify, moisture condition, and compact the materials. Whether or not these soils will be problematic will be a function of prevailing weather conditions. If the soils are wet and adequate drying conditions are not present, this may not be practical. Deeper areas of soft/pumping soils should be removed until the thickness is such that the remaining material can be moisture conditioned and properly compacted. We recommend a GMC geotechnical engineer or qualified soils' technician observe the proofrolling operations.

If any material should need to be removed, select fill should be brought in and the select material should be compacted to 95% of the soils modified Proctor density (ASTM D-1557) and within +/-2 percentage points of its optimum moisture content (OMC).

#### **Filters**

Borings B-5 and B-6 encountered an upper 8 to 12 feet of highly plastic sandy clay (CH) and clayey sand (SC) with natural moisture contents ranging from 16% to 20%. The groundwater level will likely be encountered below a depth of about 5 feet in this area. Planned excavations of 5 to 10 feet are planned for these structures; therefore, groundwater will need to be addressed during excavation. We recommend that the soils be excavated to the planned subgrade elevation and evaluated by the geotechnical engineer. The area should be sloped to drain towards the corners of the excavation and the water level be maintained by being pumped from sumps. The sump pumps may need to remain in place during construction and removed once the structures have been completed. We recommend that a geotextile separation/stabilization fabric (such as a Mirafi HP-270 or equal) be placed on the subgrade and a minimum of 12 inches of #57 stone be placed and densified over the geotextile. The structures can then be constructed on this layer.

Excavations adjacent to structures should be designed not to undermine existing foundations or structures. In addition, the structures should be monitored during excavation and dewatering for signs of distress.

#### <u>General</u>

Generally, soils with SPT N-values of <10 bpf are less stable and may require undercutting or recompaction in place. Due to the moisture-sensitive nature of the fine-grained soils, additional undercutting and/or stabilization will likely be required if proper site maintenance, protection from surface water, and equipment traffic control are not implemented. At the end of each day, the grading contractor should "weatherproof" exposed soil subgrades, and provide positive drainage for surface water flow if inclement weather is expected. The contractor should have water trucks available to wet subgrades exposed to prolonged dry periods. Twisting and turning of construction equipment over exposed soils, especially during and after rain events, should be avoided, or otherwise degradation of the prepared subgrade soils will occur.

#### 4.3 Groundwater Management

As discussed, we anticipate groundwater to impact below grade excavations. If surface or rain water becomes an issue in open excavations, installation of interceptor ditches or permanent trench drains may be required. Pumping from shallow sumps can be used for temporary dewatering during construction. Extra precaution should be taken when preparing any such areas for concrete placement. In the event that water becomes a problem during concrete placement, pumps should be utilized to remove the water before the concrete is placed.

#### 4.4 Time of Year Site Preparation Considerations

During periods of heavy rain, the near surface soils can become saturated and conditions of standing or ponding water at the ground surface can occur. The near-surface soils are deemed to be moisture sensitive and may lose their strength properties if exposed to excessive moisture. The time of the year that the sitework begins can affect the project considerably. In this area, the "wet season" is generally between the months of November and May, and the "dry season" from June to October. There are many considerations that need to be addressed prior to bidding a

project that could affect the budget based on the time of year a project starts earthwork activities. The time of the year that the geotechnical borings were performed can provide a false sense of actual near surface conditions depending on the time of year and weather conditions. Below are considerations that should be addressed based on the time of the year earthwork is started.

#### "Wet" Season

During the wet season, the amount of undercutting may be greater, therefore resulting in greater excavation costs. The soils are typically proofrolled to determine their suitability for the placement of new fill or subgrade support. During the wet season, the surface soils have a higher moisture content and will tend to pump, therefore, hindering the placement of new fill. In addition, the drying time, time period between rain events, and temperature is not conducive to scarify soils, allow drying, and recompacting. At this time, the decision should be made to try either scarify/dry/compact the in-place soils, which could take time, or undercut and replace with suitable material, which could increase the sitework costs. Based on our experience, the amount of undercut could be 2 to 3 feet more (or greater in localized areas), whereas in drier weather, lesser amounts of undercutting may be necessary, if recompaction or stabilization of soils left in place can be achieved. Some undercut soils are not always "unsuitable" soil and can be moisture conditioned and reused as fill, if drying conditions are favorable.

The site contractor shall be responsible for maintaining a firm, unyielding and stable subgrade condition. Should the near surface soils become wet, the contractor should be prepared to mitigate these conditions by repeated aeration and exposure to sunlight or by admixture treatment.

#### <u>"Dry" Season</u>

During the dry season, the surface soils have a lower moisture content and will tend to "bridge" or "crust" softer underlying soils. They will generally allow the placement of new fill, but the crust can break down if repeated passes with heavily loaded equipment is persistent. In addition, new fill from cuts or other sources may need to be moisture conditioned prior to compaction. The soils can dry significantly, requiring the addition of water for proper compaction. Water trucks should be used, as required, by the contractor to condition the soils within the required specifications.

#### 4.5 Fill Placement

Select fill material beneath buildings/structures should meet the following characteristics:

Property	Requirement
Liquid Limit (LL) and Plasticity Index (PI)	LL ≤ 50 and PI ≤ 25
Maximum Dry Density (ASTM D-698)	<u>&gt;</u> 100 pcf
Maximum Particle Size	3 inches or less
Organic Matter	≤ 5%
Fill Looso Lift Thickness	8 inches or less
Thi LOOSE LITE THICKNESS	(4 inches or less for walk-behind compaction equipment)

Location	Test Method	Compaction Required (minimum)	Moisture Content
Upper 18 inches below pavements	ASTM D1557 (modified)	95%	-2% to +2% of optimum moisture
Building Areas and 5 feet beyond perimeter	ASTM D1557 (modified)	95%	-2% to +2% of optimum moisture
All other areas	ASTM D1557 (modified)	92%	-2% to +2% of optimum moisture

The following table summarizes the compacted fill requirements:

On site soils classified as SC, SM, SP, ML, and CL should be suitable for use as compacted fill. **Soils classified as elastic silt (MH) and fat clay (CH) should not be used as fill material under structures or roadways.** Any zones of debris or highly organic material should be segregated and not used beneath buildings or pavements. Samples of the proposed fill materials should be provided to the geotechnical engineer for testing and evaluation prior to placement. Density tests should be performed to document compaction and moisture content of any earthwork involving soils and other applicable materials. Density tests should be performed frequently, with a recommended minimum of one test per 5,000 square feet per lift of fill.

#### 4.6 Shallow Foundations

Based on the provided bearing elevations of the proposed structures, and the recommended site preparation methods previously discussed, it is our opinion that shallow foundations can be used to support the structures, if the anticipated settlements (both compression and liquefaction) are acceptable. The foundations should:

- Be founded a minimum of 18 inches below exterior adjacent grade.
- Foundations may be sized using a net allowable soil bearing pressure of 2,000 pounds per square foot (psf).
- The clearwell should be founded on a ringwall foundation using a net allowable soil bearing pressure of 2,000 psf.
- Even though computed footing dimensions may be less, column footings and continuous footings should have minimum dimensions of 24 inches and 18 inches, respectively. This allows for hand cleaning of materials disturbed during the excavation process and reduces the potential for punching shear failure.

The geotechnical engineer or his representative should observe all foundation excavations, prior to concrete placement. The engineer can provide geotechnical guidance to the owner's design team should any unforeseen foundation problems develop during construction. If any areas of foundation surfaces prove to be unsuitable, the foundation should be over-excavated.

The condition of the soils at the planned bearing elevations for each structure may vary, depending on the planned final subgrade elevation. If required by field conditions and directed by the geotechnical engineer, we recommend that an

allowance be included in the budget to over-excavate footing excavations through existing loose soils where present. The over-excavated area can be backfilled with "lean" concrete, controlled low strength material (CLSM) with minimum 28-day strength of 1500 psi, or compacted well-graded crushed stone up to the planned foundation bearing depth.

Foundation concrete should be placed the same day they are excavated so that disturbance of the foundation bearing soils can be reduced. Foundation bearing surfaces should not be disturbed or left exposed during inclement weather. Saturation of the on-site soils can cause a loss of strength and increased compressibility. Excavations for footings should be hand cleaned to remove any loose soil or mud from the foundation bearing surface. If construction occurs during inclement weather and concreting is not possible immediately after excavation, we recommend that a thin layer (approximately 2 inches) of lean concrete or flowable fill be placed on the bearing surface for protection after we have observed and evaluated the exposed bearing surfaces.

#### 4.7 Settlement Considerations

Consolidation data from the previous geotechnical reports were reviewed along with the information gathered in our borings. The laboratory data indicates the soils in the upper 10 to 12 feet are over-consolidated and the primary settlements would occur in the loose sandy zone below 12 feet.

Based on our analysis, the following settlements of foundations designed with an allowable bearing pressure of 2,000 psf would be:

Structure	Approx. total settlement (inches)	Approx. differential settlement (inches)	Approx. total settlement due to liquefaction (inches)	Borings encountered
Clearwell	1.6 – center 0.75 - edge	0.86	< 0.1	B-7, B-8, B-9
PAC Contactor	<1	< 0.5	<1	B-1, B-2
Filters/ Flocculation and Sedimentation Basin/ Control Building	<1	< 0.5	4.47	B-3, B-4, B-5, B-6

We recommend that the clearwell and PAC be pre-filled prior to all permanent piping connections are made. The permanent connections should be flexible to withstand the potential settlements due to liquefaction.

A liquefaction analysis was performed using the soil profiles of B-4 and B-7. A factor of safety of greater than 1.1 is considered safe against liquefaction. The analysis of the soil profile B-4, assuming one (1) foot of ground improvement (125 psf), yielded a liquefaction potential of greater than 4 inches. The results are presented in the Appendix.

For the analysis of soil profile B-7, assuming one (1) foot of ground improvement, yielded a liquefaction potential of about 2.3 inches. When a ground improvement surcharge of 1250 psf was added (modeling the clearwell), the

liquefaction was reduced to less than 0.1 inch. The clearwell will act like ground improvement once the tank has been filled and the sandy soils have compressed under the load of the clearwell. We believe the PAC will act accordingly.

If the above referenced settlements are not tolerable, we recommend a deep foundation consisting of augercast piles or driven precast concrete piles be used to support the structure. Recommendations for these foundations can be provided if requested.

#### 4.8 Slabs-on-grade

If any grade slabs for buildings will be constructed, an effective vapor barrier should be used to reduce slab dampness due to soil moisture. We note that penetrations of the vapor barrier by construction staking and traffic should be kept to a minimum as they will greatly reduce the barrier effectiveness. We recommend that slabs be supported on a minimum of 4 inches of crushed aggregate or sand compacted to at least 92% of modified Proctor maximum dry density.

Slab subgrades are often disturbed between completion of grading and slab construction due to weather, footing, utility line installation, and other construction activities. For this reason, we recommend that slab subgrades be evaluated by a Geotechnical Engineer prior to slab construction. This can be accomplished by proofrolling with heavy rubber-tired construction equipment. Areas determined by the Geotechnical Engineer to be unsatisfactory for slab support should be undercut to stable materials and replaced with properly compacted structural fill.

Care should be taken so that fines from the subgrade are not allowed to contaminate the granular layer. If fines do contaminate this layer, capillary rise and subsequent damage to moisture sensitive floor coverings could occur. On most projects, there is some time lag between initial grading and the time when the contractor is ready to place concrete for the slab-on-grade. Inclement weather just prior to placement of concrete for the slab-on-grade can result in trapped water in the granular layer.

#### 4.9 Below Grade Walls

Below grade walls must be designed to resist the lateral earth pressures that will be induced by the weight of the backfill materials, hydrostatic pressures on the walls and any adjacent slab or foundation surcharge loads exerted on the walls. Below grade walls that are not designed to resist hydrostatic pressures should be supported as outlined above and backfilled with a free draining material such as crushed stone/gravel or clean sand (less than 10% passing a No. 200 sieve). A drainage system should be provided near or at the base of the walls to collect and remove groundwater or seepage and to prevent buildup of hydrostatic pressures.

Walls that support buildings or otherwise need to have little horizontal movement at the top should be designed for "at rest" earth pressure conditions. Walls that are free to deflect should be designed for "active" earth pressure conditions. The "passive" earth pressure state should be used for soils supporting the retaining structure, such as toe backfill.

Relatively free-draining crushed stone/gravel or sand should be used as backfill. Samples of all backfill material should be evaluated for use as backfill. The design values and recommendations presented above assume that the backfill

behind the wall will be horizontal with no surcharge loads and that a permanent drainage system will be installed behind the retaining wall to prevent the development of hydrostatic pressures. The noted backfill should extend from the wall and upward from the top of the footing on a line 30 degrees from the vertical.

The course-grained soils such as sands and gravels (SC, SM, SP, SW, GW, GP) are acceptable to be used as backfill behind the walls. The fine-grained soils (CL, CH, ML, and MH) will not be acceptable to be used as backfill behind the walls. Using a select material can significantly reduce the horizontal loads on the wall as well as improve the effectiveness of the wall drainage system.

Soil Devementer		Backfill Type	
Soll Parameter	SM, SC	SP, SW	GW, GP
Soil Unit Weight (pcf)	120	125	130
Buoyant unit Weight (pcf)	58	63	68
Angle of Internal Friction, $\Phi$ , deg	32	34	38
At rest Pressure Coefficient, $K_{\rm o}$	0.47	0.44	0.38
Active Pressure Coefficient, K <sub>a</sub>	0.31	0.28	0.24
Passive Pressure Coefficient, $K_P$	3.25	3.54	4.20
Coefficient of Friction, $ an \Phi$	0.62	SM, SC         SP, SW         GW, GP           120         125         130           58         63         68           32         34         38           0.47         0.44         0.38           0.31         0.28         0.24           3.25         3.54         4.20           0.62         0.67         0.78           56         55         50           89         90         88           37         35         31           80         80         78           391         442         546	
At-rest Equivalent Fluid Pressure, pcf	56	55	50
(Above GWT, below GWT)	89	90	88
Active Equivalent Fluid Pressure, pcf	37	125       130         63       68         34       38         0.44       0.38         0.28       0.24         3.54       4.20         0.67       0.78         55       50         90       88         35       31         80       78         442       546	
(Above GWT, below GWT)	80	80	78
Passive Equivalent Fluid Pressure, pcf	391	442	546
(Above GWT, below GWT)	251	285	348

The table below presents recommended values of earth pressure coefficients for the select backfill materials:

GWT - Ground Water Table

For analysis of sliding resistance of the base of the retaining walls, the ultimate coefficient of friction may be taken as 0.35 between concrete and firm soil.

Compaction of backfill behind walls should be performed by appropriate manual equipment. The wall should be properly braced and heavy equipment should not be allowed behind the wall. No equipment or construction loads should be allowed within 10 feet of retaining walls or half the distance of the freestanding wall-height. This will help prevent any surcharge loads from adding lateral earth pressures above that previously recommended to the retaining wall.

Below grade walls should be braced during any backfilling operations and monitored for movement. If the footing construction precedes the subgrade preparation, then the footings should either be embedded below the subgrade a sufficient distance to achieve the required horizontal component or the footing should include a shear key to prevent movement.

#### 4.10 Backfilling of Utility Trenches

Backfilling of storm drain and utility trenches must be performed in a controlled manner to reduce settlement of the fill and cracking of overlying floor slabs and pavements. We recommend that utility trenches be backfilled with acceptable borrow or dense-graded crushed stone in 6-inch loose lifts compacted with mechanical piston tampers to the project requirements. Should seepage occur in utility trenches, it may be necessary to "floor" the trench with dense-graded gravel. Open-graded crushed stone such as #57 can serve as a channel for seepage toward structures and therefore is not recommended for use as general utility trench backfill.

#### 4.11 Subgrade Restoration

Typically, due to the movement of heavy equipment and weather conditions, the subgrade soil can become disturbed during construction. As a result, these soils have a tendency to lose shear strength and support capability. Therefore, additional effort on the Contractor's part will be required to reduce traffic and limit disturbance of soils. It is essential that the subgrade be restored to a properly compacted condition based on optimum moisture and density.

#### 4.12 Drainage Considerations

Adequate drainage should be provided at the site to reduce possible increased moisture content of the foundation soils. We recommend that driveway areas, walkways, and the ground surface be sloped away from the structures on all sides. Roof drainage should be collected by gutters and downspouts and transmitted by pipe to the storm water drainage system or discharge a minimum of 5 feet away from the building.



#### **5.0** REPORT LIMITATIONS

#### 5.1 General

The recommendations submitted are based on the available soil information obtained by GMC and design details furnished by GMC for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, we should be notified immediately to determine if changes in the foundation, or other, recommendations are required. If GMC is not retained to perform these functions, GMC cannot be responsible for the impact of those conditions on the performance of the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans are more complete, the geotechnical engineer should be provided the opportunity to review the design plans to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations.

We emphasize that this report was prepared for design and informational purposes only and may not be sufficient to prepare an accurate construction budget. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design and informational purposes only. A more comprehensive exploration and testing program would be required to assist the contractor in preparing the final building pad preparation, grading, and foundation construction budgets. In no case should this report be utilized as a substitute for development of earthwork specifications.

The information contained in this report is not intended, nor is sufficient, to aid in the design of segmental or mechanically stabilized earth (MSE) retaining walls. Segmental or MSE wall designers and builders should not rely on this report and should perform independent analysis to determine all necessary soil characteristics for use in their wall design, including but not limited to, soil shear strengths, bearing capacities, global stability, etc.

#### 5.2 Construction Testing

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of the geotechnical design. We recommend that Goodwyn, Mills, and Cawood, Inc. be allowed to continue our involvement in the project through these phases of remediation and/or construction.

Quality assurance observations and testing related to earthwork should be performed by competent personnel under the general administrative supervision of a geotechnical engineer familiar with the design requirements and considerations of this project. We recommend that qualified geotechnical personnel observe proofrolling and associated undercutting, as required, foundation excavations and subgrades, evaluate the materials to be used as fill, and test the compaction of fill and backfill.

### APPENDIX

Site Location Map Boring Location Plan Soil Classification Chart Subsurface Diagrams Boring Records Summary of Laboratory Results Field and Laboratory Procedures





# GM()

### SOIL CLASSIFICATION CHART

м		ONS	SYME	BOLS	TYPICAL
IVI		0113	GRAPH	LETTER	DESCRIPTIONS
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	RETAINED ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS	SAND AND	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LARGER THAN NO. 200 SIEVE SIZE	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
	PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)	SC		CLAYEY SANDS, SAND - CLAY MIXTURES
				ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE				МН	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		СН	INORGANIC CLAYS OF HIGH PLASTICITY
				ОН	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
н	GHLY ORGANIC S	SOILS		PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS



				300	SURFACE L		5P	СН
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IT Beaufor	rt - Jasper Water & Sewer A	uthority	PROJECT	NAME Purrysburg Plant			SOIL	
ECT NUMB	GGRE180005		PROJECT	LOCATION _Purrysburg, SC	2			
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25								
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-55								-30
-40	50		100	150	200	250	300	4(
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CLIEI	NT Be	aufort -	Jasper Water & S	Sewer Authority	PROJE	CT NAME	Purry	sburg Plan	ıt						
PRO	IECT N	UMBER	GGRE180005		PROJE			Purrysburg	, SC						
DATE	STAR	<b>TED</b> _1	/17/19	COMPLETED _1/17/19	GROUN	D ELEVA		19 ft		HOLE	E SIZE	6"			
DRIL	LING C	ONTRA	CTOR Whitaker	Laboratory Inc.	GROUN	D WATEF	R LEVE	LS:							
DRIL	LING M	ETHOD	CME 45 truck, /	Auto Hammer, Mud rotary with SPT	\[\] <b>A</b>	t time of	F DRILI	LING <u>8.00</u>	) ft / E	lev 11	.00 ft				
LOGO	GED BY	<u>T. Fo</u>	ord	CHECKED BY K. Wales	A	T END OF	DRILL	.ING							
NOTE	ES Ele	vation a	approximated from	n previous reports	A	FTER DRI	LLING				1				
ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG		MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	09-N	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)				INES CONTENT (%)
	0		SANDY FAT stiff	CLAY (CH), brownish-gray, stiff to	very	∑ ss	-	3-3-5	15	-	23	-		<u>a</u>	
								(8) 3-5-6	21	-	26	54	21	33	58
	   		SILTY SANE	D (SM), grayish-brown, stiff, fine		$\times \frac{2}{3}$		(11) 5-5-6 (11)	21	-					1
<u>   10   </u> -	 _ <u>10</u> _		POORLY GF	RADED SAND (SP), brownish-gray lium, medium to fine, moist to wet	to gray,	SS 4		2-2-2 (4)	8						
						SS 5	_	2-2-3 (5)	9	-					
 								3-4-5 (9)	17		18	-			8
						SS 7	_	3-3-4 (7)	13	_					
			ELASTIC SI	LT with SAND (MH), olive gray, me	dium		_	2-2-3 (5)	9	_					
			ELASTIC SI	LT with SAND (MH), olive gray, har		SS 9	_	7-7-10	32	_					
20	40	-				SS 10	- /	6-8-11 (19)	36	-	69	-			
 			ELASTIC SI	LT with SAND (MH), olive gray, har		ss 11		20-32-50 (82)	100+						
- <u>-30</u>	50		Boring was t	erminated at 50.0 feet.		SS 12		8-15-28 (43)	82						

#### ... ----

CLIENT Beaufort - Jasper Water & Sewer Authority PROJECT NUMBER GGRE180005					PROJE	CT NAME	Purry	sburg Plan	t						
PROJ	ECT N	UMBER	GGRE180005	5	PROJECT LOCATION Purrysburg, SC										
DATE	STAR	<b>TED</b> <u>1</u>	/22/19	_ COMPLETED _1/22/19	GROUND ELEVATION 20 ft HOLE SIZE 6"										
DRILI	ING C	ONTRA	CTOR Whitake	er Laboratory Inc.	GROUND WATER LEVELS:										
DRILI	ING M	ETHOD	CME 45 truck	, Auto Hammer, Mud rotary with SPT	<u>⊻</u> A'	T TIME O	FDRIL	LING <u>8.50</u>	) ft / E	lev 11.	.50 ft				
LOGO	ED BY	<u>T. Fc</u>	rd	CHECKED BY K. Wales	A .	t end oi	F DRILL	_ING							
NOTE	<b>S</b> <u>Ele</u>	vation a	approximated fro	om previous reports	<u> </u>	hrs AFT		LLING <u>4.5</u>	50 ft / I	Elev 1	5.50 ft				1
z		0			Ë,	% /	<i>a</i> îii		۷T.	щ <sup>(%)</sup>			ERG S	ENT	
€ TIC	t) TH	HC					D ER	NTS	0	Т Т Э	INT NT NT NT	0.	<u>ප</u> .	È,	UNT (3
Щ. Д.	DEF (f	LC		MATERIAL DESCRIPTION			N N N	I VA	9- Z	59	NTE N	MT	AST	E E E E E E E	じ し の
Щ		0				SAN	RE(	02		DR	ΣŌ		PL	NAN NAN	INE INE
20	0		SANDY FA	AT CLAY (CH), brown to brownish gra	ay, stiff										
-			to very stif	f				3-3-4 (7)	13		21	-			
-			¥			X ss		3-4-6	19	-	22	-			
-								3-3-5	15						
-				ND (SM) grav medium fine moist			_	(8)							
10	10							(8)	15	-	25	26	22	4	29
-			BOODLY			_									
_			medium, m	nedium to fine, wet		M SS	-	2-2-2	0	-					
						$A_{5}$		(4)	8	-					
-															
-						⊠ ss	-	3-4-5	17						
0	20					6	_	(9)	<u> </u>	-					
-															
-						🛛 ss	-	3-3-4	13	_					
-						<u>7</u>	_	(7)							
		TIT	ELASTIC S	SILT with SAND (MH), olive gray, stif	:	_									
-10	30					X ss	-	2-3-4	13	_					
						<u> </u>	-1	(7)		1					
-			ELASTIC	SILT with SAND (MH), olive gray, har	d	1									
-						SS SS	1	7-11-15	49		69	101	75	26	81
-						<u> </u>	1	(20)		]					
-															
-20	40							8-12-16 (28)	53	-					
_	L _														
			ELASTIC S	SILT with SAND (MH), olive gray, har	d			11.00.50							
-								11-22-50	100+	-					
-															
-						⊠ ss	-	15-27-50	100-	-					
-30	_ 50	╷╻╻╻╻				12		(77)	100+			1		1	1

### BORING NUMBER B-3

	3	4(								БС	<b>Y</b> KIIN	IG I		PAGE	E 1 C	<b>)-3</b> )F 1
CLIEN	NT Be	aufort -	Jasper Wate	r & Sewer Authori	ty	PROJEC	T NAME	Purry	sburg Plan	ıt						
PROJ	ECT N	UMBER	GGRE180	005		PROJEC	T LOCAT		Purrysburg	, SC						
DATE STARTED _1/22/19         COMPLETED _1/22/19						GROUN	D ELEVA		20 ft		HOLE	SIZE	6"			
DRILL	ING C	ONTRA	CTOR White	aker Laboratory In	C.	GROUN		R LEVE	LS:							
DRILL	ING M	ETHOD	CME 45 tru	ick, Auto Hammer	, Mud rotary with SPT		T TIME OF	DRIL	LING <u>8.50</u>	) ft / E	lev 11	.50 ft				
LOGO	GED BY	<u>T. Fo</u>	rd	CHECKED	BY K. Wales	A	FEND OF	DRILL	.ING							
NOTE	S Ele	vation a	approximated	from previous rep	orts	<u> </u>	hrs AFTE	R DRI	LLING <u>5.0</u>	00 ft /	Elev 1	5.00 ft				
S ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG		MATERIAL	DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	09-N	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIMIT LIMIT			FINES CONTENT (%)
	0		SANDY	LEAN CLAY (CL)	, brownish gray, stiff		M ss	-	3-3-2	0	+	21	12	21	21	57
									(5)	9		21	42	21	21	57
	ļ .		<b>Y</b>				2		(6)	11		22				
					(SP) brownish grov	10050			(8)	15	_	6	-			
10	10		and ver	y loose, fine, mois	t to wet	loose		)	4-4-6 (10)	19						
							SS 5	-	2-2-1 (3)	6	_					
0	20							_	2-3-4 (7)	13	_					
 			FAT CL	AY (CH), olive gra	iy, medium to very stif	t	SS 7	/	2-1-2 (3)	6	-					
	30		FLACT		<b>N (A.I.I.)</b>			_	4-4-6 (10)	19	_					
		-	hard		σ (mπ), onve gray, ver	y sun to	SS 9	_	5-6-7 (13)	25	-					
	40						SS 10		6-8-12 (20)	38	-					
							SS 11		5-8-24 (32)	61	-	83	97	67	30	76
-30 	50		Boring v	vas terminated at	50.0 feet.		SS 12	)	12-23-31 (54)	100+	-					
<u>i</u> – –	+ -	1														

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(	31	4(			BORING NUMBER B-4 PAGE 1 OF 1											
CLIE	NT Be	aufort - 、	Jasper Water & Sewer Authority	PROJEC		Purry	sburg Plar	nt								
PROJ DATE	PROJECT NUMBER         GGRE180005           DATE STARTED         2/5/19         COMPLETED         2/5/19					PROJECT LOCATION       Purrysburg, SC         GROUND ELEVATION       21 ft         HOLE SIZE       6"										
DRILI DRILI LOGO NOTE	LING C LING M GED BY	ONTRAC	CTOR Whitaker Laboratory Inc. CME 45 truck, Auto Hammer, Mud rotary with SPT d CHECKED BY K. Wales pproximated from previous reports	GROUN V AT AT AF	D WATEF TIME OI END OF TER DRI	r Leve F Drili Drill Lling	LS: LING <u>9.00</u> .ING	<u>) ft / E</u>	lev 12	.00 ft						
ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	09-N	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT			FINES CONTENT		
20			LEAN CLAY (CL), brownish-gray, stiff- FILL		X ss		2-2-5	13	-							
			SANDY LEAN CLAY (CL), brownish-gray, stiff		$\begin{bmatrix} 1 \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ $		( <i>1</i> ) 4-4-4 (8)	15		14	-					
			SANDY FAT CLAY (CH), brownish-gray, stiff				2-3-4 (7)	13		24	57	20	37	58		
10	10		POORLY GRADED SAND (SP), grayish-brown t brownish-gray, loose to dense, medium to fine, r wet	o noist to			5-8-10 (18)	34		15	-					
							2-2-2 (4)	8	-							
	 					_	2-2-2 (4)	8	-							
	  				SS 7	/	4-4-5 (9)	17		22	NP	NP	NP	11		
	30					,	3-3-1 (4)	8								
			ELASTIC SILT with SAND (MH), olive gray, stiff	to hard	SS 9	_	2-3-4 (7)	13								
20	40				SS 10	_	7-8-11 (19)	36	-							
					SS 11		7-8-9 (17)	32								
30	 _ <u>50</u>		Boring was terminated at 50.0 feet.		X SS 12		38-50/5"	95								

CLIENT _Beaufort - Jasper Water & Sewer Authority       PROJECT NAME _Purrysburg Plant         PROJECT NUMBER _GGRE180005       PROJECT LOCATION _Purrysburg, SC         DATE STARTED _2/8/19       COMPLETED _2/8/19       GROUND ELEVATION _21 ft       HC	LE SIZE	Ξ_6"												
PROJECT NUMBER _GGRE180005       PROJECT LOCATION _Purrysburg, SC         DATE STARTED _2/8/19       COMPLETED _2/8/19       GROUND ELEVATION _21 ft       HO	LE SIZE	E <u>6</u> "												
	<u>12.00 ft</u>													
DRILLING CONTRACTOR Whitaker Laboratory Inc. GROUND WATER LEVELS:	12.00 ft													
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT		1												
LOGGED BY T. Ford CHECKED BY K. Wales AT END OF DRILLING NOTES Elevation approximated from previous reports AETER DRILLING	ш.,													
	шХ		TERB	ERG	Ļ									
ELEVATION     ELEVATION       ELEVATION     ELEVATION       (fi)     (fi)	(pcf) MOISTURI CONTENT (				FINES CONTEN (%)									
20 FAT CLAY (CH), brownish-gray, medium to stiff	16	_												
	16	-												
$\begin{array}{c} \begin{array}{c} \\ \\ \\ \end{array} \end{array} = \begin{array}{c} \begin{array}{c} \\ \\ \end{array} \end{array} \begin{array}{c} \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \end{array} \begin{array}{c} \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \\ \end{array} \end{array} \begin{array}{c} \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \\ \end{array} \end{array} \begin{array}{c} \\ \\ \\ \\ \\ \\ \end{array} \end{array} \begin{array}{c} \\ \\ \\ \\ \\ \end{array} \end{array} \begin{array}{c} \\ \\ \\ \\ \\ \\ \end{array} \end{array} \begin{array}{c} \\ \\ \\ \\ \\ \\ \\ \end{array} \end{array}$														
$\begin{array}{c} \begin{array}{c} \\ \\ \\ \\ \end{array} \end{array} = \begin{array}{c} \\ \\ \\ \\ \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \\ \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \\ \\ \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \\ \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \\ \\ \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \end{array} \\ \end{array} \\ \end{array} \\ \end{array} \\ \begin{array}{c} \\ \end{array} \\ $														
L CLAYEY SAND (SC), brownish-gray, medium, fine SS (14) 27 (14) 27														
POORLY GRADED SAND with SILT (SP-SM), gray, loose to medium, medium to fine, wet	20		ND		0									
	20				9									
20 $35$ $2-2-3$ $9$ $(5)$ $9$														
SS 2-3-3 11														
$3^{-1}$ $30^{-1}$ $3^{-7.6}$ $25^{-10}$ $(13)^{-10}$	18	_												
ELASTIC SILT with SAND (MH), olive gray, very stiff to														
hard $SS = 5-6-11 32$														
$\frac{1}{2}$														
$\begin{bmatrix} SS \\ 11 \end{bmatrix} = \begin{bmatrix} 6-8-12 \\ (20) \end{bmatrix} = \begin{bmatrix} 8-8-12 \\ (20) \end{bmatrix}$														
$\frac{7}{50} - \frac{1}{50} = \frac{1}{50} $	55	88	44	44	78									
Boring was terminated at 50.0 feet.					-									
(	3	4(						BC	RIN	IG N	IUN	<b>IBE</b> PAGI	<b>RE</b> ≣ 1 C	<b>B-6</b> DF 1
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CLIE	NT Be	aufort -	Jasper Water & Sewer Authority	PROJEC	T NAME	Purry	/sburg Plar	nt						
PROJ	ECT N	UMBER	GGRE180005	PROJEC	T LOCA		Purrysburg	, SC						
DATE	STAR	<b>TED</b> _2	/5/19 <b>COMPLETED</b> 2/5/19	GROUN	D ELEVA		21 ft		HOLE	SIZE	6"			
DRILI	ING C	ONTRA	CTOR Whitaker Laboratory Inc.	GROUN	D WATEF	RLEVE	LS:							
DRILI	ING M	ETHOD	CME 45 truck, Auto Hammer, Mud rotary with SPT	¥ <b>A</b> 1		F DRIL	LING <u>9.00</u>	Oft/E	lev 12	.00 ft				
LOGO	GED BY	′ <u> </u>	CHECKED BY K. Wales	A	END OF	DRILL	_ING							
NOTE	S Ele	vation a	approximated from previous reports	AF	TER DRI	LLING								
ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIMIT LIMIT			-INES CONTENT (%)
20	0	7777	Organic Laden Material (OLM), 4 inches											<u>u</u>
			CLAYEY SAND (SC), brownish-gray, medium to	loose		]	2-3-3	11		17	]			
	 				X ss	1	3-3-3	1	-	20	29	11	18	46
							(6)							
	 				$A \frac{33}{3}$		(4)	8	-					
	10		<u>4⊻</u>		X ss 4	)	2-1-3 (4)	8						
	 - 		POORLY GRADED SAND (SP), brownish gray to medium, medium to fine, wet	o gray,		_	1-1-1 (2)	4	_	24	-			
0	 					}	2-1-4 (5)	9						
					SS 7		2-4-4 (8)	15						
			FAT CLAY (CH), olive gray, stiff		-									
	30						2-3-3 (6)	11		78	106	33	73	60
-10 -	 		ELASTIC SILT with SAND (MH) alive grav bard	1	_									
					SS 9		5-7-11 (18)	34						
					V ss	_	10-12-17							
-20	40					)	(29)	55						
							6-8-12 (20)	38	_					
	50		Boring was terminated at 50.0 feet.				8-12-16 (28)	53	-					

?	21	<u>/</u>						BO	RIN	IG N	NUN	<b>/IBE</b> PAGI	<b>R E</b> = 1 C	<b>3-7</b> DF 2
CLIEN	NT <u>Be</u>	aufort	- Jasper Water & Sewer Authority	PROJE		E Purry	ysburg Plar	nt						
PROJ	ECT N	UMBEI	<b>GGRE180005</b>	PROJE	CT LOC	ATION _	Purrysburg	g, SC						
DATE	STAR		2/7/19 COMPLETED 2/7/19	GROUN	D ELEV	ATION	21 ft		HOLE	SIZE	_6"			
DRILL			CTOR Whitaker Laboratory Inc.	GROUN			ELS:							
DRILL			CME 45 truck, Auto Hammer, Mud rotary with SPT	A			LING							
NOTE		<u> </u>		A										
	3 <u>   e</u>	valion		A			·	1			ΔT	TEDRI	PC	
ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	09-N	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)				INES CONTENT (%)
20	0	<u>1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1</u>	Organic Laden Material (OLM), 12 inches											ш
			CLAYEY SAND (SC), brownish dark gray, loose	trace		\$]	2-2-2 (4)	8		16	27	13	14	36
	- 		CLAYEY SAND (SC), grayish orange, medium, i moist	⁄` ïne,			4-6-8 (14)	27		19	-			
						5	5-5-6 (11)	21						
 10			POORLY GRADED SAND with SILT (SP-SM), li brown to gray, loose to medium, medium to fine,	ght wet		<u> </u>	3-4-4 (8)	15	-	23	NP	NP	NP	14
						<u> </u>	2-3-4 (7)	13	_					
	20					3	2-2-2 (4)	8	-	30	-			
						<u> </u>	3-4-5 (9)	17	-					
 10	30		ELASTIC SILT with SAND (MH), olive dark gray, stiff to hard	very		3	5-5-5 (10)		_					
						3	7-10-12 (22)	42	_					
20	40	-				<u>}</u> )	6-8-30 (38)	72	-					
						3	42-50/5"	95	-					
 30	50					<u>}</u>	10-30-50 (80)	100+	-	85	-			
					X ss	3	10-10-15	48	_					

(Continued Next Page)

# BORING NUMBER B-7 PAGE 2 OF 2

(	)N	!(						BO	RIN	IG N	NUN	<b>IBE</b> PAGE	<b>R B</b> ≣ 2 0	<b>5-7</b> )F 2
CLIEN	■ ■	ort - J	Jasper Water & Sewer Authority	PROJECT	NAME	Purry	sburg Plan	nt						
PROJ	ECT NUM	BER	GGRE180005	PROJECT			Purrysburg	, SC						
ELEVATION (ft)	DEPTH (ft) CBADHIC	LOG LOG	MATERIAL DESCRIPTION		SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	09-N	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIMIT LIMIT			FINES CONTENT
			ELASTIC SILT with SAND (MH), olive dark gray, stiff to hard (continued)	very	13		(25)							
 -40	 60				SS 14	,	5-5-10 (15)	29	_					
					SS 15	,	10-10-15 (25)	48	-					
50					SS <u>16</u>	-	5-5-12 (17)	32	-	102	-			
	-  -				SS 17	_	6-7-11 (18)	34	_					
 -60	 _ <u>80</u>			Z	SS 18	_	8-8-13 (21)	40	_					
	-  -			2	SS 19	_	9-10-14 (24)	41	_					
 70	90			2	SS 20	_	11-13-17 (30)	57	_					
	-  -			2	SS 21	-	10-10-12 (22)	42	_					
	100		Boring was terminated at 100.0 feet.		SS 22	_	7-9-13 (22)	42	_					
	110													

(	31	4(						BO	RIN	IG N	IUN	<b>IBE</b> PAGE	<b>R E</b> = 1 C	<b>3-8</b> )F 1
CLIEN	NT Be	aufort -	Jasper Water & Sewer Authority	PROJEC	T NAME	Purry	sburg Plar	nt						
PROJ	ECT N	UMBER	GGRE180005	PROJEC			Purrysburg	, SC						
DATE	STAR	TED _1/	31/19 COMPLETED 1/31/19	GROUN	D ELEVA		21 ft		HOLE	SIZE	6"			
DRILI	ING C	ONTRA	CTOR Whitaker Laboratory Inc.	GROUN		R LEVE	LS:							
DRILI	ING M	ETHOD	CME 45 truck, Auto Hammer, Mud rotary with SPT	A	TIME OF	- DRILI	LING							
LOGO	GED BY	<u>T. Fo</u>	rd CHECKED BY K. Wales	A	END OF	DRILL	.ING							
NOTE	S Ele	vation a	pproximated from previous reports	AF	TER DRI	LLING								
EVATION (ft)	DEPTH (ft)	RAPHIC LOG	MATERIAL DESCRIPTION		IPLE TYPE UMBER	:OVERY % (RQD)	BLOW OUNTS VALUE)	N-60	' UNIT WT. (pcf)	DISTURE NTENT (%)				S CONTENT (%)
Ц		G			SAN	REC	υĘ		DRY	ъõ	2	PLP	N N N	INE.
20			Organic Laden Material (OLM), 6 inches	/_									-	<u> </u>
			FAT CLAY (CH), grayish-orange, very stiff, fine				4-5-7 (12)	23						
· -	 		CLAYEY SAND (SC), orangish-gray, dense, fine	•	SS 2		6-8-10 (18)	34	_	18	-			
· -			SANDY FAT CLAY (CH), orangish-gray, very sti	ff, fine			4-5-8	25		31	52	16	36	58
10	10		POORLY GRADED SAND (SP), light brown to g loose to medium, medium to fine, wet	ray,	SS 4		3-2-3 (5)	9		18	-			
					SS 5	-	3-3-2 (5)	9	_					
  0						-	2-2-3 (5)	9	-					
· -						_	3-4-5 (9)	17						
10	30		ELASTIC SILT with SAND (MH), olive dark gray stiff to hard	, very		_	4-4-5 (9)	17	_					
· -		-			SS 9	_	5-7-10 (17)	32						
-20	40				SS 10	-	7-10-12 (22)	42	-	66	125	62	63	90
  			Auger refusal was encountered at 47.0 feet.		SS 11 SS 12	_	50/5"	<u>100+</u>						
<u>-30</u>														

(	3	4(	<b>`</b>					BO	RIN	IG N	NUN	<b>IBE</b> PAGI	<b>R E</b> ≣ 1 C	<b>3-9</b> DF 1
CLIER	• • • • •	aufort -	- Jasper Water & Sewer Authority	PROJE	CT NAME	Purry	/sburg Plar	nt						
PROJ	ECT N	UMBER		PROJE			Purrysburg	, SC						
DATE	STAR	TED _1/:	31/19 <b>COMPLETED</b> 1/31/19	GROUN	ID ELEVA		21 ft		HOLE	SIZE	6"			
DRILI	ING C	ONTRAC	CTOR Whitaker Laboratory Inc.	GROUN		R LEVE	LS:							
DRILI	ING M	ethod	CME 45 truck, Auto Hammer, Mud rotary with SPT	Α		F DRIL	LING							
LOGO	GED BY	T. For	d CHECKED BY K. Wales	Α	T END OF	DRILL	.ING							
NOTE	S Ele	vation a	pproximated from previous reports	Α	FTER DRI	LLING								
NO	-	<u>ں</u>			'YPE IR	۲۲ % )	s (E)		WT.	RE - (%)	AT	FERBE LIMITS	ERG	TENT
ELEVATI (ft)	DEPTH (ft)	GRAPH LOG	MATERIAL DESCRIPTION		SAMPLE T NUMBE	RECOVER (RQD)	BLOW COUNT (N VALU	09-N	DRY UNIT (pcf)	MOISTU	LIQUID	PLASTIC LIMIT	PLASTICIT INDEX	FINES CON
20	0		─ Organic Laden Material (OLM), 6 inches		_								-	-
			SANDY FAT CLAY (CH), brownish-gray, stiff, fir	e, FILL			2-3-4	13		25				
	   		CLAYEY SAND (SC), brownish-gray, medium, fi	ne	SS 2		3-5-7 (12)	23	_	22	39	17	22	39
							5-5-5 (10)	19	-					
 _ 10	10		POORLY GRADED SAND (SP), light brown to g loose to medium, medium to fine, wet	ray,	SS 4		4-4-5 (9)	17	-	21				
					SS 5		2-1-2 (3)	6						
 _ 0	20					_	5-5-6 (11)	21		17	-			9
					SS 7	_	3-4-5 (9)	17						
 10	30		ELASTIC SILT with SAND (MH), olive dark gray hard	, stiff to			3-3-4 (7)	13						
		-			SS 9		4-5-9 (14)	27	_					
 20	40				SS 10		5-8-12 (20)	38						
 			Auger refusal was encountered at 46.0 foot		SS 11	]	50/5"	<u>100+</u>						
 - <u>-30</u> 		-	-											



**CivilTech Corporation** 



**CivilTech Corporation** 



**CivilTech Corporation** 

# SUMMARY OF LABORATORY RESULTS

IENT Beaufor	t - Jasper Wat	er & Sewer	Authority		PROJ	ECT NAME	Purrysburg	g Plant			
ROJECT NUMBI	ER GGRE18	0005	1	1	PROJ	ECT LOCA	TION Purry	sburg, SC			
Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Max. Sieve Size Tested (mm)	%<#200 Sieve	Natural Moisture (%)	Class- ification	Opt. Moisture Content (%)	Max Dry Density (pcf)	Spec Grav
B-1	1-2.5						23.4				
B-1	3.5-5	54	21	33	4.75	58	26.5	СН			
B-1	18.5-20				4.75	8	18.3				
B-1	38.5-40						68.6				
B-1A	0-10	32	19	13	4.75	51	25.6	CL	11.1	125.7	
B-2	1-2.5						21.1				
B-2	3.5-5						22.2				
B-2	8.5-10	26	22	4	2	29	25.3	SM			
B-2	33.5-35	101	75	26	2	81	69.4	MH			
B-3	1-2.5	42	21	21	4.75	57	20.7	CL			
B-3	3.5-5						21.7				
B-3	6-7.5						5.7				
B-3	43.5-45	97	67	30	2	76	83.4	MH			
B-4	3.5-5						14.2				
B-4	6-7.5	57	20	37	2	58	23.6	СН			
B-4	8.5-10						15.2				
B-4	23.5-25	NP	NP	NP	4.75	11	21.8	SP-SM			
B-4A	0-10	44	17	27	25	55	21.5	CL	12.8	117.7	
B-5	1-2.5						16.1				
B-5	13.5-15	NP	NP	NP	4.75	9	19.9	SP-SM			
B-5	28.5-30						18.4				
B-5	48.5-50	88	44	44	2	78	55.3	MH			
B-6	1-2.5						17.0				
B-6	3.5-5	29	11	18	4.75	46	20.4	SC			
B-6	13.5-15						23.9				
B-6	28.5-30	106	33	73	4.75	60	78.4	СН			
B-7	1-2.5	27	13	14	25	36	16.4	SC			
B-7	3.5-5						19.3				
B-7	8.5-10	NP	NP	NP	4.75	14	23.0	SM			
B-7	18.5-20						30.2				
B-7	48.5-50						84.8				
B-7	68.5-70						102.0				
B-8	3.5-5						18.0				
B-8	6-7.5	52	16	36	9.5	58	30.9	СН			
B-8	8.5-10						18.4				
B-8	38.5-40	125	62	63	2	90	66.0	MH			
B-9	1-2.5						25.2				
B-9	3.5-5	39	17	22	2	39	21.5	SC			
B-9	8.5-10						20.6	-			
B-9	18.5-20				9.5	9	16.0				















# **FIELD TEST PROCEDURES**

### General

The general field procedures employed by Goodwyn, Mills and Cawood, Inc. (GM&C), are summarized in the American Society for Testing and Materials (ASTM) Standard D420 which is entitled "Investigating and Sampling Soil and Rock". This recommended practice lists recognized methods for determining soil and rock distribution and groundwater conditions. These methods include geophysical and in-situ methods as well as borings.

The detailed collection methods used during this exploration are presented in the following paragraphs.

# **Standard Drilling Techniques**

<u>General:</u> To obtain subsurface samples, borings are drilled using one of several alternate techniques depending upon the subsurface conditions. These techniques are as follows:

In Soils:

- a) Continuous hollow stem augers.
- b) Rotary borings using roller cone bits or drag bits, and water or drilling mud to flush the hole.
- c) "Hand" augers.

In Rock:

- a) Core drilling with diamond-faced, double or triple tube core barrels.
- b) Core boring with roller cone bits.

<u>Hollow Stem Auger:</u> A hollow stem augers consists of a hollow steel tube with a continuous exterior spiral flange termed a flight. The auger is turned into the ground, returning the cuttings along the flights. The hollow center permits a variety of sampling and testing tools to be used without removing the auger.

<u>Rotary Borings</u>: Rotary drilling involves the use of roller cone or drag type drill bits attached to the end of drill rods. A flushing medium, normally water or bentonite slurry, is pumped through the rods to clear the cuttings from the bit face and flush them to the surface. Casing is sometimes set behind the advancing bit to prevent the hole from collapsing and to restrict the penetration of the drilling fluid into the surrounding soils. Cuttings returned to the surface by the drilling fluid are typically collected in a settling tank, to allow the fluid to be recirculated.

<u>Hand Auger Boring</u>: Hand auger borings are advanced by manually twisting a 4" diameter steel bucket auger into the ground and withdrawing it when filled to observe the sample collected. Posthole diggers are sometimes used in lieu of augers to obtain shallow soil samples. Occasionally these hand auger borings are used for driving 3-inch diameter steel tubes to obtain intact soil samples.

<u>Core Drilling</u>: Soil drilling methods are not normally capable of penetrating through hard cemeted soil, weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound, continuous rock. Material that cannot be penetrated by auger or rotary soil-drilling methods at a reasonable rate is designated as "refusal material". Core drilling procedures are required to penetrate and sample refusal materials.

Prior to coring, casing may be set in the drilled hole through the overburden soils, to keep the hole from caving and to prevent excessive water loss. The refusal materials are then cored according to ASTM D2113 using a diamond studded bit fastened to the end of a hollow, double or triple tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run,



the core barrel is brought to the surface, the core recovery is measured, and the core is placed, in sequence, in boxes for storage and transported to our laboratory.

### Sampling and Testing in Boreholes

<u>General:</u> Several techniques are used to obtain samples and data in soils; however, the most common methods in this area are:

- a) Standard Penetrating Testing
- b) Water Level Readings

These procedures are presented below. Any additional testing techniques employed during this exploration are contained in other sections of the Appendix.

<u>Standard Penetration Testing</u>: At regular intervals, the drilling tools are removed and soil samples obtained with a standard 2-inch diameter split tube sampler connected to an A or N-size rod. The sampler is first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140-pound safety hammer falling 30 inches. Generally, the number of hammer blows required to drive the sampler the final 12 inches is designated the "penetration resistance" or "N" value, in blows per foot (bpf). The split barrel sampler is designed to retain the soil penetrated, so that it may be returned to the surface for observation. Representative portions of the soil samples obtained from each split barrel sample are placed in jars, sealed and transported to our laboratory.

The standard penetration test, when properly evaluated, provides an indication of the soil strength and compressibility. The tests are conducted according to ASTM Standard D1586. The depths and N-values of standard penetration tests are shown on the Boring Records. Split barrel samples are suitable for visual observation and classification tests but are not sufficiently intact for quantitative laboratory testing.

<u>Water Level Readings</u>: Water table readings are normally taken in the borings and are recorded on the Boring Records. In sandy soils, these readings indicate the approximate location of the hydrostatic water table at the time of our field exploration. In clayey soils, the rate of water seepage into the borings is low and it is generally not possible to establish the location of the hydrostatic water table through short-term water level readings. Also, fluctuation in the water table should be expected with variations in precipitation, surface run-off, evaporation, and other factors. For long-term monitoring of water levels, it is necessary to install piezometers.

The water levels reported on the Boring Records are determined by field crews immediately after the drilling tools are removed, and several hours after the borings are completed, if possible. The time lag is intended to permit stabilization of the groundwater table, which may have been disrupted by the drilling operation.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the cave-in zone. The cave-in depth is measured and recorded on the Boring Records.

#### **Boring Records**

The subsurface conditions encountered during drilling are reported on a field boring record prepared by the Driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of coarse gravel, cobbles, etc., and observations of ground water. It also contains the driller's interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are kept on file in our office.

After the drilling is completed, a geotechnical professional classifies the soil samples and prepares the final Boring Records, which are the basis for all evaluations and recommendations. The following terms are taken



from ASTM D2487 or Deere's Technical Description of Rock Cores for Engineering Purposes, <u>Rock</u> <u>Mechanical Engineering Geology</u> 1, pp. 18-22.

Relative Density o From Standard	f Cohesionless Soils Penetration Test	Con	nsistency of Cohesive Soils
Very Loose	<u>&lt;</u> 4 bpf	Very Soft	<u>&lt;</u> 2 bpf
Loose	5 - 10 bpf	Soft	3 - 4 bpf
Medium	11 – 30 bpf	Medium	5 - 8 bpf
Dense	31 - 50 bpf	Stiff	9 - 15 bpf
Very Dense	>50 bpf	Very Stiff	16 - 30 bpf
(bpf = blows per fo	ot, ASTM D 1586)	Hard	> 30 bpf
Relative Har	dness of Rock	Pa	article Size Identification
Very Soft Rock disinte	grates or easily can be hard to very	Boulders	Larger than 12"
hard soil.		Cobbles	3" - 12"
Soft Rock may be brok	en with fingers.	Gravel	
		Coarse	3/4" - 3"
Moderately Soft Rock	may be scratched with	Fine	4.76mm - 3/4"
a nail, corners and edg	es may be broken with		
fingers.		Sand	
		Coarse	2.0 - 4.76 mm
Moderately Hard Rock	a light blow of hammer	Medium	0.42 - 2.00 mm
is required to break sa	mples.	Fine	0.42 - 0.074 mm
Hard Rock a hard blow	of hammer is required	Fines	
to break sample	of hammer is required	(Silt or Clay)	Smaller than 0 074 mm
to broak dampio.		(one of oldy)	
Rock C	ontinuity	R	elative Quality of Rocks
<b>RECOVERY</b> = Total Le	ngth of Core x 100 %	<b>RQD</b> = <u>Total core</u>	e, counting only pieces > 4" long x 100 %
Length of	Core Run	Length o	f Core Run
<u>Description</u>	Core Recovery %	Description	<u>RQD %</u>
Incompetent	Less than 40	Very Poor	0 - 25 %
Competent	40 - 70	Poor	25 - 50 %
Fairly Continuous	71-90	Fair	50 - 75 %
Continuous	91 - 100	Good	75 - 90 %
		Excellent	90 - 100 %



# LABORATORY TESTING

#### GENERAL

The laboratory testing procedures employed by Goodwyn, Mills and Cawood, Inc. (GM&C) are in general accordance with ASTM standard methods and other applicable specifications.

Several test methods, described together with others in this Appendix, were used during the course of this exploration. The Laboratory Data Summary sheet indicates the specific tests performed.

# **SOIL CLASSIFICATION**

Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply his past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Boring Records".

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary; grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D-2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

# **MOISTURE CONTENT**

Moisture contents are determined from representative portions of the specimen. The soil is dried to a constant weight in an oven at 100° C and the loss of moisture during the drying process is measured. From this data, the moisture content is computed.

# ATTERBERG LIMITS

Liquid Limit (LL), Plastic Limit (PL) and Shrinkage Limit (SL) tests are performed to aid in the classification of soils and to determine the plasticity and volume change characteristics of the materials. The Liquid Limit is the minimum moisture content at which a soil will flow as a heavy viscous fluid. The Plastic Limit is the minimum moisture content at which the soil behaves as a plastic material. The Shrinkage Limit is the moisture content below which no further volume change will take place with continued drying. The Plasticity Index (PI) is the numeric difference of Liquid Limit and Plastic Limit and indicates the range of moisture content over which a soil remains plastic. These tests are performed in accordance with ASTM D4318, D4943 and D427.

#### PARTICLE SIZE DISTRIBUTION

The distribution of soils coarser than the No. 200 (75-mm) sieve is determined by passing a representative specimen through a standard set of nested sieves. The weight of material retained on each sieve is determined and the percentage retained (or passing) is calculated.

A specimen may be washed through only the No. 200 sieve, if the full range of particle sizes is not required. The percentage of material passing the No. 200 sieve is reported.

The distribution of materials finer than the No. 200 sieve is determined by use of a hydrometer. The particle sizes and distribution are computed from the time rate of settlement of the different size particles while suspended in water. These tests are performed in accordance with ASTM D-421, D-422 and D-1140.



# **COMPACTION TESTS (Moisture-Density Relationships)**

Compaction tests are performed on representative soil samples to determine the maximum dry density and optimum moisture content. The results of the tests are used in conjunction with other tests to determine the desired engineering properties relating to settlement, bearing capacity, shear strength, and permeability. The results may also be used as a standard to determine the percent compaction of soil fills.

The two most commonly used compaction tests are the standard proctor test and the modified proctor test. They are performed in accordance with ASTM Specifications D-698 and D-1557, respectively. Generally, the standard proctor compaction test is run on samples from building areas and areas where moderate building loads are anticipated. The modified compaction test is generally used for analyses of highways and other areas where large building loads are expected. Both tests have three alternative methods.

		Hami	mer	Mold	Run on Material	No.	No. of Blows/
Test	Method	Wt.	Fall	Diameter	Finer Than	Layers	Layer
	А	5.5 lb.	12"	4"	No. 4 sieve	3	25
Standard	В	5.5 lb.	12"	6"	3/8" sieve	3	56
D-698	С	5.5 lb.	12"	6"	3/4" sieve	3	56
	А	10 lb.	18"	4"	No. 4 sieve	5	25
Modified	В	10 lb.	18"	6"	3/8" sieve	5	56
D-1557	С	10 lb.	18"	6"	3/4" sieve	5	56

Test results are presented in the form of a dry unit weight versus moisture content curve. The compaction method used and any deviations from the recommended procedures are noted in this report.



# Goodwyn Mills Cawood May 23, 2019

101	East Washington Street	
Suit	e 200	
Gre	enville, SC 29601	Mr. Jim Vaughn, PE
		Goodwyn, Mills and Cawood, Inc.
Т	(864) 527-0460	35 Abercorn Street
F	(864) 527-0461	Suite 210
ww	w.gmcnetwork.com	Savannah, GA 31401

RE:

ADDENDUM TO REPORT OF GEOTECHNICAL EXPLORATION PROPOSED STAGING AREA FOR CONTRACT DEWATERING PURRYSBURG WTP IMPROVEMENTS PURRYSBURG, JASPER COUNTY, SOUTH CAROLINA GMC PROJECT NO. GGRE180005 ADDENDUM NO. 1

#### Dear Mr. Vaughn,

Goodwyn, Mills and Cawood, Inc. (Geotechnical & Construction Services Division) is pleased to provide this Addendum to the report of geotechnical exploration performed for the above referenced project. This letter includes the results of field testing and general site preparation recommendations.

#### Field Exploration

On May 9, 2019, GMC personnel performed two (2) hand auger borings at the proposed location of the Staging Area for Contract Dewatering. The locations were provided to us via GPS coordinates and are shown below:



**Approximate Hand Auger Locations** 



Dynamic Cone Penetrometer tests (DCP) were performed in the borings as they were advanced. This test is intended to provide data that can be correlated to the standard penetration test (SPT). A 1.5-inch O.D. cone is seated to penetrate any loose cuttings, then driven three, 1-3/4" increments with blows from a 15-pound weight falling 20 inches. The average number of blows required to drive the cone three increments is an index to soil strength and compressibility.

The soils encountered in the borings consisted of the following:

<b>D</b> · <b>N</b> /			DC	P Blows		
Boring No./	Soil Description	Test	1st	2nd	3rd	
Location		Depth*	1-3/4"	1-3/4"	1-3/4"	Avg.
	Top soil	0-5"	0	0	0	0
<b>HA-1</b>	Sandy, medium to high plasticity CLAY (CL-CH)	-1.5	10	8	9	8
-81.125503	Clayey SAND (SC)	-2.5	9	10	10	10
	Clayey SAND (SC)	-2.8	25	0	0	0
	Clayey SAND (SC)	-1	5	6	6	6
	Clayey SAND (SC)	-2	10	10	10	10
<b>HA-2</b> 32.356883, -81.125498	Clayey SAND (SC)	-3	7	8	8	8
	Clayey SAND (SC)	-4	5	7	8	7
	Clayey SAND (SC) - Water filling Auger Hole	-5	n/a	0	0	0

#### **Recommendations**

We understand this area may be raised by placing new fill up to 5 feet in thickness. Based on the conditions encountered, the upper 2 to 2.5 feet consists of loose and medium sands and clays underlain by very loose and loose sands the groundwater between 3 and 5 feet below grade. Generally, soils with SPT/DCP values of <10 bpf are less stable and may require undercutting or recompaction in place. However, in this location, the groundwater level could impact the excavations if undercutting is required. In this area, we recommend the following:

- 1. Surface vegetation and deleterious materials in the planned construction area should be completely removed. Based on our observations, we recommend 6 inches of stripping be budgeted to remove organics and root zones in the area. It should be noted that deeper depths of organics may be present in lower lying areas of the site or in drainage features.
- 2. We recommend that once the area is excavated to the planned subgrade elevation, the subgrade should be proofrolled with a loaded dump truck to verify the existing subgrade soils are suitable for new fill placement. Proofrolling consists of repeated passes with a loaded dump truck to locate



areas of soft soil. Areas that rut or pump excessively will indicate those soils that will need remediation. If the layer of soft/pumping soils is relatively thin, less than about 1 foot, an attempt can be made to scarify, moisture condition, and compact the materials. Whether or not these soils will be problematic will be a function of prevailing weather conditions. If the soils are wet and adequate drying conditions are not present, this may not be practical. We recommend a GMC geotechnical engineer or qualified soils' technician observe the proofrolling operations.

3. In lieu of undercutting, a stabilization geotextile fabric such as a Mirafi HP270 (or similar properties) should be placed on the subgrade for stabilization prior to fill placement. The manufacturers installation guidelines should be followed. A 12-inch layer of granular material should be placed on the fabric and compacted as an initial lift. The initial lift should be compacted to between 90 and 92% modified Proctor density (ASTM D-1557). After the initial lift, select fill should be brought in and used up to the required subgrade elevation. The select material should be compacted to 95% of the soils modified Proctor density (ASTM D-1557) and within +/-2 percentage points of its optimum moisture content (OMC).

We appreciate the opportunity to perform this study on this phase of the project for you and look forward to continued participation during the construction phase of this project. If you have any questions pertaining to this report, or if we may be of further service, please do not hesitate to call us.

Sincerely,

GOODWYN, MILLS, AND CAWOOD, INC.

and W. Walos

Kevin W. Wales Executive Vice President

Cc: Mr. Mitch Freeman, PE – GMC Mr. Tony Reid, PE – GMC Mr. Mitch Freeman, PE - GMC



Licensed South Carolina 25912

Goodwyn Mills Cawood Inc. No. 339 

**EXPANSION TO 30 MGD-PHASE I** 

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

# PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. All concrete structures designed to hold water shall be constructed of Class A reinforced concrete, and all structures shall be made completely watertight. The General Specifications for Reinforced Concrete included herein set forth the requirements for mix design details of constructing reinforcement, etc.
- B. All surfaces of concrete structures that will be exposed after backfilling shall be formed with prefabricated plywood or metal forms. All exposed surfaces shall be rubbed with a Carborundum stone until all form marks have been removed and all exposed surfaces shall be formed true to within a plus or minus 1/8" tolerance.

# 1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- B. Cast-in-place concrete includes the following:
  - 1. Foundations and footings
  - 2. Slabs-on-grade
  - 3. Fill for steel deck
  - 4. Foundation walls
  - 5. Shear walls
  - 6. Load-bearing building walls
  - 7. Building frame members
  - 8. Equipment pads and bases
  - 9. Fill for steel pan stairs

# 1.3 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related work specified elsewhere includes:
  1. Section 03 20 00 Anchorage in Concrete

#### 1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Section 013300.

GOODWYN, MILLS & CAWOOD, INC. GMC PROJECT NO. CGRE180057

# **EXPANSION TO 30 MGD-PHASE I**

- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Engineer.
- C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.
- D. Shop drawings for formwork indicating fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.
- E. Samples of materials as requested by Engineer, including names, sources, and descriptions, as follows:
  - 1. Color finishes
  - 2. Normal weight aggregates
  - 3. Fiber reinforcement
  - 4. Reglets
  - 5. Waterstops
  - 6. Vapor retarder/barrier
  - 7. Form liners
- F. Laboratory test reports for concrete materials and mix design test.
- G. Material certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
- H. Minutes of preinstallation conference.

# 1.5 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
  - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
  - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
  - 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
  - 4. ACI 350R-89, "Environmental Engineering Concrete Structures."
- B. Concrete Testing Service: Engage a testing agency acceptable to Engineer to perform material evaluation tests and to design concrete mixes.

**EXPANSION TO 30 MGD-PHASE I** 

- C. Materials and installed work may require testing and retesting at any time during progress of Work. If no allowance is set, all testing and retesting of rejected materials for installed Work, shall be done at Contractor's expense.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings" and the following:
  - 1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:
    - a. Contractor's superintendent.
    - b. Agency responsible for concrete design mixes.
    - c. Agency responsible for field quality control.
    - d. Ready-mix concrete producer.
    - e. Concrete subcontractor.
    - f. Primary admixture manufacturers.

# PART 2 - PRODUCTS

# 2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
  - 1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
  - 2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Engineer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.
- D. Forms for Cylindrical Columns and Supports: Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.
- E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to support weight of placed concrete without deformation.

**EXPANSION TO 30 MGD-PHASE I** 

- F. Carton Forms: Biodegradable paper surface, treated for moisture-resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- G. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- H. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.
  - 1. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

# 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed
- B. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf), hot-dip galvanized after fabrication and bending.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 775.
- D. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- E. Welded Wire Fabric: ASTM A 185 welded steel wire fabric.
- F. Deformed-Steel Welded Wire Fabric: ASTM A 497
- G. Epoxy-Coated Welded Wire Fabric: ASTM A 884, Class A.
- H. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.
  - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
  - 2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

# 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type II. The cement shall be low alkali, less than 0.60 percent. All cement used in concrete that will be in contact with wastewater shall have a tricalcium aluminate (C<sub>3</sub>A) content of less than 8 percent.
  - 1. Use one brand of cement throughout Project unless otherwise acceptable to Engineer.

#### **EXPANSION TO 30 MGD-PHASE I**

- B. Fly Ash: ASTM C 618, Type F.
- C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
  - 1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
  - 2. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Engineer.
- D. Lightweight Aggregates: ASTM C 330.
- E. Water: Potable.
- F. Fiber Reinforcement: Polypropylene fibers Engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C 1116, Type III.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Gilco Fibers, Cormix Construction Chemicals.
    - b. Durafiber, Durafiber Corp.
    - c. Fiberstrand 100, Euclid Chemical Co.
    - d. Fibermesh, Fibermesh Co., Div. Synthetic Industries, Inc.
    - e. Forta CR, Forta Corp.
    - f. Grace Fibers, W.R. Grace & Co.
    - g. Polystrand, Metalcrete Industries
- G. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
- H. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Air-Tite, Cormix Construction Chemicals.
    - b. Air-Mix or Perma-Air, Euclid Chemical Co.
    - c. Darex AEA or Daravair, W.R. Grace & Co.
    - d. MB-VR or Micro-Air, Master Builders, Inc.
    - e. Sealtight AEA, W.R. Meadows, Inc.
    - f. Sika AER, Sika Corp.
- I. Water-Reducing Admixture: ASTM C 494, Type A.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Chemtard, ChemMasters Corp.
    - b. PSI N, Cormix Construction Chemicals.
    - c. Eucon WR-75, Euclid Chemical Co.

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- d. WRDA, W.R. Grace & Co.
- e. Pozzolith Normal or Polyheed, Master Builders, Inc.
- f. Metco W.R., Metalcrete Industries.
- g. Prokrete-N, Prokrete Industries.
- h. Plastocrete 161, Sika Corp.
- J. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G. High-range water reducing admixtures shall be in all concrete used in the construction of structures designed to hold water.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Super P, Anti-Hydro Co., Inc.
    - b. Cormix 200, Cormix Construction Chemicals.
    - c. Eucon 37, Euclid Chemical Co.
    - d. WRDA 19 or Daracem, W.R. Grace & Co.
    - e. Rheobuild or Polyheed, Master Builders, Inc.
    - f. Superslump, Metalcrete Industries.
    - g. PSPL, Prokrete Industries.
    - h. Sikament 300, Sika Corp.
- K. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Q-Set, Conspec Marketing & Manufacturing Co.
    - b. Lubricon NCA, Cormix Construction Chemicals.
    - c. Accelguard 80, Euclid Chemical Co.
    - d. Daraset, W.R. Grace & Co.
    - e. Pozzutec 20, Master Builders, Inc.
    - f. Accel-Set, Metalcrete Industries.
- L. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. SI-R Plus, Cormix Construction Chemicals.
    - b. Eucon Retarder 75, Euclid Chemical Co.
    - c. Daratard-17, W.R. Grace & Co.
    - d. Pozzolith R, Master Builders, Inc.
    - e. Protard, Prokrete Industries.

# 2.4 RELATED MATERIALS

A. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217-inch-thick (26-gage) galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

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- B. Dovetail Anchor Slots: Hot-dip galvanized sheet steel, not less than 0.0336 inch thick (22 gage) with bent tab anchors. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.
- C. Waterstops: Provide ribbed, dumbbell-type or centerbulb-type waterstops at construction joints and other joints as indicated, minimum 6 inches wide. In areas where the installation of conventional waterstop is difficult due to limited space, Waterstop-RX by ACC may be used subject to the approval of the Engineer.
- D. Rubber Waterstops: Corps of Engineers CRD-C 513.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
    - a. The Burke Co.
    - b. Progress Unlimited.
    - c. Williams Products, Inc.
    - d. Or Approved Equal
- E. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
    - a. The Burke Co.
    - b. Greenstreak Plastic Products Co.
    - c. W.R. Meadows, Inc.
    - d. Progress Unlimited.
    - e. Schlegel Corp.
    - f. Vinylex Corp.
    - g. Or Approved Equal
- F. Pipe and Column Penetration Seal
  - 1. Seal indicated in drawings and specifications for concrete\_construction joints to be CAPwrap<sup>™</sup> **Part No. CW2110** as\_manufactured by JP Specialties, Inc. 551 Birch Street, Lake, Elsinore, CA 92530 Phone: 951-674-6869; OR EQUAL
- G. Steel Waterstop
  - 1. As directed in the structural plans.
  - 2. General:  $\frac{1}{4}$  x 6" welded steel water stop
- H. Sand Cushion: Clean, manufactured or natural sand.
- I. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:
  - 1. Polyethylene sheet not less than 8 mils thick.

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- 2. Water-resistant barrier consisting of heavy kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.
  - a. Product: Subject to compliance with requirements, provide Moistop by Fortifiber Corporation.
- J. Vapor Barrier: Premolded seven-ply membrane consisting of reinforced core and carrier sheet with fortified bitumen layers, protective weathercoating, and plastic antistick sheet. Water vapor transmission rate of 0.00 grains per sq. ft. per hr. when tested according to ASTM E 96, Method B. Provide manufacturer's recommended mastics and gusset tape.
  - 1. Product: Subject to compliance with requirements, provide Sealtight Premoulded Membrane by W.R. Meadows, Inc.
- K. Nonslip Aggregate Finish: Provide fused aluminum oxide granules or crushed emery as the abrasive aggregate for a nonslip finish, with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, nonglazing, and unaffected by freezing, moisture, and cleaning materials.
- L. Colored Wear-Resistant Finish: Packaged dry combination of materials consisting of Portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground nonfading mineral oxides interground with cement. Color as selected by Engineer from manufacturers' standards, unless otherwise indicated.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Conshake 600 Colortone, Conspec Marketing & Mfg. Co.
      - b. Floorcron, Cormix Construction Chemicals.
      - c. Quartz Tuff, Dayton-Superior.
      - d. Surflex, Euclid Chemical Co.
      - e. Colorundum, A.C. Horn, Inc.
      - f. Quartz Plate, L&M Construction Chemicals, Inc.
      - g. Colorcron, Master Builders, Inc.
      - h. Floor Quartz, Metalcrete Industries
      - i. Lithochrome Color Hardener, L.M. Scofield Co.
      - j. Harcol Redi-Mix, Sonneborn-Chemrex.
      - k. Hard Top, Symons Corp.
      - 1. Or Approved Equal
- M. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- N. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
  - 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. Polyethylene-coated burlap.
- O. Liquid Membrane-Forming Curing Compound: Liquid-type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq. ft./gal.

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- 1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 mg per liter.
- 2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
- 3. Products: Subject to compliance with requirements, provide one of the following:
  - a. A-H 3 Way Sealer, Anti-Hydro Co., Inc.
  - b. Spartan-Cote, The Burke Co.
  - c. Conspec #1, Conspec Marketing & Mfg. Co.
  - d. Sealco 309, Cormix Construction Chemicals.
  - e. Day-Chem Cure and Seal, Dayton Superior Corp.
  - f. Eucocure, Euclid Chemical Co.
  - g. Horn Clear Seal, A.C. Horn, Inc.
  - h. L&M Cure R, L&M Construction Chemicals, Inc.
  - i. Masterkure, Master Builders, Inc.
  - j. CS-309, W.R. Meadows, Inc.
  - k. Seal N Kure, Metalcrete Industries.
  - l. Kure-N-Seal, Sonneborn-Chemrex.
  - m. Stontop CS2, Stonhard, Inc.
  - n. Or Approved Equal
- P. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Highseal, Conspec Marketing and Mfg. Co.
    - b. Sealco VOC, Cormix Construction Chemicals.
    - c. Safe Cure and Seal, Dayton Superior Corp.
    - d. Aqua-Cure, Euclid Chemical Co.
    - e. Dress & Seal WB, L&M Construction Chemicals, Inc.
    - f. Masterkure 100W, Master Builders, Inc.
    - g. Vocomp-20, W.R. Meadows, Inc.
    - h. Metcure, Metalcrete Industries.
    - i. Stontop CS1, Stonhard, Inc.
    - j. Or Approved Equal
- Q. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aquafilm, Conspec Marketing and Mfg. Co.
    - b. Eucobar, Euclid Chemical Co.
    - c. E-Con, L&M Construction Chemicals, Inc.
    - d. Confilm, Master Builders, Inc.
    - e. Waterhold, Metalcrete Industries.
    - f. Or Approved Equal
- R. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch thick to feathered edges.

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- 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
- 2. Products: Subject to compliance with requirements, provide one of the following:
  - a. K-15, Ardex, Inc.
  - b. Self-Leveling Wear Topping, W.R. Bonsal Co.
  - c. Conflow, Conspec Marketing and Mfg. Co.
  - d. Corlevel, Cormix Construction Chemicals.
  - e. LevelLayer II, Dayton Superior Corp.
  - f. Flo-Top, Euclid Chemical Co.
  - g. Gyp-Crete, Gyp-Crete Corp.
  - h. Levelex, L&M Construction Chemicals, Inc.
  - i. Underlayment 110, Master Builders, Inc.
  - j. Stoncrete UL1, Stonhard, Inc.
  - k. Concrete Top, Symons Corp.
  - 1. Thoro Underlayment Self-Leveling, Thoro System Products.
  - m. Or Approved Equal
- S. Bonding Agent: Polyvinyl acetate or acrylic base.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Polyvinyl Acetate (Interior Only):
      - 1) Superior Concrete Bonder, Dayton Superior Corp.
      - 2) Euco Weld, Euclid Chemical Co.
      - 3) Weld-Crete, Larsen Products Corp.
      - 4) Everweld, L&M Construction Chemicals, Inc.
      - 5) Herculox, Metalcrete Industries.
      - 6) Ready Bond, Symons Corp.
      - 7) Or Approved Equal
      - b. Acrylic or Styrene Butadiene:
        - 1) Acrylic Bondcrete, The Burke Co.
        - 2) Strongbond, Conspec Marketing and Mfg. Co.
        - 3) Day-Chem Ad Bond, Dayton Superior Corp.
        - 4) SBR Latex, Euclid Chemical Co.
        - 5) Daraweld C, W.R. Grace & Co.
        - 6) Hornweld, A.C. Horn, Inc.
        - 7) Everbond, L&M Construction Chemicals, Inc.
        - 8) Acryl-Set, Master Builders Inc.
        - 9) Intralok, W.R. Meadows, Inc.
        - 10) Acrylpave, Metalcrete Industries.
        - 11) Sonocrete, Sonneborn-Chemrex
        - 12) Stonlock LB2, Stonhard, Inc.
        - 13) Strong Bond, Symons Corp.
        - 14) Or Approved Equal
- T. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

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- 2. Products: Subject to compliance with requirements, provide one of the following:
  - a. Burke Epoxy M.V., The Burke Co.
  - b. Spec-Bond 100, Conspec Marketing and Mfg. Co.
  - c. Resi-Bond (J-58), Dayton Superior.
  - d. Euco Epoxy System #452 or #620, Euclid Chemical Co.
  - e. Epoxtite Binder 2390, A.C. Horn, Inc.
  - f. Epabond, L&M Construction Chemicals, Inc.
  - g. Concresive Standard Liquid, Master Builders, Inc.
  - h. Rezi-Weld 1000, W.R. Meadows, Inc.
  - i. Metco Hi-Mod Epoxy, Metalcrete Industries.
  - j. Sikadur 32 Hi-Mod, Sika Corp.
  - k. Stonset LV5, Stonhard, Inc.
  - 1. R-600 Series, Symons Corp.
  - m. Or Approved Equal

# 2.5 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.
  - 1. Do not use the same testing agency for field quality control testing.
  - 2. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been approved by Engineer.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
  - Class A 4000-psi, 28-day compressive strength; 0.45 maximum with 6% air-entrainment (± 1%). Use for all structures designed to be watertight. Use of HRWR (High-range water reducer) may be used with approved mix design.
  - 2. Class B 3000-psi, 28-day compressive strength; water-cement ratio, 0.54 maximum (air-entrained).
  - 3. Mud-mat 2500-psi, 28-day compressive strength; water-cement ratio, 0.58 maximum.
- D. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows: (W/C ratio is defined by weight as the maximum water/cementitious material ratio, including the use of flyash as a cementitious component.
  - 1. Subjected to freezing and thawing: W/C 0.45.
  - 2. Subjected to deicers/watertight: W/C 0.40.
  - 3. Subjected to brackish water, salt spray, or deicers: W/C 0.40.
- E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
  - 1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
  - 2. Reinforced foundation systems: Not less than 1 inch and not more than 4 inches.

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- 3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-4 inch slump concrete.
- 4. Other concrete: Not more than 4 inches.
- F. Lightweight Structural Concrete: Lightweight aggregate and concrete shall conform to ASTM C 330. Proportion mix to produce concrete with a minimum compressive strength of 3000 psi at 28 days and a calculated equilibrium unit weight of 110 pcf plus or minus 3 pcf as determined by ASTM C 567. Concrete slump at the point of placement shall be the minimum necessary for efficient mixing, placing, and finishing. Maximum slump shall be 6 inches for pumped concrete and 5 inches elsewhere. Air entrain concrete exposed to weather according to ACI 301 requirements.
- G. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in Work.
- H. Fiber Reinforcement: Add to mix at rate of 1.5 lb per cu. yd. unless otherwise recommended by manufacturer.

# 2.6 <u>ADMIXTURES</u>

- A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
- B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
- C. Use high-range water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, Engineering concrete, parking structure slabs, concrete required to be watertight, and concrete with water-cement ratios below 0.50.
- D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
  - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
    - a. 4.5 percent (moderate exposure); 5.5 percent (severe exposure) for 1-1/2-inch maximum aggregate.
    - b. 4.5 percent (moderate exposure); 6.0 percent (severe exposure) for 1-inch maximum aggregate.
    - c. 5.0 percent (moderate exposure); 6.0 percent (severe exposure) for 3/4-inch maximum aggregate.
    - d. 5.5 percent (moderate exposure); 7.0 percent (severe exposure) for 1/2-inch maximum aggregate.
  - 2. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.
3. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

# 2.7 CONCRETE MIXING

- A. Job-Site Mixing: Mix concrete materials in appropriate drum-type batch machine mixer. For mixers of 1 cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than 1 cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd.
  - 1. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- B. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information. Batching tickets should show target versus "as-batched" data and identify any materials out of tolerance. The batch tickets should further identify mix water as-batched or held, allowable water to add and batch time as specified in ASTM C94.
  - 1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
  - 2. All batch plants and equipment including mixer trucks or other delivery equipment shall meet requirements of the NRMCA and be certified by the Alabama Highway Department as a class A or Class B plant.

# 2.8 JOBSITE ADDITION OF WATER

- A. Job-Site addition of water may be done with a portion of the design mixing water which was held back during the initial mixing.
  - 1. When concrete arrives at the jobsite with a slump that is lower than that allowed by design or specification and/or is of such consistency so as to adversely affect the placeability of the concrete, water can be added to the concrete to bring the slump up to an acceptable or specified level. This can be done when the truck arrives on the jobsite as long as the specified slump and/or water-cement ratio is not exceeded. The addition of water shall be in accordance with ASTM C 94, Standard Specification for Ready Mixed Concrete. If the purchaser requests additional water, in excess of the design mix, the purchaser assumes responsibility for the resulting concrete quality. A water reducing admixture or superplacticizer to increase concrete slump may be used if approved by the Structural Engineer and added by the concrete supplier or Contractor. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
    - a. The maximum allowable slump of the concrete must be specified or determined from the specified nominal slump plus tolerances.
    - b. Prior to discharging concrete on the job, the actual slump of the concrete must be estimated or determined. If the slump is measured, it should be on a sample from the first <sup>1</sup>/<sub>4</sub> cu. yd. of discharge concrete and the result used as an indicator of

concrete consistency and not an acceptance test. Tests for acceptance of concrete should be made in accordance with ASTM C 172.

- c. All water added to the concrete on the jobsite must be measured and recorded and approved by the Engineer and/or Inspector. Upon obtaining the desired slump and/or maximum water-cement ratio, no further addition of water on the jobsite is permitted.
- 2. The maximum specified or approved w/cm should never be exceeded. If all the water allowed by the specification or approved mixture proportions has not been added at the start of mixing, it may be permissible, depending upon project specifications, to add the remaining allowable at the point of delivery. The production of concrete of excessive slump or adding water in excess of the proportional w/cm to compensate for slump loss resulting from delays in delivery or placement is prohibited.

# PART 3 - EXECUTION

### 3.1 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.
- B. Samples shall be collected from each pour made and test certificates shall be furnished to the Engineer by an approved commercial testing laboratory. All concrete samples shall be clearly identified so the location in which the sampled concrete was placed can be determined in the event of a compressive strength less than that specified. The cost of all concrete and other material testing shall be included in the lump sum bid for the work.
- C. Unless otherwise specified, the floors of all structures holding water, the entrance stoops of the buildings, the sidewalks, walkways and other surfaces on which operating personnel will walk, shall be provided with a brush or broom finish.
- D. A detailed layout of the reinforcing steel in the several structures shall be submitted to the Engineer for approval prior to fabrication.
- E. All exterior concrete surfaces that are not wetted or subject to splash shall be rubbed to remove all voids and form marks.
- F. All surfaces to be coated shall first be cured for at least 40 days, and then inspected for any signs of any remaining moisture. Concrete surfaces shall be swept clean and dry prior to application of required paint.

# 3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment,

elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

- 1. Provide Class A tolerances for concrete surfaces exposed to view.
- 2. Provide Class C tolerances for other concrete surfaces.
- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.
- D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

# 3.3 VAPOR RETARDER/BARRIER INSTALLATION

- A. General: Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.
- B. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape.
  - 1. Cover vapor retarder/barrier with sand cushion and compact to depth indicated.

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# 3.4 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
  - 1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Engineer.
- D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. In all structures, the horizontal reinforcing bars shall be wrapped around the corners of the wall and the horizontal baffles, weirs, beams and other transverse members shall be doweled into the walls.
- E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

# 3.5 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Engineer.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's printed instructions.
- F. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

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- G. Joint fillers and sealants are specified in Section 079200.
- H. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.
  - 1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
  - 2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
  - 3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
  - 4. Joint fillers and sealants are specified in Section 079200.
- I. Joint Filler
  - 1. Joint fillers may consist of cork, rubber, foam and other materials conforming to ASTM D 1056 and D 1752.

### 3.6 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- B. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- C. Install dovetail anchor slots in concrete structures as indicated on drawings.
- D. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

### 3.7 PREPARING FORM SURFACES

- A. Forms shall be set and braced to provide exterior surfaces that are straight and true both horizontally and vertically, within a maximum tolerance of  $\pm \frac{1}{4}$ " in a length of 40 feet.
- B. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- C. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

- 1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.
- D. All exposed surface corners and edges shall be provided with a formed 1" chamfer in all directions.

# CONCRETE PLACEMENT

3.8

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location. Tremies shall be used where required in order to prevent segregation and splashing. Concrete that has splashed and dried on reinforcing prior to embedment shall be removed by acceptable methods. Fresh concrete shall be protected from rains, running water and damage. The Contractor shall always have available for prompt use sufficient protective covering.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
  - 1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
  - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
  - 1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
  - 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
  - 3. Maintain reinforcing in proper position on chairs during concrete placement.

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- F. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- G. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- H. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
  - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
  - 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
  - 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.

# 3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with the holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Smooth-Rubbed Finish: Provide smooth-rubbed finish on scheduled concrete surfaces that have received smooth-formed finish treatment not later than 1 day after form removal.
- D. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

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- E. Grout-Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.
  - 1. Combine one part Portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
  - 2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.
- F. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

#### 3.10 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.
  - 1. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.
  - 1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
  - 1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F(F) 20 (floor flatness) and F(L) 17 (floor levelness) measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.

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- D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.
- E. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
- F. Nonslip Aggregate Finish: Apply nonslip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and where indicated.
  - 1. After completing float finishing and before starting trowel finish, uniformly spread 25 lb of dampened nonslip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as specified.
  - 2. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose nonslip aggregate.
- G. Colored Wear-Resistant Finish: Apply a colored wear-resistant finish to monolithic slab surface indicated.
  - 1. Apply dry shake materials for the colored wear-resistant finish at a rate of 100 lb per 100 sq. ft., unless a greater amount is recommended by material manufacturer.
  - 2. Cast a trial slab approximately 10 feet square to determine actual application rate, color, and finish, as acceptable to Engineer.
  - 3. Immediately following the first floating operation, uniformly distribute with mechanical spreader approximately two-thirds of the required weight of the dry shake material over the concrete surface, and embed by power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material with overlapping applications to ensure uniform color, and embed by power floating.
  - 4. After broadcasting and floating, apply a trowel finish as specified. Cure slab surface with a curing compound recommended by the dry shake material manufacturer. Apply the curing compound immediately after the final finishing.

# 3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct

elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and trowel-finish concrete surfaces.
- E. Pipe Penetrations: provide pipe sleeves or collars wherever pipe penetrations of walls or slabs are required.

# 3.12 CONCRETE CURING AND PROTECTION

- A. General: All concrete shall be cured in accordance with ACI Standard 308, "Recommended Practice for Curing Concrete" except that the concrete shall be protected from direct rays of sun for at least a three-day period. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than seven (7) days.
- C. All concrete surfaces on hydraulic structures shall be kept continuously moist for a period of not less than seven days by direct application of potable water by means of sprinklers or perforated piping. The water shall be clean and free from any elements that might cause permanent discoloration of the concrete. Application of plastic film or liquid membrane forming curing compounds is not acceptable for use on concrete structures designed to contain water.
- D. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
- E. Provide moisture curing by the following methods:
  - 1. Keep concrete surface continuously wet by covering with water.
  - 2. Use continuous water-fog spray.
  - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
- F. Provide moisture-retaining cover curing as follows:
  - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- G. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:

- 1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- 2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- H. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- I. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.
  - 1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.
- J. The Contractor shall protect finish surfaces from damage, stains and abrasions. The concrete surfaces including floors and stairs or edges likely to be marred during construction shall be protected by leaving the forms in place or covering the concrete in a manner satisfactory to the Engineer.

#### 3.13 SHORES AND SUPPORTS

- A. General: Comply with ACI 347 for shoring and reshoring in multistory construction, and as specified.
- B. Extend shoring from ground to roof for structures four stories or less, unless otherwise permitted.
- C. Extend shoring at least three floors under floor or roof being placed for structures over four stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.
- D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to support work without excessive stress or deflection.
- E. Keep reshores in place a minimum of 15 days after placing upper tier, or longer, if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

# 3.14 REMOVING FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 3 days after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.
- B. The Engineer will accept a reduction to 24 hours so long as the Contractor can demonstrate that the concrete will not be damaged by the form removal and the wet curing requirements are maintained.
- C. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- D. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

## 3.15 REUSING FORMS

- A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Engineer.

# 3.16 SEALER FOR EXPOSED INTERIOR CONCRETE FLOORS

- A. Sealer for General Use and For Exposed Interior Concrete Floors: ASTM C 309, Type 1, Class
   B, USDA accepted, VOC compliant; Equivalent to "Sealtight Vocomp-25" water-emulsion
   acrylic curing and sealing compound, as manufactured by W.R. Meadows, Inc.
- B. Shall be prepared and completed per the manufacturer's recommendations.

# 3.17 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Engineer.

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- B. Mix dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
  - 1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
  - 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent. Ridges and bulges shall be removed by careful chipping or tooling, followed by rubbing with a grinding stone.
  - 1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
  - 1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
  - 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
  - 3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Engineer.
  - 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- E. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Place dry-pack

before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

- F. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar. If in the process of cutting out defective areas, reinforcing bars are exposed, the chipping shall continue until a depth of 2" behind the exposed reinforcement. The grout shall be installed in strict accordance with the recommendations of the manufacturer.
- G. Repair methods not specified above may be used, subject to acceptance of Engineer.

### 3.18 CONCRETE STRUCTURES SHRINKAGE CRACK REPAIR PROCEEDURE

- A. All concrete structures that are to hold water shall first be cured for 30 days, and then filled with clean water and allowed to stand for at least 10 days. Then, the structure shall be carefully examined on the floor and inside and outside surfaces for shrinkage cracks, and other sources of seepage or leaks. All sources of seepage and obvious cracks shall then be repaired.
- B. The repair procedure to be used shall be to drill 5/8" diameter holes diagonally along each crack to intercept the crack near the center of the wall. A high pressure packer shall then be fitted into each drill hole, and high pressure water pumped into the packer to clean out the interior of the crack, and to minimize the number of holes that must be drilled. When all the holes that are necessary have been drilled and flushed with water, plural component pumping equipment shall then be used to inject a dense polyurethane resin to seal the crack.
- C. The repairs shall be conducted by a skilled and experienced Contractor that is familiar with this procedure, such as Structural Solutions, Wedowee, Alabama.
- D. Within 30 days of the expiration of the one year warranty period on the plant, the Contractor shall return to the site, re-inspect all crack repairs, and then rub the entire exterior area where the cracking occurred with neat cement grout and carborumdum stone to remove all visible evidence of leaks, cracks, and repairs.

# 3.19 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Contractor will employ a testing agency to perform tests and to submit test reports to the Engineer.
- B. Sampling and testing for quality control during concrete placement may include the following, as directed by Engineer.
  - 1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
    - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.

- b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
- c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
- d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
- e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
- 2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
- 3. When total quantity of a given class of concrete is less than 50 cu. yd., Engineer may waive strength testing if adequate evidence of satisfactory strength is provided.
- 4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
- 5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- C. Test results will be reported in writing to Engineer, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

# 3.20 WET TESTING

- A. General
  - 1. All new, water-retaining concrete structures shall be tested for water-tightness by the testing procedure described below, which is in accordance with ACI 350.1.

- 2. All testing work shall be performed by the Contractor in the presence of the Engineer. The Engineer shall be notified at least five (5) days in advance of the time at which testing will be performed.
- B. Testing Water
  - 1. Water for wet testing shall be furnished by the Contractor. The source of the water must be approved by the Engineer prior to filling of the structure. As a general rule, plant effluent water is acceptable for use as testing water; however, this must be confirmed by the Engineer.
  - 2. Once testing is complete, testing water shall be disposed of in a manner acceptable to the Engineer and, unless otherwise permitted by the Engineer, shall not be allowed to enter other parts of the system.
- C. Test Equipment
  - 1. All temporary equipment needed for wet testing must be provided by the Contractor (e.g. connections between the structure to be tested and the water source, pumping equipment, metering devices, pressure or vacuum gauges, temporary flanges, valves, bulkheads, bracing, blocking, and other equipment that may be necessary to perform the testing).
  - 2. All temporary equipment shall be removed upon satisfactory completion of wet testing.
- D. Test Preparation
  - 1. Unless otherwise specified, wet testing shall be performed after installation of pipe sleeves and before placement of backfill, cleaning, disinfection, installation of process equipment, or any other activities that would hinder visual inspection of the structure during the test.
  - 2. Exposed concrete surfaces of the structure (including the floor) shall be cleaned of all foreign material and debris prior to the test. Standing water in or outside the structure that would interfere with the observation of the exposed concrete surfaces of the structure shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential points of leakage, and those areas shall be repaired prior to filling the structure with water.
  - 3. Adjacent structures having common walls shall be tested individually at different times to allow examination of the dividing walls for leaks.
  - 4. Pipe connections or openings to structures, if not provided with drip tight valves, shall be temporarily plugged during testing. Where slide gates, sluice gates or similar devices are located, the Contractor shall provide bulkheads or the means to make them drip tight, and shall measure any leakage.
  - 5. Filling of the structure shall not begin before the designed compressive strength of all concrete elements of the structure has been reached or before fourteen (14) days after all concrete walls or base slabs have been placed.
- E. Test Procedure
  - 1. Soaking Period: Fill the unlined concrete structure to 1 foot above the maximum operating water surface level and maintain that water level for a minimum of 72 hours, to minimize absorption of water into the concrete during testing. Identify and repair all visible leaks during the soaking period.
  - 2. Testing Period: At the end of this soaking period, once all leaks have been repaired and the water level brought back to the required elevation, the testing period shall begin. Mark the water level with a weight suspended from a string and measure its elevation

with a surveyor's level. Allow the structure to sit for a minimum of 48 hours. Following this period, identify and repair all visible leaks. Record and submit to the Engineer measurements of the water level at the beginning and end of the testing period.

- Evaporation/Precipitation: During the testing period, suspend a bucket or pan in the 3. structure and fill it halfway with testing water. Record and submit to the Engineer measurements of the water level at the beginning and end of the testing period, for use in accounting for any evaporation and precipitation that may have occurred during testing.
- F. Leakage
  - 1. Leakage requiring repair shall be defined as any moisture on the exterior surface of the structure, ranging from damp spots to dripping or trickling to shooting streams of water. All visible leakage is to be repaired even if magnitude is within allowable leakage.
  - 2. Allowable leakage: For unlined tanks with a side-water depth of 25 feet or less, the net loss of water volume (including evaporation/precipitation) shall not exceed 0.1 percent in 24 hours.
- G. Test Conclusion
  - If the leakage observed during testing (including evaporation/precipitation) is less than 1 the allowable leakage, the structure shall be considered sufficiently water-tight. If it is greater than the allowable, the structure shall be drained, necessary repairs shall be made, and the structure shall be re-tested.

END OF SECTION 03 30 00

### SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: High-performance coatings and special preparation of surfaces.
  - 1. Use high performance coating systems specified in this section to finish water plant components, unless otherwise indicated. Without restricting volume or generality, work to be performed under this section may include, but is not limited to:
    - a. Exterior concrete where indicated
    - b. Interior concrete of existing tanks and other surfaces indicated.
    - c. Exposed bare pipes (including color coding)
  - 2. Painting or finishing is not needed for following:
    - a. Surfaces or materials specifically scheduled or shown on Drawings to remain unfinished
    - b. Items provided with factory finish.
    - c. Equipment nameplates, fire rating labels, and operating parts of equipment
  - 3. Materials and products having factory-applied primer shall not be considered factory finished.

### 1.2 REFERENCE STANDARDS

- A. American Society for Testing and Materials:
  - 1. ASTM B117 Test Method for Salt Spray (fog) Testing
  - 2. ASTM D16 Terminology Relating to Paint, Varnish, Lacquer, and Related Products
  - 3. ASTM D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
  - 4. ASTM D522 Test Methods for Mandrel Bend Test of Attached Organic Coatings
  - 5. ASTM D870 Practice for Testing Water Resistance of Coatings Using Water Immersion
  - 6. ASTM D1014 Practice for Conducting Exterior Exposure Tests of Paints on Steel
  - 7. ASTM D1653 Test Methods for Water Vapor Transmission of Organic Coating Films
  - 8. ASTM D2794 Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
  - 9. ASTM D3273 Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
  - 10. ASTM D3359 Test Method for Measuring Adhesion by Tape Test
  - 11. ASTM D3363 Test for Film Hardness by Pencil Test
  - 12. ASTM D4060 Test Method for Abrasion of Organic Coatings by the Taber Abrader
  - 13. ASTM D4141 Practice for Conducting Accelerated Outdoor Exposure Tests of Coatings
  - 14. ASTM D4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

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- 15. ASTM D4541 Test Method for Pull-Out Strength of Coatings Using Portable Adhesion-Testers
- 16. ASTM D4585 Practice for Testing the Water Resistance of Coatings Using Controlled Condensation
- 17. ASTM E84 Test Methods for Surface Burning Characteristics of Building Materials
- 18. ASTM G8 Test Methods for Cathodic Disbonding of Pipeline Coatings
- 19. ASTM G53 Practice for Operating Light-and-Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
- B. SSPC: The Society for Protective Coatings:
  - 1. SSPC Painting Manual, Volume 2: Systems and Specifications.
  - 2. SSPC-Paint 16 Coal Tar Epoxy-Polyamide Black (or Dark Red).
  - 3. SSPC-SP 2 Hand Tool Cleaning.
  - 4. SSPC-SP 3 Power Tool Cleaning.
  - 5. SSPC-SP 5 White Metal Blast Cleaning.
  - 6. SSPC-SP 6 Commercial Blast Cleaning.
  - 7. SSPC-SP 7 Brush-Off Blast Cleaning.
  - 8. SSPC-SP 10 Near-White Metal Blast Cleaning.
  - 9. SSPC-SP 11 Power Tool Cleaning to Bare Metal.

# 1.3 PREINSTALLATION MEETINGS

- A. Section 013100 Project Management and Coordination.
- B. Convene onsite a minimum two weeks prior to commencing Work of this Section.
- C. Schedule a conference and inspection to be held on-site before field application of coating systems begins.
- D. Conference shall be attended by CONTRACTOR, OWNER'S Representative, ENGINEER, coating applicators, and a representative of coating material manufacturer.
- E. Topics to be discussed at meeting shall include:
  - 1. A review of Contract Documents and accepted shop drawings shall be made and deviations or differences shall be resolved.
  - 2. Review items such as environmental conditions, surface conditions, surface preparation, application procedures, and protection following application.
  - 3. Establish which areas on-site will be available for use as storage areas and working area
- F. Pre-construction conference and inspection shall serve to clarify Contract Documents, application requirements and what work should be completed before coating application can begin.

# 1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

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- B. Product Data:
  - 1. Submit manufacturer information indicating coating materials, manufacturer's name, product name, product number, performance ratings, curing times, mixing, thinning and application requirements.
    - a. Provide material analysis, including vehicle type and percentage by weight and by volume of vehicle, resin and pigment.
    - b. Submit manufacturer's Material Safety Data Sheets (MSDS) and other safety requirements.
- C. Samples: Submit one color chart/color samples, illustrating colors for selection.
- D. Schedule: Contractor shall submit a schedule of items that will receive high-performance coatings per Specification 09 96 00.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer Instructions: Submit special procedures, perimeter conditions requiring special attention.
- G. Quality Assurance Submittals:
  - 1. Test Reports:
    - a. Provide certified test reports, prepared by an independent testing laboratory, confirming compliance with specified performance criteria.
  - 2. Certificates:
    - a. Coatings manufacturer shall certify that coating materials utilized are "non-lead" (less than 0.06% lead by weight in dried film) as defined in Part 1303 of Consumer Product Safety Act.
    - b. Provide certification that specialized equipment as may be required by manufacturer for proper application of coating materials shall be utilized for work of this Section.
    - c. Provide manufacturer's certification that products to be used comply with specified requirements and are suitable for intended application.
  - 3. Manufacturer's Instructions:
    - a. Submit manufacturer's installation procedures which shall be basis for accepting or rejecting actual installation procedures.
- H. Qualifications Statements:
  - 1. Submit qualifications for manufacturer and applicator.
  - 2. Submit manufacturer's approval of applicator.

# 1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for submittals.
- B. Operation and Maintenance Data: Submit maintenance and cleaning requirements for coatings, repair and patching techniques.

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### 1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

### B. Extra Stock Materials:

- 1. Furnish 5 gal of each color of each type of coating specified, for Owner's maintenance use.
- 2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

#### 1.7 QUALITY ASSURANCE

A. Conform to applicable codes and ordinances for flame, fuel, smoke, and volatile organic compound (VOC) ratings requirements for finishes at time of application.

#### 1.8 QUALIFICATIONS

- A. Provide products from a company specializing in manufacture of high performance coatings with a minimum of 10 years' experience.
- B. Applicator shall be trained in application techniques and procedures of coating materials and shall demonstrate a minimum of 2 years successful experience in such application.
  - 1. Maintain, throughout duration of application, a crew of painters who are fully qualified to satisfy specified qualifications.
- C. Single Source Responsibility:
  - 1. Materials shall be products of a single manufacturer or items standard with manufacturer of specified coating materials.
  - 2. Provide secondary materials which are produced or are specifically recommended by coating system manufacturer to ensure compatibility of system.

# 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Container Labeling: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Inspection:
  - 1. Accept materials on Site in manufacturer's sealed and labeled containers.
  - 2. Inspect for damage and to verify acceptability.

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- D. Store materials in ventilated area and otherwise according to manufacturer instructions.
- E. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.

#### 1.10 AMBIENT CONDITIONS

- A. Section 01 50 00 Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions: Do not install materials when temperature is below 35 degrees F or above 110 degrees F.
- C. Refer to specific product information sheets for minimum surface temperature requirements. Surface temperatures shall be at least 5 degrees F (15 degrees C) above dew point and in a rising mode.
- D. Subsequent Conditions: Maintain above temperature range, 24 hours before, during, and 72 hours after installation of coating.
- E. Relative humidity shall be no higher than 85%.
- F. For exterior spray application, wind velocity shall be less than 15 mph (25 kph).
- G. Atmosphere shall be relatively free of airborne dust.
- H. Restrict traffic from area where coating is being applied or is curing.

### 1.11 WARRANTY

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for warranties.
- B. Include coverage for bond to substrate, and degradation of chemical resistance.

#### PART 2 - PRODUCTS

#### 2.1 HIGH-PERFORMANCE COATINGS

- A. Manufacturers:
  - 1. Exposed Piping:
    - a. Tnemec Company, Inc. Series 66 Hi-Build Epoxoline w/ Series 73 Endura Shield

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- b. Sherwin-Williams Company Macropoxy 646 w/ Acrolon 218 HS
- c. Sauereisen
- 2. Concrete Structure Internal
  - a. HDPE
    - 1) Hanson Agru Sure Grip
- 3. High Build Epoxy Piping
  - a. Raven
  - b. Tnemec
  - c. Sherwin-Williams

### 2.2 COMPONENTS

- A. Coatings:
  - 1. Description:
    - a. Complete multicoat systems formulated and recommended by manufacturer for intended applications and in indicated thicknesses.
    - b. Specified number of coats does not include primer or filler coat.
  - 2. Lead content: None.
  - 3. Chromium Content as Zinc Chromate or Strontium Chromate: None.
  - 4. Maximum VOC Content: As required by applicable regulations.
  - 5. Colors: As selected from manufacturer's standard colors.
- B. Epoxy Coating:
  - 1. Modified Polyamine Epoxy
    - a. Usage: A thick film, 100% solids, abrasion-resistant lining designed for wastewater immersion and fume environments. Provides low permeation to H2S gas, protects against MIC and provides chemical resistance to severe wastewater environments.
    - b. Exposure: Severe.
    - c. Number of Coats: See schedule.
    - d. Finish: Gloss.
    - e. Minimum Solids Content: 100% (mixed).
    - f. Minimum Dry Film Thickness Per Coat: See schedule.
    - g. Perma-Glaze, Series 435, as manufactured by Tnemec.
    - h. Primer: See schedule.
  - 2. Modified Polyamidoamine Epoxy
    - a. Usage: High-build coating with superior wetting for marginally prepared rusty steel and tightly adhering old coatings. Excellent abrasion-, chemical- and corrosion-resistance. Perfect foundation for aliphatic-polyurethanes. NOT FOR IMMERSION SERVICE.

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- b. Exposure: Moderate.
- c. Number of Coats: See schedule.
- d. Finish: Semi-gloss.
- e. Minimum Solids Content:  $84.0 \pm 2.0\%$  (mixed).
- f. Minimum Dry Film Thickness Per Coat: See schedule.
- g. Chembuild, Series 135, as manufactured by Tnemec.
- h. Primer: See schedule.
- 3. Polyamidoamine Epoxy
  - a. Usage: Potable water coating which offers high-build edge protection and allows for application at a wide range of temperatures (down to 35°F or 2°C with 44-700 Accelerator). For use on the interior and exterior of steel or concrete tanks, reservoirs, pipes, valves, pumps and equipment in potable water service.
  - b. Exposure: Moderate.
  - c. Number of Coats: See schedule.
  - d. Color: 1211 Red, 1255 Beige, 00WH Tnemec White, 15BL Tank White, 35GR Black and 39BL Delft Blue.
  - e. Minimum Solids Content: 67.0  $\pm$  2.0% (mixed—A, B & 44-700 Epoxy Accelerator).
  - f. Minimum Dry Film Thickness Per Coat: See schedule.
  - g. Pota-Pox Plus, Series N140, as manufactured by Tnemec.
  - h. Primer: See schedule.
- 4. Polyamidoamine Epoxy
  - a. Usage: Potable water coating which offers high-build edge protection and allows for application at a wide range of temperatures (down to 35°F or 2°C). For use on the interior and exterior of steel or concrete tanks, reservoirs, pipes, valves, pumps and equipment in potable water service.
  - b. Exposure: Moderate.
  - c. Number of Coats: See schedule.
  - d. Color: 1211 Red, 1255 Beige, 00WH Tnemec White, 15BL Tank White, 39BL Delft Blue, 35GR Black.
  - e. Minimum Solids Content:  $68.0 \pm 2.0\%$  (mixed).
  - f. Minimum Dry Film Thickness Per Coat: See schedule.
  - g. Pota-Pox Plus, Series N140F, as manufactured by Tnemec.
  - h. Primer: See schedule.
- 5. High-Build Epoxy Coating Polyamidoamine Epoxy
  - a. Usage: Application characteristics in adverse and varied conditions.
  - b. Exposure: Moderate.
  - c. Number of Coats: See schedule.
  - d. Finish: Satin.
  - e. Minimum Solids Content: 67.0% +/- 2.0% (mixed).
  - f. Minimum Dry Film Thickness Per Coat: See schedule.
  - g. Hi-Build Epoxoline II, Series N69, as manufactured by Tnemec.
  - h. Primer: See schedule.
- 6. Waterborne Acrylic Epoxy
  - a. Usage: High performance coating suitable for concrete, steel and other commonly used building materials. Features include high-build, low odor, non-yellowing

white and fade resistant colors; easy cleanup and stain-, abrasion-, chemical- and moisture-resistance. Good exterior performance.

- b. Exposure: Moderate
- c. Number of Coats: See schedule.
- d. Color: Refer to Tnemec Color Guide.
- e. Finish: Satin.
- f. Minimum Solids Content:  $44.0 \pm 2.0\%$  (mixed)
- g. Minimum Dry Film Thickness Per Coat: See schedule.
- h. H.B. Tneme-Tufcoat, Series 113, as manufactured by Tnemec.
- i. Primer: See schedule.
- 7. Modified Polyamine Epoxy
  - a. Usage: High-solids moisture tolerant epoxy used for priming concrete, wood and drywall. Also as a stand-alone one-coat clear floor sealer.
  - b. Exposure:
  - c. Number of Coats: See schedule.
  - d. Color: Clear. Can be field-tinted (Series 820 Field Tint) in 16 StrataShield colors and certain custom colors.
  - e. Minimum Solids Content: 100% (mixed).
  - f. Minimum Dry Film Thickness Per Coat: See schedule.
  - g. Epoxoprime, Series 201, as manufactured by Tnemec.
  - h. Primer: See schedule.
- C. Polyurethane Coating:
  - 1. Modified Aromatic Polyurethane Primer
    - a. Usage: A single component, moisture-cured resin, containing micaceous iron oxide and zinc to function as a primer which is field and shop friendly. May be used in OEM manufacturing, potable water and wastewater immersion with the proper topcoats. May also be used for marginally prepared rusty steel and tightly adhering old coatings for non-immersion maintenance situations.
    - b. Exposure: Moderate.
    - c. Number of Coats: See schedule.
    - d. Color: 1216 Greenish-Gray.
    - e. Minimum Solids Content:  $61.0 \pm 2.0\%$  (mixed).
    - f. Minimum Dry Film Thickness Per Coat: See schedule.
    - g. Omnithane, Series 1, as manufactured by Tnemec.
    - h. Primer: See schedule.
  - 2. Hydrophobic Aromatic Polyurethane
    - a. Usage: A moisture-cured, hydrocarbon-modified coating providing excellent protection to steel and concrete substrates in wastewater environments. Provides excellent resistance to H2S gas permeation, protects against MIC and provides chemical resistance to domestic wastewater environments. It is user-friendly and rapid curing.
    - b. Exposure: Moderate.
    - c. Number of Coats: See schedule.
    - d. Color: 1221 Black, 1222 Gray, 1223 Red.
    - e. Minimum Solids Content:  $71.0 \pm 2.0\%$  (mixed).
    - f. Minimum Dry Film Thickness Per Coat: See schedule.

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- g. Perma-Shield MCU, Series 446, as manufactured by Tnemec.
- h. Primer: See schedule.
- 3. Aliphatic Acrylic Polyurethane
  - a. Usage: A coating highly resistant to abrasion, wet conditions, corrosive fumes and exterior weathering. High build quality combines with project specific primers for two-coat, labor saving systems. Fast curing options are available; see Curing Time below. NOT FOR IMMERSION SERVICE.
  - b. Exposure: Moderate.
  - c. Number of Coats: See schedule.
  - d. Finish: Gloss.
  - e. Minimum Solids Content:  $66 \pm 2.0\%$  (mixed).
  - f. Minimum Dry Film Thickness Per Coat: See schedule.
  - g. Endura-Shield II, Series 1074, as manufactured by Tnemec.
  - h. Primer: See schedule.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for application examination.
- B. Examine areas and conditions under which application of coating systems shall be performed for conditions that will adversely affect execution, permanence, or quality of coating system application.
- C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes until moisture content of surface is below following limits:
  - 1. Masonry Surfaces: 12% maximum
  - 2. Vertical Concrete Surfaces: 12% maximum
  - 3. Horizontal Concrete Surfaces: 8% maximum
- D. Correct conditions detrimental to timely and proper execution of Work.
- E. Do not proceed until unsatisfactory conditions have been corrected.
- F. Commencement of installation constitutes acceptance of conditions and responsibility for satisfactory performance.

# 3.2 PREPARATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for application preparation.
- B. Protection:

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- 1. Take precautionary measures to prevent fire hazards and spontaneous combustion. Remove empty containers from Site.
- 2. Place cotton waste, cloths and hazardous materials in containers, and remove from Site daily.
- 3. Provide drop cloths, shields, and other protective equipment.
- 4. Protect elements surrounding work of this section from damage or disfiguration.
- 5. As Work proceeds, promptly remove spilled, splashed, or splattered materials from surfaces.
- 6. During application of coating materials, post Wet Paint signs.
- 7. During application of solvent-based materials, post No Smoking signs.
- C. Clean surfaces of loose foreign matter.
- D. Remove substances that would bleed through finished coatings; if removal is not possible, seal surface with shellac.
- E. Remove finish hardware, fixture covers, and accessories and store.
- F. Existing Painted and Sealed Surfaces:
  - 1. Remove loose, flaking, and peeling paint, and feather edge and sand smooth edges of chipped paint.
  - 2. Clean with mixture of trisodium phosphate and water to remove surface grease and foreign matter.
- G. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent.
- H. Ferrous Metal:
  - 1. Surfaces shall be free of residual deposits of grease, rust, scale, dirt, dust, and oil.
    - a. Solvent clean.
    - b. Hand Tools: Comply with SSPC-SP 2.
    - c. Power Tools: Comply with SSPC-SP 3.
    - d. Blasting: Comply with SSPC-SP 7.
  - 2. For shop primed surfaces, sand and scrape to remove loose primer and rust. Feather edges to make touchup patches inconspicuous. Field welds and touchups shall be prepared to conform to original surface preparation standards as indicated in Schedule of Coating Systems below.
  - 3. Shop applied prime coatings which are damaged during transportation, construction or installation shall be thoroughly cleaned and touched up in field. Use repair procedures which insure complete protection of adjacent primer. Repair methods and equipment may include wire brushing, hand or power tool cleaning or dry air blast cleaning. Follow cleaning methods listed in the Coating Schedule Section of this specification. In order to prevent injury to surrounding painted areas, blast cleaning may necessitate use of lower air pressure, small nozzle and abrasive particle sizes, short blast nozzle distance from surface, shielding and masking. If damage is too extensive to tough-up, item shall be recleaned and coated or painted.
  - 4. For surfaces not shop primed, surfaces shall be cleaned in compliance with specifications of Steel Structures Painting Council as indicated in Schedule of Coating Systems below.

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### 3.3 APPLICATION

- A. Comply with MPI Architectural Painting Manual.
- B. Apply primer to each surface, unless specifically not required by coating manufacturer.
- C. Apply coating systems in compliance with manufacturer's instructions and using application method best suited for obtaining full, uniform coverage of surfaces to be coated.
- D. Apply primer, intermediate, and finish coats to comply with wet and dry film thickness and spreading rates for each type of material as recommended by manufacturer.
  - 1. Application rates in excess of those recommended and fewer numbers of coats than specified shall not be accepted.
- E. Number of coats specified shall be minimum number acceptable. Apply additional coats as needed to provide a smooth, even application.
  - 1. Closely adhere to re-coat times recommended by manufacturer. Allow each coat to dry thoroughly before applying next coat. Provide adequate ventilation for tank interior to carry off solvents during drying phase.
- F. Employ only application equipment that is clean, properly adjusted, and in good working order, and of type recommended by coating manufacturer.
- G. After surface preparation, interior weld seams shall be brush applied.
- H. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping.
- I. Apply coatings to specified thicknesses.
- J. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish.
- K. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

# 3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for inspecting and testing.
- B. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Inspecting and Testing: Comply with MPI Architectural Painting Manual.

# 3.5 CLEANING

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for cleaning.
- B. Collect waste material that may constitute fire hazard, place in closed metal containers, and remove daily from Site.

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- C. Clean surfaces immediately of overspray, splatter, and excess material.
- D. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

#### 3.6 SCHEDULE

- A. Interior Service
  - 1. Interior Exposed Ferrous Metals: 16 gauge or heavier
    - a. Shop primed; field applied finish coats or field applied system
      - 1) Surface Preparation: SSPC SP10 Near White Blast Cleaning
      - 2) Primer/Shop Coat: Series 91 H20 Hydro-Zinc
        - a) Dry Film Thickness: 2.5 to 3.5 mils
      - 3) First Coat: Series N69 Hi-Build Epoxoline II
        - a) Dry Film Thickness: 3.0-5.0 mils
      - 4) Finish Coat: Series 1074 Endura-Shield II
        - a) Dry Film Thickness: 2.0-3.0 mils
      - 5) Total Dry Film Thickness: 6.5 to 9.5 mils
  - 2. Ferrous Metals Submerged or Intermittently Submerged in Wastewater: 16 gauge or heavier
    - a. Surface Preparation: SSPC SP10 Near White Blast Cleaning
      - 1) Primer/Shop Coat: Series N140-1211 Pota-Pox Plus
        - 2) Dry Film Thickness: 4.0 6.0 mils
          - a) 1<sup>st</sup> Coat: Series 435 Perma-Glaze
      - 3) Dry Film Thickness: 15.0 20.0 mils.
        - a) 2<sup>nd</sup> Coat: Series 435 Perma-Glaze
      - 4) Dry Film Thickness: 15.0 20.0 mils
        - a) Total Dry Film Thickness: 34.0 to 46.0 mils
      - 5) Holiday Detection: All surfaces shall be tested for discontinuities (holidays) utilizing a Tinker & Rasor AP/W High Voltage Holiday Detector in accordance with the instructions of Tnemec Technical Services. Holidays shall be repaired in accordance with the instructions of the manufacturer.
  - 3. Lightweight Metals: Ferrous, Non-Ferrous, and Galvanized Metals (18 gauge or lighter)
    - a. Shop primed; field applied finish coats or field applied system
    - b. Surface Preparation: For Galvanized Metal, Aluminum, Other Non-Ferrous Metals. Etch entire surface using Clean & Etch by Great Lakes Laboratories. For Ferrous Metals clean per SSPC- SP3 Power Tool Cleaning
      - 1) Primer/Shop Coat: Manufacturers Standard Type Primer Compatible with finish coats below
        - a) Perform crosshatch field adhesion test per ASTM D 3359 to determine compatibility of manufacturer's primer with herein specified coating system prior to coating system application.
      - 2) First Coat: Series 37H-77 Chemprime
        - a) Dry Film Thickness: 2.0-3.0 mils
      - 3) Intermediate Coat: Series 2H Tneme-Gloss
        - a) Dry Film Thickness: 2.0-3.0 mils
      - 4) Finish Coat: Series 2H Tneme-Gloss

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- a) Dry Film Thickness: 2.0-3.0 mils
- 5) Total Dry Film Thickness: 6.0 to 9.0 mils (excluding shop primer coat)
- 4. Non-Submerged Ductile Iron:
  - a. Surface Preparation: Abrasive blast to remove all contaminants.
  - b. Primer: Series N140-1211 Pota-Pox Plus
    - 1) Dry Film Thickness: 6.0 8.0Intermediate:
  - c. Series N69 Hi-Build Epoxoline II
    - 1) Dry Film Thickness: 3.0 5.0
  - d. Finish Coat: Series 1074 Endura-Shield
    - 1) Dry Film Thickness: 2.0 3.0
  - e. Total Dry Film Thickness: 11.0 16.
- 5. Concrete:
  - 1. Surface Preparation: Clean and Dry
  - 2. First Coat: Series 215 Surfacing Epoxy To fill holes
    - a) Dry Film Thickness: N/A
  - 3. Second Coat: N69 Hi-Build Epoxoline II
    - a) Dry Film Thickness: 6.0 8.0 mils
  - 4. Third Coat: N69 Hi-Build Epoxoline II
    - a) Dry Film Thickness: 6.0 8.0 mils
  - 5. Total Dry Film Thickness: 12.0 16.0 mils
- 8. Exterior Service

\*All coating thickness are expressed in dry film thickness (DFT.)

- 5. Exterior Exposed Ferrous Metals: 16 gauge or heavier
  - a. Shop primed; field applied finish coat or field applied system
  - b. Surface Preparation: SSPC SP6 Commercial Blast Cleaning
  - c. Primer/Shop Coat: Series 91 H20 Hydro-Zinc
    - 1) Dry Film Thickness: 2.5 to 3.5 mils
  - d. First Coat: Series N69 Hi-Build Epoxoline II
    1) Dry Film Thickness: 2.0-3.0 mils
  - e. Finish Coat: Series 1074 Endura-Shield II
    - 1) Dry Film Thickness: 2.0-3.0 mils
  - f. Total Dry Film Thickness: 6.5 to 9.5 mils
- 6. Lightweight Metals: Ferrous, Non-Ferrous, and Galvanized Metals (18 gauge or lighter)
  - a. Surface Preparation: For Galvanized Metal, Aluminum, Other Non-Ferrous Metals. Etch entire surface using Clean & Etch by Great Lakes Laboratories. For Ferrous Metals clean per SSPC- SP3 Power Tool Cleaning
  - b. Primer/Shop Coat: Manufacturers Standard Type Primer Compatible with finish coats below
    - 1) Perform crosshatch field adhesion test per ASTM D 3359 to determine compatibility of manufacturer's primer with herein specified coating system prior to coating system application.

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- c. First Coat: Series 37H-77 Chemprime
  - 1) Dry Film Thickness: 2.0-3.0 mils
- d. Intermediate Coat: Series 2H Tneme-Gloss
   1) Dry Film Thickness: 2.0-3.0 mils
- Dry Film Thickness: 2.0-3.0 m
   Finish Coat: Series 2H Tneme-Gloss
  - Finish Coat: Series 2H Theme-Gloss
  - 1) Dry Film Thickness: 2.0-3.0 mils
- f. Total Dry Film Thickness: 6.0 to 9.0 mils (excluding shop primer coat)
- 7. Previously Painted Non-Submerged Ferrous Metals & Ductile Iron:
  - a. Surface Preparation: Clean all surfaces of all dirt, dust, chalk, and any other foreign matter that may interfere with the adhesion of the proposed coating system. Clean all corroded areas in accordance with SSPC-SP 3 Power Tool Cleaning. Feather Edges. Spot Prime all areas cleaned to bare metal.
  - b. Spot Prime: Series 135 Chembuild
    - 1) Dry Film Thickness: 3.0 5.0
  - c. Full Prime: Series 135 Chembuild
    - 1) Dry Film Thickness: 2.0 3.0
  - d. Finish Coat: Series 1074 Endura-Shield II
    - 1) Dry Film Thickness: 2.0 3.0
- 8. Non-Submerged Ductile Iron:

b.

d.

- a. Surface Preparation: Abrasive blast to remove all contaminants.
  - Primer: Series N140-1211 Pota-Pox Plus
  - 1) Dry Film Thickness: 6.0 8.0
- c. Intermediate: Series N69 Hi-Build Epoxoline II
   1) Dry Film Thickness: 3.0 5.0
  - Finish Coat: Series 1074 Endura-Shield
  - 1) Dry Film Thickness: 2.0 3.0
- e. Total Dry Film Thickness: 11.0 16.0
- 6. Concrete Masonry Block & Concrete: (where indicated in finish schedule)
  - a. Surface Preparation: SSPC SP13/NACE 6 Surface Preparation of Concrete. Surface shall be clean and dry.
  - b. First Coat: Series 151 Elasto-Grip FC
    - 1) Dry Film Thickness: 0.7 1.5 mils
  - c. Second Coat: Series 156 Enviro-Crete
    - 1) Dry Film Thickness: 6.0 8.0 mils
  - d. Third Coat: Series 156 Enviro-Crete
    - 1) Dry Film Thickness: 6.0 8.0 mils
  - e. Total Dry Film Thickness: 12. 7 -17.5 mils
- B. Immersion or Vapor Zone Service
  - 1. \*All coating thickness are expressed in dry film thickness (DFT.)
  - 2. Ferrous Metals Submerged or Intermittently Submerged in Waste Water
  - 3. Surface Preparation: SSPC-SP 10 Near White Blast Cleaning
    - a. Primer: Series 1 Omnithane
      - 1) Dry Film Thickness: 2.5 3.5
      - Intermediate: Series 446 Perma-Shield MCU
        - 1) Dry Film Thickness: 7.0 9.0

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b.

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- c. Finish: Series 446 Perma-Shield MCU
  - 1) Dry Film Thickness: 7.0 9.0
- d. Total Dry Film Thickness: 14.5 19.5

# C. COLOR SYSTEM MATERIAL INDENTIFICATION

Wastewater	
Raw Water (WW)	Aqua
Backwash Water (Waste) (BWW	Light Brown
Filtered Water (FE)	Dark Blue
Finished Water (FW)	Dark Blue
Process Drain or Drain (DP or DR)	Dark Gray
Sewer (Sanitary or other)	Dark Gray
Chemical	
Alum. Or Primary	Orange
Ammonia	White
Carbon Slurry	Black
Caustic	Yellow with green band
Chlorine (Gas and Solution)	Yellow
Fluoride	Light blue with red band
Lime Slurry	Light green
Ozone	Yellow with orange band
Phosphate Compounds	Light green with red band
Polymers or Coagulant Aids	Orange with green band
Sodium Permanganate	Violet
Ozone	Light green with orange band
Sulfuric Acid	Yellow with red band
Sulfur Dioxide	Light green with yellow band
Other	
Compressed Air	Dark green
Gas	Red
Other Lines	Light gray
Hoists/Trolleys	Yellow

END OF SECTION 09 96 00

# SECTION 13 31 24 – TENSION-FABRIC GEOMEMBRANE BAFFLE CURTAIN

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Tension-fabric geomembrane baffle curtain system.
- B. General Description:
  - 1. The baffles shall conform to the specified dimensions and shall be designed for installation in potable water. All parts shall be made from corrosion resistant and chemical resistant materials suitable for service in raw or treated water storage facilities and comply with current AWWA and ANSI/NSF-61 standards. The suspended baffles and accessory materials shall be capable of withstanding exposure to chlorine and ammonia, extreme temperatures, rips, and hydraulic shock. The baffle system shall be suitable for expected water levels with daily fluctuations and shall have adequate strength to resist 0.5 inch of water depth difference across the baffle.
  - 2. The baffles shall be erected and anchored to the floor, walls, and roof as shown in the plans to provide a flow path for maximum contact time for potable water in the tank.
- C. Related Requirements:
  - 1. Section 33 16 32 Prestressed Composite Storage Tanks

#### 1.2 REFERENCES

- A. ASTM D413 Standard Test Methods for Rubber Property—Adhesion to Flexible Substrate
- B. ASTM D471 Standard Test Method for Rubber Property—Effect of Liquids
- C. ASTM D751 Standard Test Method for Coated Fabrics.
- D. ASTM D696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer
- E. ASTM D1204 Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
- F. ASTM D4437 Standard Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- G. ASTM D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

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- H. ASTM D2136 Standard Test Method for Coated Fabrics—Low-Temperature Bend Test
- I. ASTM D3389 Standard Test Method for Coated Fabrics Abrasion Resistance
- J. ASTM G153 Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

#### 1.3 QUALIFICATIONS

A. The baffle fabricator shall have furnished and had in satisfactory service for a period of not less than five (5) years, at least five (5) baffle systems with dimensions and quantities similar to the one specified for this project. The fabricator shall submit evidence of experience.

### 1.4 SUBMITTALS

A. Submit to the Engineer complete design calculations and a complete set of detailed working drawings for the baffle and accessories, in accordance with Section 01 33 00 – Submittal Procedures.

### PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. The baffle and accessories, shall be manufactured by:
  - 1. Seaman Corporation Wooster, OH
  - 2. Lange Containment Systems Denver, CO
  - 3. Or Approved Equal

# 2.2 FABRIC

- A. The fabric shall be listed by NSF61 as being acceptable for use in potable water. The fabric shall have a knitted polymer coated polyester fabric with a 6.5 oz. /sq. yd. minimum weight.
- B. The fabric shall be of good appearance and free of all defects such as holes, tears, blisters, and any other defects that may affect its serviceability.
- C. The coated fabric shall not be less than 30 mils thickness with a 10 percent allowable variation. There shall be not less than 7 mils thickness of polymer coating over the base fabric.
- D. The polyester fabric shall be non-wicking.
- E. The coated fabric shall be UV stable (either black or black/white) in order to possess maximum UV resistance when exposed to the atmosphere for extended periods of time.
- F. The fabric shall meet or exceed the following minimum physical properties:
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Fabric	Standard	Metric
Base Fabric Type	Polyester	
Base Fabric Weight (nominal)	6.5 oz/yd <sup>2</sup>	220 g/m <sup>2</sup>
Thickness ASTM D 751	30.0 mils min	0.75 mm min
Weight ASTM D 751	$30.0 \pm 2 \text{ oz/yd}^2$	$1020 \pm 70 \text{ g/m}^2$
Tear Strength ASTM D 751, Trapezoid Tear	35/35 lb min	155/155 N min
Breaking Yield Strength ASTM D 751, Grab Tensile Procedure A	550/550 lb min	2450/2450 N min
Low Temperature ASTM D 2136, 4 hr - 1/8" mandrel	Pass @ -30°F	Pass @ -35° C
Dimensional Stability ASTM D 1204, 212°F - 1 hr	1.5% max each direction	1.5% max each direction
Adhesion Heat Sealed Seam ASTM D 751, Dielectric Weld	35 lb/2 in min	150 N/5 cm min
Dead Load Seam Shear Strength ASTM D 751, 4 hr test	2 in seam, 1 in strip 210 lb @ 70°F 105 lb @ 160°F	5 cm seam, 2.5 cm strip 935 N @ 21°C 465 N @ 70°C
Bursting Strength ASTM D 751, Ball Tip	650 lb min 800 lb typical	2890 N min 3560 N typical
Hydrostatic Resistance ASTM D 751, Method A	800 psi min	540 N/sq cm min
Blocking Resistance ASTM D 751, 180°F/82°C	#2 rating max	
Adhesion - Ply	15 lb/min	65 N/2.5 cm min
ASTM D 413, Type A	or Film Tearing Bond	or Film Tearing Bond
Bonded Seam Strength ASTM D 751, Grab Test Method, Procedure A	550 lb min	2450 N min
Abrasion Resistance ASTM D 3389, H-18 Wheel 1000 g load	2000 cycles (min) before fabric exposure 50 mg/100 cycles max weight loss	
Weathering Resistance ASTM G 153 (Carbon-Arc)	8000 hrs (min) - No appreciable changes or stiffening or cracking of coating	
Water Absorption ASTM D 471, Section 12 7 Days	0.025 kg/m <sup>2</sup> max @ 70°F/21°C 0.14 kg/m <sup>2</sup> max @ 212°F/100°C	
Wicking ASTM D 751	1/8 in max	0.3 cm max
Puncture Resistance	250 lb min	1110 N min

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ASTM D 4833		
Coefficient of Thermal Expansion/Contraction ASTM D 696	8 x 10 <sup>-6</sup> in/in/°F max	1.4 x 10 <sup>-5</sup> cm/cm/°C max

#### 2.3 FASTENERS AND HARDWARE

- A. All bolts, washers, nuts, and expansion anchors shall be type 316 stainless steel, minimum 3/8-inch diameter.
- B. Curtain connections shall be fiberglass angle, minimum <sup>1</sup>/<sub>4</sub>-inch thickness by 2 inches long by 2 inches wide.
- C. Suspension and tension for the top and open ends of the curtain(s) shall be type 316 stainless steel 3/16" diameter cable with type 316 stainless steel 3/16" cable clamps and thimbles.

## PART 3 - EXECUTION

#### 3.1 COORDINATION

- A. The baffle manufacturer shall coordinate with the Engineer and the tank manufacturer concerning loading on the reservoir, attachment details, and the sequence of construction. Installation details shown on the plans are provided as a guide for the Contractor and baffle manufacturer.
- B. The Contractor shall provide thickened areas beneath the membrane slab as required for securing the base of the baffle curtain.

#### 3.2 PREPARATION AND FABRICATION

- A. Prior to factory seaming, all rolled goods shall be inspected. All factory seams shall be made by thermal fusion methods. All factory seams shall have a minimum scrim-to-scrim overlap of one and one-half inches (1½") when fabricated. Fabricated seams found to have less than the specified minimum overlap shall be repaired by adding an overlap or cap strip that provides the minimum specified overlap, or it will be rejected. All seams shall be made so that thermal fusion bond extends fully along the width of the sheet, so that no loose edges are present.
- B. Prior to installation, all unnecessary material and equipment shall be removed from the tank and the floor slab installation areas shall be swept clean.

#### 3.3 INSPECTION

A. All sheets and seams shall be 100% visually inspected during fabrication. No defective seams or exposed scrim will be allowed. All exposed scrim edges shall be sealed with an additional

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strip of 8130 XR-3PW. All indicated repairs shall be made by the geomembrane fabricator before the panels are packaged for shipment.

- B. In addition to visual inspection, a 48-inch (1.2m) weld sample shall be made with each factory seam welding unit used in this work at the beginning of every work shift and every four (4) hours of production thereafter. Sample shall be taken from a seam specifically made for quality testing and not taken from the fabricated panel itself. Test specimens shall be cut at quarter points from each 48-inch seam sample (a total of three places) and tested for seam strength and peel adhesion. The shear seam strength shall be tested in accordance with ASTM D751 as modified in Annex A of ANSI/NSF 54. The peel adhesion shall be tested in accordance with ASTM D 4437 as modified in Annex A of ANSI/NSF 54.
  - 1. A log shall be maintained showing the date, time, panel number, and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the material and/or seams as appropriate. The fabricator shall provide the test results to the Owner or Engineer upon request.
- C. Upon completion of baffle wall installation, the Contractor shall visually inspect the baffle walls for damage from ground level. Any repairs shall be made with newly manufactured material cut with rounded corners extending 4-inches in each direction from the damaged area. The entire repair shall be completely welded to the baffle wall.

#### 3.4 INSTALLATION

- A. Field verify dimensions and provide the field dimensions to the baffle curtain fabricator prior to fabrication of the baffle curtains.
- B. Fabricate and erect all work in accordance with the approved submittal drawings. No field seaming shall be allowed.
- C. Secure the baffle to the floor and wall with fiberglass angles with type 316 stainless steel expansion anchors or cast in place threaded inserts. All baffle penetrations shall be punched.
- D. Provide a 3/8-inch polypropylene rope in the perimeter of the baffle curtain(s). Rope shall be secured with a 4½-inch wide double hem at the floor and wall connections and a 3-inch wide double hem at the top and open-end connections. The floor and wall hems shall be reinforced with an additional 2½-inch wide chafing strip on both sides of the hem, front and back. Install curtain(s) so that chaffing strip is mounted behind the angles in direct contact with the concrete.
- E. Provide fiberglass NSF approved or stainless steel angle sandwiching the baffle curtain on the top edge and open end of the baffle wall with 3/8-inch bolts for attaching the baffle to the top and the open end wall of the tank as shown on the drawings.
- F. Provide type 316 stainless steel 3/16" diameter cable from the tank roof/wall to the top edge or open end of the baffle curtain to tension or suspend the baffle curtain. The type 316 stainless steel 3/16" diameter cable shall be secured using type 316 stainless steel 3/16" cable clamps.
- G. All hardware and fasteners shall be made of type 316 stainless steel.

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END OF SECTION 13 31 24

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**DIVISION 26** 

# **ELECTRICAL SPECIFICATIONS**

PREPARED BY



John Averrett, PE

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SECTION 26 00 00 - ELECTRICAL

PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Work under this item of the Contract shall include the furnishing of all labor, material, equipment, supplies, and services necessary to construct and install the complete electrical systems, including exterior and interior of buildings as shown on the drawings and specified herein.
- B. The Contractor shall base his proposal on the materials specified herein and on the drawings. Reference to a particular product by the manufacturer, trade name, or catalog number establishes the quality standards of materials and equipment required for this installation and is not intended to exclude products equal in quality and similar in design. Where two or more designations are listed, choice shall be optional with the Contractor. The Engineer reserves the sole right to decide the equality of materials proposed for use in lieu of those specified.

#### 1.2 RELATED DOCUMENTS:

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

#### 1.3 CODES, PERMITS, AND INSPECTIONS

A. Comply with applicable laws of the community, with latest edition of NEC where not in conflict with those laws, and with the service rules of the local utility company. Obtain and pay for all permits required. After completion of the work, submit certificate of final inspection and approval from the local electrical inspector, certifying that the installation complies with all regulations governing same.

#### 1.4 DRAWINGS AND SPECIFICATIONS

A. Consider as complementary each to the other. What is called for by one shall be as binding as if called for by both. Where conflicts occur, secure clarification from Engineer in advance of bidding; otherwise provide the more expensive quality or quantity. Follow figures in preference to scale dimensions; verify all dimensions and existing conditions.

# 1.5 CONFLICTS, COORDINATION AND CHANGES

A. In the event that interferences or conflicts develop, the Engineer shall decide which equipment shall be relocated regardless of which was first installed. In the interest of avoiding such conflicts, the electrical sub-contractor who is using common space such as mechanical rooms, chases, ceiling space, etc., shall coordinate his work with all other trades

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and other parts of his own work. If, during this coordination, it is discovered that necessary or desirable changes should be made, advise the Engineer and secure his decision in writing.

#### 1.6 SUBMITTALS

- A. The Electrical Contractor shall submit five copies of a list of items proposed for use. The Electrical Contractor shall also submit five copies of catalog data and shop drawings on proposed substitutions and on panelboards, exhaust fans, transformers, motor control centers, switchboards, light fixtures, electric heaters, safety switches, surge suppressors, lightning arrestors, etc. Where substitutions alter the design or space requirements, the Electrical Contractor shall defray all items of cost for the revised design and construction including costs of all allied trades involved.
- B. The Electrical Contractor shall include in his submittals layout drawings of all electrical rooms, layout drawings of all common space rooms, and/or layout drawings of all backboards or any other space where electrical equipment is mounted showing that he has taken into account other trades that may share this space.
- C. Record Drawings: Provide, and in such detail as required.
- D. Operations and Maintenance Manuals: Provide, and in such detail as required.

# 1.7 WARRANTY

A. Warrant the entire electrical system in proper working order. Replace, without additional charge, all work or material which may develop defects (ordinary wear and tear or damage resulting from improper handling excepted) within a period of one year from date of final acceptance.

#### PART 2 - PRODUCTS

- 2.1 GENERAL
  - A. All materials shall be new and shall be listed as approved by the Underwriter's Laboratories, Inc. in every case where a standard has been established for the particular type of material in question. All work shall be executed in workmanlike manner and shall present a neat and mechanical appearance when completed.

#### 2.2 ELECTRICAL SERVICE

A. General: Coordinate with Utility Company. Provide all material and labor not supplied by Utility Company so as to produce a complete installation meeting the Utility regulations. The Electrical Contractor shall be responsible for including all fees associated with bringing power to this site in their original bid per the allowance noted in the front end documents of these specifications. A copy of the bill showing the cost to provide the electrical service shall be given to the owner for verification of the cost.

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- B. Characteristics of Service: Upgrade existing 277/480 volt, 60 cycle, 3 phase, 4 wire, with a ground service onsite as shown on the drawings..
- C. Metering: Obtain from Utility Company.
- D. Main Service Equipment: Install as per the Riser Diagram and per the Utility Company's regulations. Coordinate any increase or decrease in transformer size with utility.
- E. Service Feeder: Install as per the Riser Diagram and per the Utility Company's regulations. Coordinate any increase or decrease in transformer size with utility.
- F. Transformer: Coordinate with Utility for correct size of service transformer prior to installation connection. Coordinate any increase or decrease in transformer size with utility.

## PART 3 - EXECUTION

## 3.1 VISIT TO SITE

A. Before submitting a bid, visit the site and ascertain all existing conditions. Make such adjustments in work as are required by the actual conditions encountered.

## 3.2 CUTTING AND CHASING

A. Where possible all work shall be built in as the job progresses. Where this is not possible, secure approval and do necessary cutting, chasing, etc. required. Do not cut through any structural members without securing approval in advance; such holes shall be neatly cut or drilled – not chipped.

## 3.3 TRENCHING AND BACKFILLING

A. Do all excavating necessary for installation of work; backfill trenches and excavations after work has been installed and inspected. Backfill within the building and under paved areas shall meet compaction requirements and fill material shall be pit run gravel or similar granular material.

## 3.4 ELECTRICAL SERVICE INSTALLATION

- A. Project Conditions: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated.
- B. Notify Project Manager and Owner no fewer than seven days in advance of proposed interruption of electrical service.
- C. Indicate method of providing temporary electrical service.

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- D. Do not proceed with interruption of electrical service without Project Manager's written permission.

# 3.5 SALVAGE MATERIAL

A. All metals and devices removed from the project that can be returned for scrap shall be the property of the owner. Owner shall have first right of refusal on all items that are to be demolished, removed or scrapped from the project. Contractor shall provide a list of such items in written form to the owner. Prior to the contractor salvaging any material for his own gain, the contractor shall obtain written approval from the owner.

END OF SECTION 26 00 00

# SECTION 26 03 30 - SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

# PART 1 GENERAL

#### 1.1 SUMMARY

A. This section covers work necessary for the modification, design, documentation, assembly, test, installation, field testing, startup, training, and final documentation for the Whitewater Creek WWTP Improvements project as shown on the drawings and specified herein.

#### 1.2 DESCRIPTION

- A. Work included: Provide modifications to the existing pump stations with appurtenant equipment and accessories as indicated, specified, and as necessary for a complete and proper operating system.
  - 1. Work includes, but is not necessarily limited to, the following:
    - a. All PLC hardware, programmable logic controller I/O Boards and other appurtenances as indicated and specified herein and as required by the pump stations descriptions.
    - b. All engineering, hardware and software development, installation, startup, calibration services, programming and necessary supervision required.
    - c. New operator workstations complete with accessories was described herein.
    - d. Testing and operational demonstrations as specified.
    - e. Training programs as specified.
    - f. Preparation of instruction manuals.

#### 1.3 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related work specified elsewhere includes:
  - 1. Division 40
  - 2. Division 43
  - 3. Division 46
  - 4. Division 26

#### 1.4 SUBMITTALS

- A. Hardware Submittals: Before any components are fabricated, and/or integrated into assemblies or shipped to the job site, furnish to the ENGINEER, for their review, submittal documents in accordance with Section 013300. Submittals shall include full details, shop drawings, catalog cuts and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these specifications. Specifically, the CONTRACTOR shall submit the following materials:
  - 1. Block diagram and operational description of the system showing all major components and their interconnections and interrelationships. Label each diagram and specify all external power and communications interfaces. All diagrams shall be in an 11 by 17 format. Required documentation sets shall be furnished in bound hardcopy and final documentation shall also be provided in electronic format on CD.
  - 2. Drawings of equipment to be supplied shall include, as a minimum: overall dimension details for each panel, console, etc., including internal and external arrangements and door mounted

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operator devices with nameplate designations. Wiring diagrams of equipment including field device connections shall be included and specific installation/wiring requirements identified.

- 3. Operational Description shall include the principal functions/capabilities of the personal computer (PC) and PLC's as provided and configured /programmed. Included shall be a description of system communications.
- 4. Provide a detailed Bill of Materials along with descriptive literature identifying component name, manufacturer, model number, and quantity supplied.
- 5. Provide Warranty information for entire installation.
- B. Software Submittals:
  - 1. Provide complete user manuals for all supplier configured software and firmware. For ancillary software such as operating systems, spreadsheets, etc. being supplied under this contract, only a listing of the manuals, which will be included with the Operations and Maintenance documentation is required.
  - 2. Sample communication and control database programs for project in hardcopy form. As a minimum, hardcopy form shall be fully documented, including code, comments, addressing data and cross-references, etc. Every line or section of code shall be accompanied by a comment describing its function.
  - 3. Provide initial graphic display and report format layouts as described later in this specification. List and briefly describe all operator interface functions provided at the PC, including: alarm annunciation and acknowledgment, status displays, control capabilities, report generation, event logging, charting and trending, etc.
- C. Operation and Maintenance Manuals
  - 1. The CONTRACTOR shall provide hard-covered, ring bound loose-leaf O&M manuals in accordance with Section 01782. In addition to "as-built" system drawings, the manuals shall include internal wiring diagrams and operating and maintenance literature for all components provided under this section.
  - 2. The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, programming and configuration, adjustment, calibration, testing and maintenance of each component and/or instrument.
  - 3. Operation and Maintenance manuals shall include copies of all commented PLC programs written to accomplish the monitoring and control functions specified, as well as all passwords associated with the SCADA system. Programs shall be updated after startup is complete, with the program(s) provided to the OWNER on compact disk (CD). Two (2) copies to be provided.
  - 4. The contents of the O&M manuals shall be generally organized as follows:
    - a. System Hardware/Installation
    - b. System Software, including all passwords
    - c. Operation
    - d. Maintenance and Troubleshooting
- D. Test Outlines and Procedures Submittals: Test descriptions shall be in sufficient detail to fully describe the specific tests to be conducted to demonstrate conformance with this specification.
- E. Spares and Expendable Recommendations: The CONTRACTOR shall provide a list of recommended spares and expendable items. The list shall be exclusive of any spares furnished under this Contract.
- 1.5 QUALITY ASSURANCE

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- A. The CONTRACTOR'S attention is directed to the fact that all specified instruments and controls must form a completely integrated system and, as such, the system integrator shall become familiar with requirements necessary to provide equipment specified for the system regardless of manufacture, and shall be responsible to the CONTRACTOR for the complete and satisfactory operation of the entire plant instrumentation and control system.
  - 1. These specifications cover the intended function of the equipment, but do not necessarily cover all details necessary for a complete, operable and functional system. The manufacturer shall supply all devices and appurtenances necessary to provide a complete, operable and satisfactory system as indicated or specified.
  - 2. The Control System Integrator shall have a minimum of five years experience in providing similar operational systems of which a listing may be requested.
- B. The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired. Alternate equipment shall be submitted to the ENGINEER at least 14 days prior to bid (in accordance with the following prebid submittal requirements and Section 01625). The ENGINEER will issue an addendum prior to bid listing approved alternate control systems.
- C. Control System Integrator
  - 1. It is the intent of these specifications and drawings that the Contractor shall engage an approved and qualified Control System Integrator to provide the system as specified and indicated.
  - 2. The Control System Integrator shall have an UL508A panel shop and have a Field Service Engineer within 250 miles of the site.
  - 3. The Control System Integrator shall design and furnish a complete, integrated and functionally operating system, warranted to perform the intended functions as herein specified.
  - 4. Provide or supply all hardware and software specified herein or required and provide all required and specified collateral services in connection with the system such as testing, calibration, start-up, operation and maintenance manuals, and operator training without additional cost to the OWNER.
  - 5. Provide system integration for control systems by other equipment manufacturers supplying control equipment.
- D. Individual Responsibilities
  - 1. System Integrators
    - a. The system integrator shall have the authority to organize the data layout within each individual device used in the user interface system. This said data layout will be based on the device provider's listing of available data points for monitor and control. The system integrator will dictate the data used and the layout needed to facilitate the most efficient system possible. This efficient system methodology will be to minimize the number of queries needed to retrieve the necessary information. The system integrator may also require the separation of status and control registers to more easily facilitate expansion and/or changes to the data structure. The system integrator does not have the authority to change the program algorithm for the subsystem device. The actual functionality of the system integrator is responsible for contacting each device provider and attaining the **LLS & CAWOOD, INC.**

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listing of data available and then communicating with the provider the proper organization of data in the system.

- 2. Device Providers
  - a. Device providers must generate a listing of all pertinent data available for monitor and control within the user interface system. Based on this listing, the system integrator shall direct the provider on how the data shall be made public and also how to efficiently organize data as needed by the user interface. Device must be capable of communicating this data over the deemed standard protocol for this job such as Modbus TCP or Ethernet-IP over Ethernet TCP/IP. The device provider is responsible for making the said device to respond properly and safely to changes made in control variables. It is the device provider's responsibility to be in contact with the system integrator to ensure proper operation within the integrators scope of work. The device provider has direct control over the program algorithm for the portion of the system the said device is specified.
- E. System Integrator/Supplier(s)
  - 1. MR Systems, Norcross, Ga
  - 2. Or Approved Equal.

# 1.6 RESPONSIBILITY FOR COMPLETE SYSTEM

- A. The CONTRACTOR shall be responsible for and shall provide for the design, supply, delivery, installation, certification, calibration and adjustment, software configuration, testing and startup, OWNER training, warranty and routine future field services, of a complete coordinated system which shall perform the specified functions.
- B. The OWNER and the ENGINEER will review system technical information as submitted by the CONTRACTOR for software; operating system, database, control strategies and the graphical user interface, i.e. report and log formats, graphics, trends, alarming, etc. for complete compliance with these specifications.
- 1.7 WARRANTY
  - A. Systems supplier shall furnish a hardware and software maintenance contract for the computer system, providing for an 8-hour response time in normal working hours, five days per week for the length of the warranty period.
    - 1. For any service visit during this period, provide the OWNER and ENGINEER with a written report stating the reason for equipment failure and recommendations to prevent recurrence.
  - B. At the end of this period, the maintenance contract shall be made available for transfer to the OWNER.

## PART 2 PRODUCTS

- 2.1 GENERAL
  - A. Major components of this system shall include the specified software, materials, equipment, and installation required to implement a complete and operational SCADA system along with any associated panel or field modifications.
  - B. In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, to the greatest extent possible, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

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- C. Requirements for the electrical work associated with the installation of the SCADA system and associated instrumentation equipment are as specified in Division 26 ELECTRICAL.
- D. The functions and features specified herewith are the minimum acceptable requirements for the SCADA system. The provided system shall equal or exceed each requirement.
- E. In some cases, the specifications may allow the accomplishing of certain functions by means of more than one hardware/firmware/software approach. No other approach may be taken that is different from that specified.
- F. The total control and monitoring system shall consist of a series of individual control and monitoring sub-systems, each configured to perform a specific function associated with the total system operational scheme.
- G. All equipment and materials shall be new, unused and proved by previous use of similar products to be completely suitable for the service intended.
- H. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the SCADA system. The completed system shall be compatible with the functions required and other equipment furnished by the CONTRACTOR.
- I. System manufacturer to supply "as-built" drawings containing all necessary information for proper maintenance and operation of the system.
  - 1. Wire log table showing connections (wire terminations) between all furnished components to be supplied to facilitate field wiring.
  - 2. Interconnection information between system components and equipment found in other sections of these Specifications shall be complete with all necessary interconnection information.
  - 3. Notes, which refer to equipment manufacturer's drawings for proper interconnection will not be acceptable.

# 2.2 WATER TREATMENT PLANT SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM

- A. System Description and System Components:
  - 1. The existing Supervisory Control and Data Acquisition (SCADA) System shall be modified as described herein:
    - a. Incorporate new Clearwell and associated Level Transmitter and Element into the existing LCP-H PLC panel, utilizing existing I/O termination points inside the panel for the new analog input for clearwell level. These signals will be terminated in LCP-H PLC panel using hardwired signals in the High Service Pump Station building and the PLC will be modified by the Systems Integrator as required to control and monitor the above noted signals.
    - b. Incorporate new NaOCL feed pump running and failed status signals, as well as a dosage signal to set the dosing rate for each pump into the SCADA system from the new FCP-NaOCL-MP-2 and incorporate the seal leak signal for each new pump from existing FCP-NaOCL-MP-1. These signals will be terminated in LCP-E PLC panel using hardwired signals in the same building and the PLC will be modified by the Systems Integrator as required to control and monitor the above noted signals.
    - c. Incorporate new Ammonia Water Booster Pump running and failed status signals for each pump into the SCADA system via ethernet communications. These signals will be terminated in LCP-E PLC panel in the same building and the PLC will be modified by the Systems Integrator as required to control and monitor the above noted signals.

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- d. The remainder of the existing plant that is to remain online shall remain connected to the system as is currently done. If changing of the existing system is required, contact the Engineer for approval.
- e. Main Computers and Graphics modified as follows:
  - 1) The existing SCADA software and control algorithms shall be modified to include the new instrumentation and process equipment in the new clearwell process area, the new process equipment in the existing NaOCL feed room process area, and the new process equipment in the existing ammonia feed room process area.

# 2.3 HUMAN-MACHINE INTERFACE (HMI) SOFTWARE PACKAGE

- A. The supervisory control and data acquisition (SCADA) system shall be modified by the System Integrator specifically for the I/o and PLC equipment additions noted. As a minimum, the following graphics shall be required:
  - 1. Provide Updated System Overview Screen for the Clearwell process area, including the new Level Transmitter.
  - 2. Provide Updated System Overview Screen for the NaOCL feed process area, including the new Pump FCP.
  - 3. Provide Updated System Overview Screen for the Ammonia Feed process area, including the new Water Booster Pump skid and FCP.
  - 4. Updated Display Screen for each Location
  - 5. Individual Control for each new Process Equipment
  - 6. Real Time Trend Screens for each new tagged variable.
  - 7. An updated "Alarm Screen" which shows all signals which are presently in alarm and the status of each (i.e. "Acknowledged" or "Unacknowledged") of the new signals and the alarms associated with them.

#### 2.3 SOFTWARE ALARMS

A. All analog inputs to the SCADA system shall have the capability for low and high software alarms. Where low and/or high software alarms are not specified elsewhere in this document, they shall initially be turned off or set for 0% (low alarm) and 100% (high alarm) of the signal range. This will help eliminate nuisance alarms during checkout and start-up. All software alarms shall be reviewed with the Owner, or his designee, during panel start-up. The System Integrator shall change all software alarm set-point values as instructed by the plant superintendent. For critical alarms, the System Integrator shall configure the associated graphic symbol to flash or change color when in an alarm condition. Critical software alarms that provide equipment interlock, (i.e., pump low level stop) will be generated in the (PLC) but set-points will be set at the HMI.

## 2.4 CONTROL STRATEGY

## A. General

- 1. The Instrumentation and Controls System Integrator shall coordinate actual control strategy requirements and implementation with site constraints, equipment vendors, contractors and operations personnel.
- 2. Coordinate with process drawings and specifications for a complete control scenario. Also, the systems integrator is required to have process control meetings with the owner, operators, and engineers prior to starting work so that the SCADA system functions as desired.

## PART 3 EXECUTION

# 3.1 GENERAL

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A. Coordinate all work with the ENGINEER and OWNER to avoid conflicts, errors, delays and unnecessary interference with operation of the process during installation, testing, cutover and startup.

#### 3.2 SURFACE CONDITIONS

A. Systems Integrator shall visit site prior to bid to examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

# 3.3 INSTALLATION OF SYSTEM

- A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B. Install the work of this Section in strict accordance with the original design and the manufacturer's recommended installation procedures as approved by the ENGINEER, anchoring all components firmly into position for long life under hard use.

#### 3.4 SOFTWARE REDEVELOPMENT

A. Human-Machine Interface (HMI) software shall be fully configured by the instrumentation and control system vendor to integrate the new data. Reports, graphics displays, real-time trends, historical trends, security, and alarming shall be developed by the instrumentation and control system vendor through a collaborative effort between the ENGINEER, OWNER, and control system vendor. Graphics displays shall be designed by the instrumentation and control system vendor.

## 3.5 SYSTEM DISPLAY AND REPORTS

- A. Graphic Display Design Meeting and Submittal
  - 1. Two (2) one-day graphic display design meeting shall be held with the Engineer and Owner's personnel to discuss specific details of overall design of the graphic displays including discussions of the particular signals which are to be displayed on each graphic display and also specific control strategies for the redeveloped system. The meeting shall be held at the Owner's facility. There shall be an initial development meeting, followed by a comment and review period. Once that has been accomplished, a second meeting shall be held to review changes and make any final comments before implementation.
  - 2. Prior to the meeting the instrumentation and control system vendor shall submit detailed sketches of the proposed new graphics displays and a detailed narrative for each of the proposed control strategies to the Engineer for review.
  - 3. Travel and living costs to/from the Owner's facility shall be borne by each party.
- B. Control Strategy Design Meeting
  - 1. Two (2) one-day process control strategy design meeting shall be held with the Engineer and Owner's personnel to discuss specific details of overall control of the plant processes including discussions of the specific control strategies for the redeveloped systems. The meeting shall be held at the Owner's facility. There shall be an initial development meeting, followed by a comment and review period. Once that has been accomplished, a second meeting shall be held to review changes and make any final comments before implementation.
  - 2. Prior to the meeting the instrumentation and control system vendor shall submit a detailed narrative for each of the proposed control strategies to the Engineer for review.
  - 3. Travel and living costs to/from the Owner's facility shall be borne by each party.

- C. Report Design Meeting
  - 1. A one-day report strategy design meeting shall be held with the Engineer and Owner's personnel to discuss specific details of the various historical data reports and state reports which are to be developed for the system. The meeting shall be held at the Owner's facility.
  - 2. Prior to the meeting the instrumentation and control system vendor shall submit detailed sketches of the proposed new graphics displays and a detailed narrative for each of the proposed control strategies to the Engineer for review.
  - 3. Travel and living costs to/from the Owner's facility shall be borne by each party.

## 3.6 TRAINING

- A. System supplier to provide operation and maintenance training for Owner's personnel to ensure their adequate knowledge of use of the system.
- B. Training to be conducted on-site by instructors thoroughly familiar with operation of the system.
- C. Analog and digital hardware maintenance training:
  - a. Instruct Owner's maintenance personnel in the proper preventative maintenance and repair tasks associated with system maintenance.
  - b. For analog instrumentation, include detailed instruction of calibration and checking along with familiarization training for basic repair and maintenance tasks that are expected to be encountered.
  - c. For computer hardware maintenance, include general familiarization with computer hardware and peripheral devices with instruction is preventative maintenance tasks associated primarily with peripheral devices. It is not intended that this course will produce trained computer maintenance technicians.
  - d. Include detailed instruction in maintenance and repair work associated with the computer process I/O sub-system.
  - e. Minimum training time for this material to be two (2) hours.
  - 2. Operator familiarization training:
    - a. Instruct Owner's operating personnel in the proper use of the analog and digital process control system.
    - b. Include instruction in the system control steps and basic interface with the computer system.
    - c. Provide sufficient training to Owner's operating personnel so they can respond to the normal tasks required for operation of the plant.
    - d. Minimum training time for this material to be four (4) hours.
  - 3. Supervisor and application software training:
    - a. Provide supervisory personnel with a working knowledge of all application software supplied.
    - b. Include basic digital and computer concepts, process control concepts, database configuration, report configuration, graphic display configuration, and control strategy development.
    - c. Minimum training time for this material to be Two (2) hours.
    - d. Provide supervisory service of a factory trained service engineer, specifically trained on the type of equipment herein specified, for a period of not less than one (1) 8-hour day during construction to assist the Contractor in the location of mounting brackets, methods of installing conduit and special cable, mounting, piping, and wiring of one of each type of service, and the methods of protecting all of the equipment prior to placing it into service.

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e. Upon completion of equipment installation, provide services of the above service engineer for a period of not less than one (1) 8-hour day for calibration and start-up of the equipment and instructing the operating personnel.

# 3.7 STARTUP SERVICES

- A. All elements of the SCADA system shall be tested to demonstrate that the total system satisfies all of the requirements of this Specification. The CONTRACTOR shall provide all special testing materials and equipment. The CONTRACTOR shall coordinate and schedule all of his testing and startup work with the OWNER. As a minimum, the testing shall include both a factory test and a field test. Testing requirements are as follows:
  - 1. Factory Tests: The PC with peripherals, PLC's and all other associated hardware shall be tested at the factory, prior to shipment, so as to demonstrate that each component is operational and meets the requirements of these specifications. Test results shall be certified, with written documentation provided to the OWNER and ENGINEER upon test completion. The OWNER or ENGINEER shall be offered an invitation to witness the factory testing.
  - 2. Field Tests:
    - a. All system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. Witnessed field tests shall be performed on the complete system. Each function shall be demonstrated to the satisfaction of the OWNER and ENGINEER on a paragraph-by-paragraph basis.
    - b. Each test shall be witnessed and signed off by the CONTRACTOR and the ENGINEER upon satisfactory completion. The CONTRACTOR shall notify the OWNER at least one (1) week prior to the commencement date of the field tests.
- B. Upon final completion of all components determine date of start-up jointly with ENGINEER, OWNER and CONTRACTOR.
- C. System supplier to be responsible for placing of SCADA equipment and systems in operation.
- D. System supplier to provide qualified personnel on the job site until successful operation of system is attained.

#### 3.8 DEFINITION OF ACCEPTANCE

- A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:
  - 1. All O&M documentation has been submitted, reviewed and approved.
  - 2. The complete SCADA system and instrumentation have successfully completed all testing requirements specified herein and have successfully been started up.
  - 3. All OWNER'S staff personnel training programs have been completed.
  - 4. OWNER/ENGINEER sign a document indicating SCADA system has formally been accepted.

END OF SECTION 26 03 30

#### SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Copper building wire rated 600 V or less.
  - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
  - 1. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
  - 2. Section 27 15 13 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

#### 1.3 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer's authorized service representative.
- B. Field quality-control reports.

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#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## PART 2 - PRODUCTS

## 2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden Inc.
  - 2. General Cable Technologies Corporation.
  - 3. Okonite Company (The).
  - 4. Southwire Company.
  - 5. Or Approved Equal.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
  - 1. Type NM: Comply with UL 83 and UL 719.
  - 2. Type RHW-2: Comply with UL 44.
  - 3. Type SE: Comply with UL 854.
  - 4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
  - 5. Type THHN and Type THWN-2: Comply with UL 83.
  - 6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
  - 7. Type UF: Comply with UL 83 and UL 493.
  - 8. Type XHHW-2: Comply with UL 44.
  - 9.
- F. Shield:

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1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

## 2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Electrical Products.
  - 2. Hubbell Power Systems, Inc.
  - 3. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 4. TE Connectivity Ltd.
  - 5. Thomas & Betts Corporation; A Member of the ABB Group.
  - 6. Or Approved Equal.

## PART 3 - EXECUTION

# 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- F. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- G. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
  - A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
  - B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

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- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- F. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- J. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- K. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainlesssteel, wire-mesh, and strain relief device at terminations to suit application.
- M. VFC Output Circuits: Type XHHW-2 in metal conduit.

#### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

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#### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. <u>All wire terminations at motor leads and at motor starters shall be made with insulated ring or</u> fork type terminals and insulated for 600 volts with heat shrink sleeves.

#### 3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

## 3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

# 3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

# 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.

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- 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
- 2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors feeding the following critical equipment and services for compliance with requirements:
- 3. Perform each of the following visual and electrical tests:
  - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
  - b. Test bolted connections for high resistance using one of the following:
    - 1) A low-resistance ohmmeter.
    - 2) Calibrated torque wrench.
    - 3) Thermographic survey.
  - c. Inspect compression-applied connectors for correct cable match and indentation.
  - d. Inspect for correct identification.
  - e. Inspect cable jacket and condition.
  - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
  - g. Continuity test on each conductor and cable.
  - h. Uniform resistance of parallel conductors.
- 4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
  - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

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## SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

#### PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

#### A. Section Includes:

- 1. Backboards.
- 2. Category 6 twisted pair cable.
- 3. Twisted pair cabling hardware.
- 4. RS-485 cabling.
- 5. Low-voltage control cabling.
- 6. Control-circuit conductors.
- 7. Identification products.

## 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

#### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector, certified cabling agent and installer.
- B. Source quality-control reports.

C. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

#### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
  - 1. Flame Travel Distance: 60 inches or less.
  - 2. Peak Optical Smoke Density: 0.5 or less.
  - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

#### 2.2 BACKBOARDS

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
- B. Painting: Paint plywood on all sides and edges with black alkyd paint. Comply with requirements in Section 09 90 00 Painting and Coating.

## 2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- 1. Belden CDT Networking Division/NORDX.
- 2. General Cable; General Cable Corporation.
- 3. Mohawk; a division of Belden Networking, Inc.
- 4. Or Approved Equal.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables. All network cabling shall be certified and installed by a certified installer.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).
- F. Cable Rating: Plenum.
- G. Jacket: Blue thermoplastic.

# 2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden CDT Networking Division/NORDX.
  - 2. General Cable; General Cable Corporation.
  - 3. Hubbell Premise Wiring.
  - 4. Leviton Manufacturing Co., Inc.
  - 5. Mohawk; a division of Belden Networking, Inc.
  - 6. Or Approved Equal.
- C. General Requirements for Twisted Pair Cable Hardware:
  - 1. Comply with the performance requirements of Category 6.
  - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
  - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- E. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
  - 1. Number of Terminals per Field: One for each conductor in assigned cables.

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- G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
  - 1. Features:
    - a. Universal T568A and T568B wiring labels.
    - b. Labeling areas adjacent to conductors.
    - c. Replaceable connectors.
    - d. 24 or 48 ports.
  - 2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
  - 3. Number of Jacks per Field: One for each four-pair cable indicated.
- H. Patch Cords: Factory-made, four-pair cables in 36-inchlengths; terminated with an eight-position modular plug at each end.
  - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
  - 2. Patch cords shall have color-coded boots for circuit identification.
- I. Plugs and Plug Assemblies:
  - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
  - 2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
  - 3. Marked to indicate transmission performance.
- J. Jacks and Jack Assemblies:
  - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
  - 2. Designed to snap-in to a patch panel or faceplate.
  - 3. Standards:
    - a. Category 5e, unshielded twisted pair cable shall comply with IEC 60603-7-2.
    - b. Category 5e, shielded twisted pair cable shall comply with IEC 60603-7-3.
    - c. Category 6, unshielded twisted pair cable shall comply with IEC 60603-7-4.
    - d. Category 6, shielded twisted pair cable shall comply with IEC 60603-7.5.
    - e. Category 6a, unshielded twisted pair cable shall comply with IEC 60603-7-41.
    - f. Category 6a, shielded twisted pair cable shall comply with IEC 60603-7.51.
  - 4. Marked to indicate transmission performance.
- K. Faceplate:
  - 1. Two port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
  - 2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
  - 3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."

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- 4. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
- 5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
  - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

# L. Legend:

- 1. Machine printed, in the field, using adhesive-tape label.
- 2. Snap-in, clear-label covers and machine-printed paper inserts.

# 2.5 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CMG.
  - 1. Paired, one pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  - 1. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
  - 2. Fluorinated ethylene propylene insulation.
  - 3. Unshielded.
  - 4. Fluorinated ethylene propylene jacket.
  - 5. Flame Resistance: NFPA 262.

# 2.6 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
  - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with NFPA 262.

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#### 2.7 CONTROL-CIRCUIT CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. General Cable; General Cable Corporation.
  - 2. Southwire Company.
  - 3. Or Approved Equal.
- B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
  - 1. Smoke control signaling and control circuits.

#### 2.8 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Test cables on receipt at Project site.
  - 1. Test each pair of twisted pair cable for open and short circuits.

#### 3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
  - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

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- 2. Outlet boxes for cables shall be no smaller than 4 inches square by 1-1/2 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
- 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
  - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
  - 2. Install cable trays to route cables if conduits cannot be located in these positions.
  - 3. Secure conduits to backboard if entering the room from overhead.
  - 4. Extend conduits 3 inches above finished floor.
  - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

# 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C Series of standards.
  - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced.
  - 5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
  - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
  - 9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
  - 10. Support: Do not allow cables to lie on removable ceiling tiles.
  - 11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
  - 12. <u>All terminations shall be made with ring or fork type terminals.</u>

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- C. Twisted Pair Cable Installation:
  - 1. Comply with TIA-568-C.2.
  - 2. Install termination hardware as specified in Section 27 15 13 "Communications Copper Horizontal Cabling" unless otherwise indicated.
  - 3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.
- D. Installation of Control-Circuit Conductors:
  - 1. Install wiring in raceways. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- E. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
  - 3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.
- F. Installation of Cable Routed Exposed under Raised Floors:
  - 1. Install plenum-rated cable only.
  - 2. Install cabling after the flooring system has been installed in raised floor areas.
  - 3. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.
- G. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
  - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
    - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
    - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
  - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.

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- c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
- 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

#### 3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

#### 3.5 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
  - 1. Class 1 remote-control and signal circuits; No 14 AWG.
  - 2. Class 2 low-energy, remote-control, and signal circuits; No. 14 AWG.
  - 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

## 3.6 FIRESTOPPING

- A. Comply with TIA-569-D, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping" Chapter.

#### 3.7 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

#### 3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

## 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
  - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.

END OF SECTION 26 05 23
# SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.
  - 2. Ground bonding common with lightning protection system.
  - 3. Foundation steel electrodes.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
  - 1. Test wells.
  - 2. Ground rods.
  - 3. Ground rings.
  - 4. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

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- a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
  - 1) Test wells.
  - 2) Ground rods.
  - 3) Ground rings.
  - 4) Grounding arrangements and connections for separately derived systems.
- b. Instructions for periodic testing and inspection of grounding features at ground rings and test well based on NFPA 70B.
  - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
  - 2) Include recommended testing intervals.

# 1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

# PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

# 2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Burndy; Part of Hubbell Electrical Systems.
  - 2. ERICO International Corporation.
  - 3. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 4. Thomas & Betts Corporation; A Member of the ABB Group.
  - 5. Or Approved Equal.

# 2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:

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- 1. Solid Conductors: ASTM B 3.
- 2. Stranded Conductors: ASTM B 8.
- 3. Tinned Conductors: ASTM B 33.
- 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
- 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
- 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

# 2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with socket set screw.
- J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- N. Straps: Solid copper, copper lugs. Rated for 600 A.

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- O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.
- P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- Q. Water Pipe Clamps:
  - 1. Mechanical type, two pieces with stainless-steel bolts.
    - a. Material: Die-cast zinc alloy.
    - b. Listed for direct burial.
  - 2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

# 2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.
- B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

# PART 3 - EXECUTION

# 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum.
  - 1. Bury at least 24 inches below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

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- 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
- 3. Connections to Ground Rods at Test Wells: Bolted connectors.
- 4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

### 3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

# 3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

### 3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

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- 1. Feeders and branch circuits.
- 2. Lighting circuits.
- 3. Receptacle circuits.
- 4. Single-phase motor and appliance branch circuits.
- 5. Three-phase motor and appliance branch circuits.
- 6. Flexible raceway runs.
- 7. Armored and metal-clad cable runs.
- 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- 9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- H. Metallic Fences: Comply with requirements of IEEE C2.
  - 1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
  - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
  - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

# 3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

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- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

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- 1. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to building steel.
- 2. Bury ground ring not less than 24 inches from building's foundation.
- I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
  - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
  - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

# 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 3. Test completed grounding system at each location where a maximum ground-resistance level shall be no more than ten (10) OHMS at all locations covered by these specifications, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  - 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and

their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

- F. Grounding system will be considered defective if resistance is more than ten (10) OHMS and it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Report measured ground resistances that exceed values as listed on the plans.
- I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

# SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Steel slotted support systems.
  - 2. Aluminum slotted support systems.
  - 3. Nonmetallic slotted support systems.
  - 4. Conduit and cable support devices.
  - 5. Support for conductors in vertical conduit.
  - 6. Structural steel for fabricated supports and restraints.
  - 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
  - 8. Fabricated metal equipment support assemblies.

# 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Slotted support systems, hardware, and accessories.
    - b. Clamps.
    - c. Hangers.
    - d. Sockets.
    - e. Eye nuts.
    - f. Fasteners.
    - g. Anchors.
    - h. Saddles.
    - i. Brackets.
  - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

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- 1. Hangers. Include product data for components.
- 2. Slotted support systems.
- 3. Equipment supports.
- 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
  - 1. Include design calculations and details of hangers.
  - 2. Include design calculations for seismic restraints.

# 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Ductwork, piping, fittings, and supports.
  - 3. Structural members to which hangers and supports will be attached.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Projectors.
- B. Welding certificates.

# 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M.
  - 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
  - 2. Component Importance Factor: 1.5.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame Rating: Class 1.
  - 2. Self-extinguishing according to ASTM D 635.

### 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- B. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- C. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti, Inc.
      - 2) MKT Fastening, LLC.
      - 3) Or Approved Equal.

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- 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) B-line, an Eaton business.
    - 2) Hilti, Inc.
    - 3) MKT Fastening, LLC.
    - 4) Or Approved Equal.
- 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
- 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
- 6. Toggle Bolts: Stainless-steel springhead type.
- 7. Hanger Rods: Threaded steel.

# 2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

#### PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  - 1. NECA 1.
  - 2. NECA 101
  - 3. NECA 102.
  - 4. NECA 105.
  - 5. NECA 111.
- B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

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- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

# 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

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### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

# 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 09 91 13 "Exterior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

# SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal conduits, tubing, and fittings.
  - 2. Nonmetal conduits, tubing, and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Nonmetal wireways and auxiliary gutters.
  - 5. Surface raceways.
  - 6. Boxes, enclosures, and cabinets.
  - 7. Handholes and boxes for exterior underground cabling.

### 1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. CGRC: PVC Coated Galvanized Rigid Conduit.
- C. PVC: Schedule 40 Poly Vinyl Chloride Conduit.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

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- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

# PART 2 - PRODUCTS

# 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Tube & Conduit; a part of Atkore International.
  - 2. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 3. Perma-Cote.
  - 4. Plasti-Bond.
  - 5. Southwire Company.
  - 6. Thomas & Betts Corporation; A Member of the ABB Group.
  - 7. Wheatland Tube Company.
  - 8. Or Approved Equal.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch, minimum.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

- 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
- 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- H. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

# 2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CANTEX INC.
  - 2. RACO; Hubbell.
  - 3. Thomas & Betts Corporation; A Member of the ABB Group.
  - 4. Or Approved Equal.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fiberglass:
  - 1. Comply with NEMA TC 14.
  - 2. Comply with UL 2515 for aboveground raceways.
  - 3. Comply with UL 2420 for belowground raceways.
- D. ENT: Comply with NEMA TC 13 and UL 1653.
- E. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- F. LFNC: Comply with UL 1660.
- G. Rigid HDPE: Comply with UL 651A.
- H. Continuous HDPE: Comply with UL 651A.
- I. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- J. RTRC: Comply with UL 2515A and NEMA TC 14.
- K. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

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- L. Fittings for LFNC: Comply with UL 514B.
- M. Solvents and Adhesives: As recommended by conduit manufacturer.

### 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hoffman; a brand of Pentair Equipment Protection.
  - 2. Square D.
  - 3. Rittal
  - 4. Or Approved Equal.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 12 unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

### 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Moulded Products, Inc.
  - 2. Hoffman; a brand of Pentair Equipment Protection.
  - 3. Or Approved Equal.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

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- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- F. Solvents and Adhesives: As recommended by conduit manufacturer.

### 2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. Panduit Corp.
    - c. Wiremold / Legrand.
    - d. Or Approved Equal.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Incorporated.
    - b. Panduit Corp.
    - c. Wiremold / Legrand.
    - d. Or Approved Equal.

### 2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Crouse-Hinds, an Eaton business.
  - 2. Hoffman; a brand of Pentair Equipment Protection.
  - 3. Hubbell Incorporated; Wiring Device-Kellems.
  - 4. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 5. Plasti-Bond.
  - 6. Thomas & Betts Corporation; A Member of the ABB Group.
  - 7. Wiremold / Legrand.
  - 8. Or Approved Equal.

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- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
  - 1. Material: Cast metal or sheet metal.
  - 2. Type: Fully adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
  - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- N. Gangable boxes are allowed.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuoushinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

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- 2. Nonmetallic Enclosures: Fiberglass.
- 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

# P. Cabinets:

- 1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
- 2. Hinged door in front cover with flush latch and concealed hinge.
- 3. Key latch to match panelboards.
- 4. Metal barriers to separate wiring of different systems and voltage.
- 5. Accessory feet where required for freestanding equipment.
- 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

# 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Oldcastle Precast, Inc.
    - b. Quazite: Hubbell Power Systems, Inc.
    - c. Or Approved Equal.
  - 2. Standard: Comply with SCTE 77.
  - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 6. Cover Legend: Molded lettering, "ELECTRIC.".
  - 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  - 8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

# 2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

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- 1. Tests of materials shall be performed by an independent testing agency.
- 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
- 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

# PART 3 - EXECUTION

# 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Concealed Conduit, Aboveground: GRC.
  - 3. Underground Conduit: RNC, Type EPC-40-PVC,.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R, unless otherwise noted.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: GRC.
  - 2. Exposed, Not Subject to Severe Physical Damage: GRC.
  - 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Gymnasiums.
  - 4. Concealed in Ceilings and Interior Walls and Partitions: GRC.
  - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  - 6. Damp or Wet Locations: GRC.
  - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after

installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

- 3. EMT: Use setscrew, cast-metal fittings. Comply with NEMA FB 2.10.
- 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

#### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. All vertical turnups from underground raceways shall utilize GRC sweep 90-degree radius bends and GRC vertical conduit. The Vertical portion of the conduit shall be coated or wrapped in a bitumastic coating system from below grade to 6 inches above grade.
- J. Stub-ups to Above Recessed Ceilings:
  - 1. Use GRC for raceways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

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- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inchradius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

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- W. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
  - 2. Install backfill as specified in Section 31 20 00 "Earth Moving."
  - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
  - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
  - 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
    - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
  - 6. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

# 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

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- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

# 3.7 **PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

# PART 2 - PRODUCTS

#### 2.1 SLEEVES

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
  - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

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- F. Sleeves for Rectangular Openings:
  - 1. Material: Galvanized sheet steel.
  - 2. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
    - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

### 2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Metraflex Company (The).
    - c. Or Approved Equal.
  - 2. Sealing Elements: Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3. Pressure Plates: Stainless steel.
  - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

# 2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. HOLDRITE.
    - b. Metraflex Company (The).
    - c. Or Approved Equal.

### 2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-firerated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

### 2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

# PART 3 - EXECUTION

# 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

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- 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
- 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

#### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

# 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

# SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
  - 2. Labels.
  - 3. Bands and tubes.
  - 4. Tapes and stencils.
  - 5. Tags.
  - 6. Signs.
  - 7. Cable ties.
  - 8. Paint for identification.
  - 9. Fasteners for labels and signs.

# 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

# PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

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- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and Section 26 05 74 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

# 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on a white field.
  - 2. Legend: Indicate voltage.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
  - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 240-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
  - 4. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 5. Color for Neutral: White or gray.
  - 6. Color for Equipment Grounds: Green.
  - 7. Colors for Isolated Grounds: Green with white stripe.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:

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- 1. Black letters on an orange field.
- 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
  - 1. Identify system voltage with black letters on a white background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER ELECTRICAL SHOCK HAZARD EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

## 2.3 LABELS

- A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Brother International Corporation.
    - c. Panduit Corp.
    - d. Or Approved Equal.
  - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  - 3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

## 2.4 BANDS AND TUBES

- A. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Panduit Corp.
    - c. Or Approved Equal.
    - d. All wires and cables shall have heat-shrink identification at all terminations and splices.

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### 2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Panduit Corp.
    - c. Or Approved Equal.
- B. Underground-Line Warning Tape:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Seton Identification Products.
    - c. Or Approved Equal.
  - 2. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  - 3. Color and Printing:
    - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
    - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
  - 4. Tag: Type I:
    - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    - b. Width: 3 inches.
    - c. Thickness: 4 mils.
    - d. Weight: 18.5 lb/1000 sq. ft..
    - e. Tensile according to ASTM D 882: 30 lbf and 2500 psi.
  - 5. Tag: Type II:

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- a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
- b. Width: 3 inches.
- c. Thickness: 12 mils.
- d. Weight: 36.1 lb/1000 sq. ft.
- e. Tensile according to ASTM D 882: 400 lbf and 11,500 psi.
- 6. Tag: Type ID:
  - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
  - b. Width: 3 inches.
  - c. Overall Thickness: 5 mils.
  - d. Foil Core Thickness: 0.35 mil.
  - e. Weight: 28 lb/1000 sq. ft..
  - f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.
- 7. Tag: Type IID:
  - a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
  - b. Width: 3 inches.
  - c. Overall Thickness: 8 mils.
  - d. Foil Core Thickness: 0.35 mil.
  - e. Weight: 34 lb/1000 sq. ft.
  - f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

## 2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. Seton Identification Products.
    - d. Or Approved Equal.

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### 2.7 SIGNS

- A. Metal-Backed Butyrate Signs:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Marking Services, Inc.
    - c. Or Approved Equal.
  - 2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
  - 3. 1/4-inch grommets in corners for mounting.
  - 4. Nominal Size: 10 by 14 inches.

## 2.8 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Marking Services, Inc.
  - 2. Panduit Corp.
  - 3. Or Approved Equal.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  - 3. Temperature Range: Minus 40 to plus 185 deg F.
  - 4. Color: Black.

## 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

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## PART 3 - EXECUTION

## 3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

## 3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

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- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- M. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
  - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
  - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:

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- 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- 2. Limit use of underground-line warning tape to direct-buried cables.
- 3. Install underground-line warning tape for direct-buried cables and cables in raceways.

## X. Metal Tags:

- 1. Place in a location with high visibility and accessibility.
- 2. Secure using UV-stabilized cable ties.
- Y. Nonmetallic Preprinted Tags:
  - 1. Place in a location with high visibility and accessibility.
  - 2. Secure using UV-stabilized cable ties.
- Z. Write-on Tags:
  - 1. Place in a location with high visibility and accessibility.
  - 2. Secure using UV-stabilized cable ties.
- AA. Baked-Enamel Signs:
  - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- BB. Metal-Backed Butyrate Signs:
  - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- CC. Laminated Acrylic or Melamine Plastic Signs:
  - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- DD. Cable Ties: General purpose, for attaching tags, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.
  - 2. In Spaces Handling Environmental Air: Plenum rated.

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### 3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch-high, black letters on 20-inch centers.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot maximum intervals.
- D. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- J. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

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- K. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- L. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- M. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- N. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- O. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- P. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metalbacked, butyrate warning signs.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - a. Power-transfer switches.
    - b. Controls with external control power connections.
- Q. Arc Flash Warning Labeling: Self-adhesive labels.
- R. Operating Instruction Signs: Metal-backed, butyrate warning signs.
- S. Emergency Operating Instruction Signs: Metal-backed, butyrate warning signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- T. Equipment Identification Labels:
  - 1. Indoor Equipment: Metal-backed butyrate signs.
  - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
  - 3. Equipment to Be Labeled:

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- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Switchboards.
- f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- g. Substations.
- h. Emergency system boxes and enclosures.
- i. Motor-control centers.
- j. Enclosed switches.
- k. Enclosed circuit breakers.
- l. Enclosed controllers.
- m. Variable-speed controllers.
- n. Push-button stations.
- o. Power-transfer equipment.
- p. Contactors.
- q. Remote-controlled switches, dimmer modules, and control devices.
- r. Battery-inverter units.
- s. Battery racks.
- t. Power-generating units.
- u. Monitoring and control equipment.
- v. UPS equipment.

END OF SECTION 26 05 53

## SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
  - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  - 3. Include diagrams for power, signal, and control wiring.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.

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- C. Source quality-control reports.
- D. Field quality-control reports.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity to prevent rusting of materials during storage.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS:

- A. Square D
- B. EATON
- C. General Electric
- D. Or Approved Equal.
- 2.2 Source Limitations: Obtain each transformer type from single source from single manufacturer.

## 2.3 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

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- E. Coils: Continuous windings without splices except for taps.
  - 1. Internal Coil Connections: Brazed or pressure type.
  - 2. Coil Material: Copper.
- F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

## 2.4 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Totally enclosed, nonventilated.
  - 1. NEMA 250, As shown on the plans: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
  - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
  - 1. Finish Color: Gray.
- F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.
- G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
  - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  - 2. Indicate value of K-factor on transformer nameplate.

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- 3. Unit shall meet requirements of NEMA TP 1 when tested according to NEMA TP 2 with a K-factor equal to one.
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  - 2. Include special terminal for grounding the shield.
- M. Neutral: Rated 200 percent of full load current for K-factor rated transformers.
- N. Wall Brackets: Manufacturer's standard brackets.
- O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

## 2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

## 2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
  - 1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
  - 2. Ratio tests at the rated voltage connections and at all tap connections.
  - 3. Phase relation and polarity tests at the rated voltage connections.
  - 4. No load losses, and excitation current and rated voltage at the rated voltage connections.
  - 5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
  - 6. Applied and induced tensile tests.
  - 7. Regulation and efficiency at rated load and voltage.
  - 8. Insulation Resistance Tests:
    - a. High-voltage to ground.
    - b. Low-voltage to ground.
    - c. High-voltage to low-voltage.
  - 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

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### PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
  - 2. Brace wall-mounted transformers as specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 03 30 00 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."
  - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

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F. Remove shipping bolts, blocking, and wedges.

## 3.3 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

## 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in ANSI/NETA ATS 2017 for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- E. Remove and replace units that do not pass tests or inspections and retest as specified above.
- F. Infrared Scanning: Prior to Final Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
  - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

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## 3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

## 3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

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## SECTION 26 24 16 - PANELBOARDS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
  - 3. Load centers.
  - 4. Electronic-grade panelboards.

## 1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details.

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- 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
- 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
- 4. Detail bus configuration, current, and voltage ratings.
- 5. Short-circuit current rating of panelboards and overcurrent protective devices.
- 6. Include evidence of NRTL listing for series rating of installed devices.
- 7. Include evidence of NRTL listing for SPD as installed in panelboard.
- 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 9. Include wiring diagrams for power, signal, and control wiring.
- 10. Key interlock scheme drawing and sequence of operations.
- 11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23
   "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
  - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

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- 1.8 QUALITY ASSURANCE
  - A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

## 1.10 FIELD CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Construction Manager's written permission.
  - 3. Comply with NFPA 70E.

## 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

## 2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  - 2. Height: 84 inches maximum.
  - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
  - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
  - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  - 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  - 7. Finishes:
    - a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel.
    - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

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- G. Incoming Mains:
  - 1. Location: Convertible between top and bottom.
  - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
    - a. Plating shall run entire length of bus.
    - b. Bus shall be fully rated the entire length.
  - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
  - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  - 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
  - 6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
  - 7. Split Bus: Vertical buses divided into individual vertical sections.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
  - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  - 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
  - 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
  - 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  - 8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
  - 9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures,

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wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

- K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
  - 1. Percentage of Future Space Capacity: Ten percent.
- L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
  - 1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
  - 1. Panelboards and overcurrent protective devices rated 240 V or less shall have shortcircuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

## 2.3 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB
  - 2. GE
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

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- 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: As indicated on plans.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Overcurrent Protective Devices: Fused switches.
- H. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
  - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

## 2.4 LOAD CENTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB.
  - 2. GE.
- B. Load Centers: Comply with UL 67.
- C. Mains: Circuit breaker or lugs only, as indicated on plans.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

## 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB.
  - 2. GE.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers:

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- a. Inverse time-current element for low-level overloads.
- b. Instantaneous magnetic trip element for short circuits.
- c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with frontmounted, field-adjustable trip setting.
- 3. Electronic Trip Circuit Breakers:
  - a. RMS sensing.
  - b. Field-replaceable rating plug or electronic trip.
  - c. Digital display of settings, trip targets, and indicated metering displays.
  - d. Multi-button keypad to access programmable functions and monitored data.
  - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
  - f. Integral test jack for connection to portable test set or laptop computer.
  - g. Field-Adjustable Settings:
    - 1) Instantaneous trip.
    - 2) Long- and short-time pickup levels.
    - 3) Long and short time adjustments.
    - 4) Ground-fault pickup level, time delay, and I squared T response.
- 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
- 6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- 8. Subfeed Circuit Breakers: Vertically mounted.
- 9. MCCB Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Breaker handle indicates tripped status.
  - c. UL listed for reverse connection without restrictive line or load ratings.
  - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
  - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
  - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with fieldadjustable 0.1- to 0.6-second time delay.
  - i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
  - j. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.

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- k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- 1. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- n. Multipole units enclosed in a single housing with a single handle.
- o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
- p. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
  - 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 26 28 13 "Fuses."
  - 2. Fused Switch Features and Accessories:
    - a. Standard ampere ratings and number of poles.
    - b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
    - c. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

## 2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

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### 2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

### PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
  - 1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
  - 2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
  - 3. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

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- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- G. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box.
- I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- J. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
  - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- M. Install filler plates in unused spaces.
- N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- P. Mount spare fuse cabinet in accessible location.

## 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

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- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

## 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

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### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
  - 1. Measure loads during period of normal facility operations.
  - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
  - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

## 3.6 **PROTECTION**

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

## SECTION 26 27 26 - WIRING DEVICES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Straight-blade convenience, hospital-grade, isolated-ground, and tamper-resistant receptacles.
  - 2. USB charger devices.
  - 3. GFCI receptacles.
  - 4. SPD receptacles.
  - 5. Hazardous (classified) location receptacles.
  - 6. Twist-locking receptacles.
  - 7. Pendant cord-connector devices.
  - 8. Cord and plug sets.
  - 9. Toggle switches.
  - 10. Decorator-style convenience.
  - 11. Wall switch sensor light switches with dual technology sensors.
  - 12. Wall switch sensor light switches with passive infrared sensors.
  - 13. Wall switch sensor light switches with ultrasonic sensors.
  - 14. Digital timer light switches.
  - 15. Residential devices.
  - 16. Wall-box dimmers.
  - 17. Wall plates.
  - 18. Floor service outlets.
  - 19. Poke-through assemblies.
  - 20. Prefabricated multioutlet assemblies.
  - 21. Service poles.

## 1.3 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:
  - 1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
  - 2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
  - 3. Leviton: Leviton Mfg. Company, Inc.
  - 4. Pass & Seymour: Pass& Seymour/Legrand.
- B. BAS: Building automation system.

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- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.
- H. UTP: Unshielded twisted pair.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

## 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packinglabel warnings and instruction manuals that include labeling conditions.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

## PART 2 - PRODUCTS

## 2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

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- 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
- 2. Devices shall comply with the requirements in this Section.
- D. Devices for Owner-Furnished Equipment:
  - 1. Receptacles: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. Leviton Manufacturing Co., Inc.
    - c. Pass & Seymour/Legrand (Pass & Seymour).
    - d. Or Approved Equal.

## 2.3 GFCI RECEPTACLES

- A. General Description:
  - 1. 125 V, 20 A, straight blade, non-feed-through type.
  - 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
  - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. Leviton Manufacturing Co., Inc.
    - c. Pass & Seymour/Legrand (Pass & Seymour).
    - d. Or Approved Equal.

## 2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Hazardous (Classified) Locations Receptacles: Comply with NEMA FB 11 and UL 1010.

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- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. EGS/Appleton Electric.
  - b. Killark.
  - c. Or Approved Equal.

### 2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
  - 1. Single Pole, Two Pole, Three Way, and Four Way:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hubbell Incorporated; Wiring Device-Kellems.
      - 2) Leviton Manufacturing Co., Inc.
      - 3) Pass & Seymour/Legrand (Pass & Seymour).
      - 4) Or Approved Equal.

## 2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weatherresistant, die-cast aluminum with lockable cover.

## 2.7 FINISHES

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.
- B. Wall Plate Color: For plastic covers, match device color.
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### PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Coordinate all equipment and device locations with all other trades prior to installation.
  - 2. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 3. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 4. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 5. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The 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 all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace devices that have been in temporary use during construction and that 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 the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
  - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
  - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
  - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  - 8. Tighten unused terminal screws on the device.

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- 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
  - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
  - 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
  - 1. Install dimmers within terms of their listing.
  - 2. Verify that dimmers used for fan-speed control are listed for that application.
  - 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

# 3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

# 3.3 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### 3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:

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- 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
- 2. Test Instruments: Use instruments that comply with UL 1436.
- 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Convenience Receptacles:
  - 1. Line Voltage: Acceptable range is 105 to 132 V.
  - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
  - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
  - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the 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.
- E. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.
- F. Wiring device will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

END OF SECTION 26 27 26

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SECTION 26 28 13 - FUSES

PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Cartridge fuses rated 600 V ac and less for use in the following:
    - a. Control circuits.
    - b. Motor-control centers.
    - c. Panelboards.
    - d. Switchboards.
    - e. Enclosed controllers.
    - f. Enclosed switches.
  - 2. Spare-fuse cabinets.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
  - 5. Coordination charts and tables and related data.
  - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

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## 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
  - 1. Ambient temperature adjustment information.
  - 2. Current-limitation curves for fuses with current-limiting characteristics.
  - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
  - 4. Coordination charts and tables and related data.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## 1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Bussman.
- B. Cooper.
- C. Or Approved Equal.
- D. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

# 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  - 1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC.
  - 2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC.
  - 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
  - 4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.

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- 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
- 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- 7. Type T: 600-V, zero- to 800-A rating, 200 kAIC, very fast acting.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### 2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and keycoded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
  - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

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- 1. Service Entrance: As indicated on the plans.
- 2. Feeders: As indicated on the plans
- 3. Motor Branch Circuits: [As indicated on the plans.
- 4. Large Motor Branch (601-4000 A): Class L, time delay.
- 5. Power Electronics Circuits: As indicated on the plans.
- 6. Other Branch Circuits: As indicated on the plans.
- 7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
- 8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

# 3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

# 3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

# SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Receptacle switches.
  - 4. Shunt trip switches.
  - 5. Molded-case circuit breakers (MCCBs).
  - 6. Molded-case switches.
  - 7. Enclosures.

## 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

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- B. Shop Drawings: For enclosed switches and circuit breakers.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include wiring diagrams for power, signal, and control wiring.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

# 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
    - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
    - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

# 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: Two for each size and type.

# 1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

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1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

### 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

## 1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

# 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

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### 2.3 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB.
  - 2. GE.
- B. Type HD, Heavy Duty:
  - 1. Single or Double throw.
  - 2. Three pole.
  - 3. 600-V ac.
  - 4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
  - 5. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
  - 7. Service-Rated Switches: Labeled for use as service equipment.

# 2.4 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB.
  - 2. GE.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Three Pole, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

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- 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
- 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
- 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
- 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
- 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
- 7. Service-Rated Switches: Labeled for use as service equipment.

## 2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12), unless otherwise indicated on plans.
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

## 3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

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- 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
- 2. Indicate method of providing temporary electric service.
- 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
- 4. Comply with NFPA 70E.

## 3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Wash-Down Areas/Corrosive Environment: NEMA 250, Type 4X, stainless steel.
  - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

## 3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

### 3.5 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

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- 3.6 FIELD QUALITY CONTROL
  - A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
  - B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  - C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
  - D. Perform tests and inspections.
  - E. Tests and Inspections for Switches:
    - 1. Visual and Mechanical Inspection:
      - a. Inspect physical and mechanical condition.
      - b. Inspect anchorage, alignment, grounding, and clearances.
      - c. Verify that the unit is clean.
      - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
      - e. Verify that fuse sizes and types match the Specifications and Drawings.
      - f. Verify that each fuse has adequate mechanical support and contact integrity.
      - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
        - 1) Use a low-resistance ohmmeter.
          - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
          - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
      - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
      - i. Verify correct phase barrier installation.
      - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
    - 2. Electrical Tests:
      - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
      - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's

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published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- F. Tests and Inspections for Molded Case Circuit Breakers:
  - 1. Visual and Mechanical Inspection:
    - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, grounding, and clearances.
    - d. Verify that the unit is clean.
    - e. Operate the circuit breaker to ensure smooth operation.
    - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
    - h. Perform adjustments for final protective device settings in accordance with the coordination study.
  - 2. Electrical Tests:
    - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

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- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
- e. Determine the following by primary current injection:
  - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
- f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
- g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
- h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
- i. Verify operation of charging mechanism. Investigate units that do not function as designed.
- 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 4. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

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- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
- c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports.
  - 1. Test procedures used.
  - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

# 3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 43 13 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Requirements:1. Section 26 24 16 "Panelboards" for factory-installed SPDs.

### 1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

# 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

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- 1.5 INFORMATIONAL SUBMITTALS
  - A. Field quality-control reports.
  - B. Sample Warranty: For manufacturer's special warranty.
- 1.6 CLOSEOUT SUBMITTALS
  - A. Maintenance Data: For SPDs to include in maintenance manuals.

## 1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Ten years from date of Substantial Completion.

# PART 2 - PRODUCTS

# 2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

# 2.2 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Surge Suppression Incorporated.
  - 2. Eaton
  - 3. Or Approved Equal.
- B. SPDs: Comply with UL 1449, Type 1.
- C. Comply with UL 1283.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

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- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 1200 V for 480Y/277 V.
  - 2. Line to Ground: 1200 V for 480Y/277 V.
  - 3. Line to Line: 2000 V for 480Y/277 V.
- F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V.
  - 2. Line to Ground: 1000 V.
  - 3. Line to Line: 1000 V.
- G. SCCR: Equal or exceed 200 kA.
- H. Inominal Rating: 20 kA.

## 2.3 PANEL SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Surge Suppression Incorporated.
  - 2. Eaton.
  - 3. Or Approved Equal.
- B. SPDs: Comply with UL 1449, Type 1.
  - 1. Include LED indicator lights for power and protection status.
  - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Comply with UL 1283.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 1200 V for 480Y/277 V.
  - 2. Line to Ground: 1200 V for 480Y/277 V.
  - 3. Neutral to Ground: 1200 V for 480Y/277 V.
  - 4. Line to Line: 2000 V for 480Y/277 V

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- F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 700 V.
  - 2. Line to Ground: 700 V.
  - 3. Neutral to Ground: 700 V.
  - 4. Line to Line: 1200 V.
- G. SCCR: Equal or exceed 200 kA.
- H. Inominal Rating: 20 kA.

## 2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 4X.

## 2.5 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install SPD's in the following locations:
  - 1. Service entrance equipment
  - 2. Control Panels
  - 3. Distribution Panelboards
  - 4. All locations indicated on the plans.
- C. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- D. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not

splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

- E. Use crimped connectors and splices only. Wire nuts are unacceptable.
- F. Wiring:
  - 1. Power Wiring: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
  - 2. Controls: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

## 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

### 3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

## SECTION 26 51 19 - LED INTERIOR LIGHTING

### PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes the following types of LED luminaires:
  - 1. Linear industrial.
  - 2. Lowbay.
  - 3. Strip light.
  - 4. Surface mount, linear.
  - 5. Surface mount, nonlinear.
  - 6. Suspended, linear.
  - 7. Suspended, nonlinear.
  - 8. Materials.
  - 9. Finishes.
  - 10. Luminaire support.
- B. Related Requirements:
  - 1. Luminaire Schedule located on plan sheets.

### DEFINITIONS

- C. CCT: Correlated color temperature.
- D. CRI: Color Rendering Index.
- E. Fixture: See "Luminaire."
- F. IP: International Protection or Ingress Protection Rating.
- G. LED: Light-emitting diode.
- H. Lumen: Measured output of lamp and luminaire, or both.
- I. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

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## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaires.
  - 4. Include emergency lighting units, including batteries and chargers.
  - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
  - 6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
  - 1. Include plans, elevations, sections, and mounting and attachment details.
  - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Samples for Verification: For each type of luminaire.
  - 1. Include Samples of luminaires and accessories to verify finish selection.
- D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

# 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Luminaires.
  - 2. Suspended ceiling components.
  - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
  - 4. Structural members to which luminaires will be attached.
  - 5. Initial access modules for acoustical tile, including size and locations.
  - 6. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.

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- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of luminaire.
- F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- G. Sample warranty.

# 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

# 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

### 1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.

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D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## 1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
  - 1. ENERGY STAR certified.
  - 2. California Title 24 compliant.
  - 3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
  - 4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
  - 5. UL Listing: Listed for damp location.
  - 6. Recessed luminaires shall comply with NEMA LE 4.
  - 7. User Replaceable Lamps:
    - a. Bulb shape complying with ANSI C78.79.
    - b. Lamp base complying with ANSI C81.61 or IEC 60061-1.
- C. CRI of minimum70. CCT of 3000 K.
- D. Rated lamp life of 50,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.
- G. Nominal Operating Voltage: 120 V ac, 240 V ac, 277 V ac Multi-Tap.
  - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

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- H. Housings:
  - 1. Extruded-aluminum or steel housing and heat sink.
  - 2. Clear anodized powder-coat painted finish.

# 2.2 LINEAR INDUSTRIAL

- A. Approved Manufacturer:
  - 1. H. E. Williams.
  - 2. Phillips.
  - 3. Or Approved Equal.
- B. Minimum 5,000 lumens. Minimum allowable efficacy of 80 lumens per watt.
- C. Housing and heat sink rated to the following:
  - 1. IP 66.
  - 2. CSA C22.2 No 137.

# 2.3 STRIP LIGHT

- A. Approved Manufacturer:
  - 1. H. E. Williams.
  - 2. Phillips.
  - 3. Or Approved Equal.
- B. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.
- C. Integral junction box with conduit fittings.

# 2.4 SURFACE MOUNT, LINEAR

- A. Approved Manufacturer:
  - 1. H. E. Williams.
  - 2. Phillips.
  - 3. Or Approved Equal.
- B. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.
- C. Integral junction box with conduit fittings.

# 2.5 SURFACE MOUNT, NONLINEAR

A. Approved Manufacturer:

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- 1. H. E. Williams.
- 2. Phillips.
- 3. Or Approved Equal.
- B. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.
- C. Integral junction box with conduit fittings.

## 2.6 SUSPENDED, LINEAR

- A. Approved Manufacturer:
  - 1. H. E. Williams.
  - 2. Phillips.
  - 3. Or Approved Equal.
- B. Minimum 1,500 lumens. Minimum allowable efficacy of 85 lumens per watt.

### 2.7 SUSPENDED, NONLINEAR

- A. Approved Manufacturer:
  - 1. H. E. Williams.
  - 2. Phillips.
  - 3. Or Approved Equal.
- B. Minimum 1,500 lumens. Minimum allowable efficacy of 85 lumens per watt.
- C. Integral junction box with conduit fittings.

### 2.8 MATERIALS

- A. Metal Parts:
  - 1. Free of burrs and sharp corners and edges.
  - 2. Sheet metal components shall be steel unless otherwise indicated.
  - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
  - 1. Prismatic glass or diffuse glass clear, UV-stabilized acrylic
  - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - 3. Glass: Annealed crystal glass unless otherwise indicated.

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- 4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Housings:
  - 1. Extruded-aluminum or steel housing and heat sink.
  - 2. Powder-coat painted finish.
- E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter, shape, size, wattage, and coating.
    - c. CCT and CRI for all luminaires.

# 2.9 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.10 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 1/4-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

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- 3.2 INSTALLATION
  - A. Comply with NECA 1.
  - B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
  - C. Install lamps in each luminaire.
  - D. Supports:
    - 1. Sized and rated for luminaire weight.
    - 2. Able to maintain luminaire position after cleaning and replacing.
    - 3. Provide support for luminaire without causing deflection of ceiling or wall.
    - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
  - E. Flush-Mounted Luminaire Support:
    - 1. Secured to outlet box.
    - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
    - 3. Trim ring flush with finished surface.
  - F. Wall-Mounted Luminaire Support:
    - 1. Attached to structural members in walls
    - 2. Do not attach luminaires directly to gypsum board.
  - G. Ceiling-Mounted Luminaire Support:
    - 1. Ceiling mount with two 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.
    - 2. Ceiling mount with pendant mount with 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.
    - 3. Ceiling mount with hook mount.
  - H. Suspended Luminaire Support:
    - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
    - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
    - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
    - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
  - I. Ceiling-Grid-Mounted Luminaires:
    - 1. Secure to any required outlet box.

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- 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
- 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- J. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

## 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

# 3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 3. Adjust the aim of luminaires in the presence of the Owner.

END OF SECTION 26 51 19

## SECTION 26 56 19 - LED EXTERIOR LIGHTING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
  - 2. Luminaire supports.
  - 3. Luminaire-mounted photoelectric relays.
- B. Related Requirements:

### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaire.
  - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - 5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

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- a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
- b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- 6. Wiring diagrams for power, control, and signal wiring.
- 7. Photoelectric relays.
- 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
  - 1. Include plans, elevations, sections, and mounting and attachment details.
  - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.
- D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For luminaire supports.
  - 1. Include design calculations for luminaire supports and seismic restraints.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Luminaires.
  - 2. Structural members to which equipment and luminaires will be attached.
  - 3. Underground utilities and structures.
  - 4. Existing underground utilities and structures.
  - 5. Above-grade utilities and structures.
  - 6. Existing above-grade utilities and structures.
  - 7. Building features.
  - 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
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- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
  - 1. Luminaire.
  - 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Source quality-control reports.
- G. Sample warranty.

### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
  - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

# 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

### 1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

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- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- F. Mockups: For exterior luminaires, complete with power and control connections.
  - 1. Obtain Engineer's approval of luminaires in mockups before starting installations.
  - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

### 1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

#### 1.10 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Engineer prior to the start of luminaire installation.

#### 1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures, including luminaire support components.
    - b. Faulty operation of luminaires and accessories.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

### 2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.61.
- F. Bulb shape complying with ANSI C79.1.
- G. CRI of minimum 70. CCT of 3000 K.
- H. L70 lamp life of 50,000 hours.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: 120 V ac or 277 V ac.
- L. In-line Fusing: On the primary for each luminaire.
- M. Lamp Rating: Lamp marked for outdoor use.
- N. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

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### 2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Lithonia Lighting; Acuity Brands Lighting, Inc.
  - 2. Philips Lighting Company.
  - 3. H.E. Williams.
  - 4. Or Approved Equal.
- B. Comply with UL 773 or UL 773A.
- C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.
  - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
  - 2. Adjustable window slide for adjusting on-off set points.

### 2.4 LUMINAIRE TYPES

- A. Area and Site:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. H.E. Williams.
    - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
    - c. Or Approved Equal.
  - 2. Luminaire Shape: As indicated on plans.
  - 3. Mounting: As indicated on plans.
  - 4. Luminaire-Mounting Height: As indicated on plans.
  - 5. Distribution: As indicated on plans.
  - 6. Diffusers and Globes: Tempered Fresnel glass.
  - 7. Housings:
    - a. Extruded-aluminum housing and heat sink.
    - b. Powder-coat finish to match color indicated on drawings..
- B. Roadway:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. H.E. Williams.
    - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
    - c. Or Approved Equal
  - 2. Luminaire-Mounting Height: As indicated on the drawings.

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- 3. Mounting Type: Arm.
- 4. Distribution: As indicated on the drawings.
- 5. Diffusers and Globes: As indicated on the drawings.
- 6. Housings:
  - a. Extruded-aluminum housing and heat sink.
  - b. Powder-coat finish to match color indicated on drawings.

## 2.5 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
  - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - 2. Glass: Annealed crystal glass unless otherwise indicated.
  - 3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
  - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
  - 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp characteristics:
    - a. "USE ONLY" and include specific lamp type.

- b. Lamp diameter, shape, size, wattage and coating.
- c. CCT and CRI for all luminaires.

#### 2.6 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
  - 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  - 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
    - a. Color: As indicated on the drawings.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
  - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected from manufacturer's standard catalog of colors.
    - b. Color: Match Engineer's sample of manufacturer's standard color.
    - c. Color: As selected by Engineer from manufacturer's full range.

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### 2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 TEMPORARY LIGHTING

A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

## 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Support luminaires without causing deflection of finished surface.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls.

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- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.
- I. Coordinate layout and installation of luminaires with other construction.
- J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- K. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

#### 3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

### 3.6 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
    - a. IES LM-5.
    - b. IES LM-50.
    - c. IES LM-52.
    - d. IES LM-64.
    - e. IES LM-72.

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- 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

### 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

### 3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 3. Adjust the aim of luminaires in the presence of the Owner.

END OF SECTION 26 56 19

### SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

#### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Coarse aggregate materials.
  - 2. Fine aggregate materials.

#### B. Related Sections:

- 1. Section 312000 Earth Moving.
- 2. Geotechnical Report

### 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO M147 Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
  - 2. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
  - 1. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 2. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
  - 3. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
  - 4. ASTM D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - 5. ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

#### 1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Samples: Submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.
- C. Materials Source: Submit name of imported materials suppliers.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

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- 1.4 QUALITY ASSURANCE
  - A. Furnish each aggregate material from single source throughout the Work.
  - B. Perform Work according to State of Georgia Department of Transportation standards.
  - C. Maintain one copy of each document on site.

### PART 2 - PRODUCTS

### 2.1 COARSE AGGREGATE MATERIALS

- A. Aggregate Designation: 57
  - 1. Conform to the Georgia Department of Transportation.
  - 2. Percent Passing per Sieve Size:

a.	2 inches:	n/a.
b.	1 1/2 inches:	100.
c.	1 inch:	95 to 100
d.	3/4 inch:	n/a.
e.	1/2 inch:	25 to 60.
f.	3/8 inches:	n/a.
g.	No. 4:	0 to 10.
ĥ.	No. 8:	0 to 5.
i.	No. 16:	n/a.
j.	No. 100:	n/a.
-		

- B. Aggregate Designation: Riprap Class A
  - 1. Conform to the Georgia Department of Transportation. *Standard Specifications for Highway Construction*, 2007, Section 800.
  - 2. Provide riprap conforming to the gradation classes in the following:
    - a. Rock Size (ft): 0.75, Rock Size (lbs): 37, Percent of Riprap Smaller Than: 100.
    - b. Rock Size (ft): 0.50, Rock Size (lbs): 11, Percent of Riprap Smaller Than: 50.
    - c. Rock Size (ft): 0.20, Rock Size (lbs): 0.7, Percent of Riprap Smaller Than: 15.
- C. Aggregate Designation: Riprap Class B
  - 1. Conform to the Georgia Department of Transportation. *Standard Specifications for Highway Construction*, 2007, Section 800.
  - 2. Provide riprap conforming to the gradation classes in the following:
    - a. Rock Size (ft): 1.33, Rock Size (lbs): 200, Percent of Riprap Smaller Than: 100.
    - b. Rock Size (ft): 1.0, Rock Size (lbs): 75, Percent of Riprap Smaller Than: 85.
    - c. Rock Size (ft): 0.75, Rock Size (lbs): 37, Percent of Riprap Smaller Than: 50.
    - d. Rock Size (ft): 0.42, Rock Size (lbs): 5, Percent of Riprap Smaller Than: 10.
- D. Aggregate Designation: Riprap Class C
  - 1. Conform to the Georgia Department of Transportation. *Standard Specifications for Highway Construction*, 2007, Section 800.
  - 2. Provide riprap conforming to the gradation classes in the following:
    - a. Rock Size (ft): 1.80, Rock Size (lbs): 500, Percent of Riprap Smaller Than: 100.

2.

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- b. Rock Size (ft): 1.300, Rock Size (lbs): 200, Percent of Riprap Smaller Than: 50.
- c. Rock Size (ft): 0.40, Rock Size (lbs): 5, Percent of Riprap Smaller Than: 10.

## E. Aggregate Designation: Riprap Class D

- 1. Conform to the Georgia Department of Transportation. *Standard Specifications for Highway Construction*, 2007, Section 800.
  - Provide riprap conforming to the gradation classes in the following:
    - a. Rock Size (ft): 2.25, Rock Size (lbs): 1000, Percent of Riprap Smaller Than: 100.
    - b. Rock Size (ft): 1.80, Rock Size (lbs): 500, Percent of Riprap Smaller Than: 50.
    - c. Rock Size (ft): 0.95, Rock Size (lbs): 75, Percent of Riprap Smaller Than: 10.

# 2.2 FINE AGGREGATE MATERIALS

### A. Fine Aggregate

- 1. Conform to State of Georgia Department of Transportation Standard
- 2. Aggregate No.: FA-10M.
- 3. Percent Passing per Sieve Size:

a.	1/2 inch:	n/a.

- b. 3/8 inches: 100.
- c. No. 4: 95 to 100.
- d. No. 8: 84 to 100.
- e. No. 16: 45 to 95.
- f. No. 30: 25 to 75.
- g. No. 50: 8 to 35.
- h. No. 100: 0.5 to 20.
- i. No. 200: 0 to 10\*.

\*Dust of fracture essentially free from clay or shale, final job site testing only.

### 2.3 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Testing and inspection services.
- B. Coarse Aggregate Material Testing and Analysis: Perform according to AASHTO T96 or ASTM C131 and AASHTO T11.
- C. Fine Aggregate Material Testing and Analysis: Perform according to ASTM D1557 or AASHTO T180.
- D. When tests indicate materials do not meet specified requirements, change material and retest.

### PART 3 - EXECUTION

### 3.1 INSTALLATION OF RIP RAP

A. All rip-rap shall be embedded in place so that the top surfaces are at the grade established for the surface of rip-rap. The inclusion of objectionable quantities of overburden and rock dust

will not be permitted. The rock fragments in rip-rap need not be compacted, but shall be dumped and graded off in a manner to ensure that the larger rock fragments are uniformly distributed and that the small rock fragments serve to fill the spaces between the layer of rip-rap of the specified thickness. Hand placing will be required only to the extent necessary to secure the results specified herein.

- B. Unless otherwise specified or shown, rip-rap shall have a minimum thickness of 12".
- C. The CONTRACTOR shall maintain the rip-rap until accepted and any material displaced by any cause shall be replaced to the lines and grades shown on the plans.
- D. All rip-rap shall be underlain by an approved geotextile fabric to prevent erosion.

### 3.2 INSTALLATION OF CRUSHED STONE

- A. Crushed stone shall be placed in areas shown on the drawings. Stone shall be consolidated by mechanical means.
- B. Unless otherwise specified or shown, crushed stone shall have a minimum thickness of 6".
- C. All crushed stone shall be underlain by an approved geotextile fabric to prevent erosion

### 3.3 STOCKPILING

- A. Stockpile materials on site at locations designated by Engineer.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.
- D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.

### 3.4 STOCKPILE CLEANUP

- A. Leave unused materials in neat, compact stockpile.
- B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 31 05 16

SECTION 31 10 00 - SITE CLEARING

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Protecting existing vegetation to remain.
  - 2. Removing existing vegetation.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Stripping and stockpiling rock.
  - 6. Removing above- and below-grade site improvements.
  - 7. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
  - 8. Initial erosion and sedimentation control.
- B. Related Requirements:
  - 1. Section 01 50 00 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

#### 1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing inplace surface soil; the zone where plant roots grow.
- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing inplace surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and as indicated on Drawings. Defined by a circle concentric with each tree with a radius 105 times the diameter of the drip line unless otherwise indicated.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct at Purrysburg WTP

### 1.5 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
  - 1. Use sufficiently detailed photographs or video recordings.
- B. Topsoil stripping and stockpiling program.
- C. Rock stockpiling program.
- D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.
- E. Burning: Not allowed.

#### 1.7 QUALITY ASSURANCE

- A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
- B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

### 1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's property offsite.
- C. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant protection measures are in place.
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

### PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."
  - 1. Obtain approved borrow soil material on-site for construction area as indicated.

#### PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed.
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

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### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

### 3.3 EXISTING UTILITIES

- A. Contractor will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing.
  - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
  - 1. Arrange with utility companies to shut off indicated utilities, if required.
  - 2. Contractor will arrange to shut off indicated utilities that cannot be cut off by contractor (gas, electric, communication).
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Engineer not less than 2 days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Engineer's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.
- F. Arrange for temporary pumping if necessary for sewer main work.

### 3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

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- 2. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
- 3. Use only hand methods or air spade for grubbing within protection zones.
- 4. Chip removed tree branches and stockpile in areas approved by Engineer.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

### 3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 4 inches, or per Geotechnical Report, in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 1 inch in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
  - 1. Limit height of topsoil stockpiles to 72 inches.
  - 2. Do not stockpile topsoil within protection zones.
  - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
  - 4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

### 3.6 STOCKPILING ROCK

- A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.
  - 1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.
  - 1. Limit height of rock stockpiles to 72 inches.
  - 2. Do not stockpile rock within protection zones.
  - 3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.

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4. Stockpile Topsoil and reuse on lawn areas.

#### 3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
  - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

## 3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Burning: Not allowed.
- C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Excavating and filling for rough grading the Site.
  - 2. Preparing subgrades for process structures and buildings walks and pavements.
  - 3. Excavating and backfilling for buildings and structures.
  - 4. Drainage course for concrete slabs-on-grade.
  - 5. Subbase course for concrete walks and pavements.
  - 6. Subbase course and base course for asphalt paving.
  - 7. Subsurface drainage backfill for walls and trenches.
  - 8. Excavating and backfilling trenches for utilities and pits for buried utility structures.
- B. Related Requirements:
  - 1. Section 01 32 00 "Construction Progress Documentation" Section 013233 "Photographic Documentation" for recording pre-excavation and earth-moving progress.
  - 2. Section 03 30 00 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
  - 3. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
  - 4. Section 312319 "Dewatering" for lowering and disposing of ground water during construction.
  - 5. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

#### 1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

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- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by **Engineer.** Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
  - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
  - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be <u>without additional compensation</u>.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
  - 1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
  - 2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.
  - 3. Blasting may be required for foundation preparation.
- I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

- L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- M. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:
  - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
    - a. Personnel and equipment needed to make progress and avoid delays.
    - b. Coordination of Work with utility locator service.
    - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
    - d. Extent of trenching by hand or with air spade.
    - e. Field quality control.

# 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
  - 1. Geotextiles.
  - 2. Controlled low-strength material, including design mixture.
  - 3. Geofoam.
  - 4. Warning tapes.
- B. Samples for Verification: For the following products, in sizes indicated below:
  - 1. Geotextile: 12 by 12 inches.
  - 2. Warning Tape: 12 inches long; of each color.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and off-site soil material proposed for fill and backfill as follows:
  - 1. Classification according to ASTM D 2487.
  - 2. Laboratory compaction curve according to ASTM D 698.
- C. Blasting plan approved by City of Milledgeville.
- D. Seismic survey report from seismic survey agency.

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E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

### 1.7 QUALITY ASSURANCE

- A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:
  - 1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
  - 2. Seismographic monitoring during blasting operations.
- B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
  - 1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
  - 2. Seismographic monitoring during blasting operations.
- C. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

### 1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
  - 1. Do not proceed with work on adjoining property until directed by Engineer.
- C. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth-moving operations.
- D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 311000 "Site Clearing" are in place.

PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33/C 33M; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

## 2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.
  - 2. Survivability: As follows:
    - a. Grab Tensile Strength: 157 lbf; ASTM D 4632.
    - b. Sewn Seam Strength: 142 lbf; ASTM D 4632.
    - c. Tear Strength: 56 lbf ; ASTM D 4533.
    - d. Puncture Strength: 56 lbf; ASTM D 4833.
  - 3. Apparent Opening Size: No. 40, No. 60 sieve, maximum; ASTM D 4751.
  - 4. Permittivity: 0.5 per second, minimum; ASTM D 4491.
  - 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.
  - 2. Survivability: As follows:
    - a. Grab Tensile Strength: 247 lbf; ASTM D 4632.
    - b. Sewn Seam Strength: 222 lbf; ASTM D 4632.
    - c. Tear Strength: 90 lbf; ASTM D 4533.
    - d. Puncture Strength: 90 lbf; ASTM D 4833.
  - 3. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
  - 4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
  - 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

## 2.3 CONTROLLED LOW-STRENGTH MATERIAL

- A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:
  - 1. Portland Cement: ASTM C 150/C 150M, Type I.
  - 2. Fly Ash: ASTM C 618, Class C or F.
  - 3. Normal-Weight Aggregate: ASTM C 33/C 33M, 3/4-inch, or 3/8-inch nominal maximum aggregate size.
  - 4. Foaming Agent: ASTM C 869/C 869M.
  - 5. Water: ASTM C 94/C 94M.
  - 6. Air-Entraining Admixture: ASTM C 260/C 260M.
- B. Produce low-density, controlled low-strength material with the following physical properties:

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- 1. As-Cast Unit Weight: 30 to 36 lb/cu. ft., or 36 to 42 lb/cu. ft. at point of placement, when tested according to ASTM C 138/C 138M.
- 2. Compressive Strength: 80 psi, or 140 psi, when tested according to ASTM C 495/C 495M.
- C. Produce conventional-weight, controlled low-strength material with 80-psi 140-psi compressive strength when tested according to ASTM C 495/C 495M.
- 2.4 GEOFOAM (NOT USED)

### 2.5 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
  - 1. Red: Electric.
  - 2. Yellow: Gas, oil, steam, and dangerous materials.
  - 3. Orange: Telephone and other communications.
  - 4. Blue: Water systems.
  - 5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
  - 1. Red: Electric.
  - 2. Yellow: Gas, oil, steam, and dangerous materials.
  - 3. Orange: Telephone and other communications.
  - 4. Blue: Water systems.
  - 5. Green: Sewer systems.

# PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

### 3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

### 3.3 EXPLOSIVES

- A. Retain one of two "Explosives" paragraphs below. Retain second paragraph if explosives are permitted.
- B. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.
  - 1. Perform blasting without damaging adjacent structures, property, or site improvements.
  - 2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

### 3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
    - a. 24 inches outside of concrete forms other than at footings.
    - b. 12 inches outside of concrete forms at footings.
    - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
    - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    - e. 6 inches beneath bottom of concrete slabs-on-grade.
    - f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches.
- B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices

included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

- 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.
  - a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
- 2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
  - a. 24 inches outside of concrete forms other than at footings.
  - b. 12 inches outside of concrete forms at footings.
  - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
  - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
  - e. 6 inches beneath bottom of concrete slabs-on-grade.
  - f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

# 3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - 2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
  - 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
  - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

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### 3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

## 3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
  - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to minimum 12 inches higher than top of pipe or conduit unless otherwise indicated.
  - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - 1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
  - 3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
  - 4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
  - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- E. Trenches in Tree- and Plant-Protection Zones:
  - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrowtine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
  - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

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#### 3.8 SUBGRADE INSPECTION

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs, plant structures and pavements with a pneumatictired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
  - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

### 3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

#### 3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
  - 2. Surveying locations of underground utilities for Record Documents.

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- 3. Testing and inspecting underground utilities.
- 4. Removing concrete formwork.
- 5. Removing trash and debris.
- 6. Removing temporary shoring, bracing, and sheeting.
- 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.
- 3.12 UTILITY TRENCH BACKFILL
  - A. Place backfill on subgrades free of mud, frost, snow, or ice.
  - B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
  - C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
  - D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
  - E. Backfill voids with satisfactory soil while removing shoring and bracing.
  - F. Initial Backfill:
    - 1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
      - a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
    - 2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.
  - G. Final Backfill:
    - 1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
    - 2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
  - H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

- 3.13 SOIL FILL
  - A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
  - B. Place and compact fill material in layers to required elevations as follows:
    - 1. Under grass and planted areas, use satisfactory soil material.
    - 2. Under walks and pavements, use satisfactory soil material.
    - 3. Under steps and ramps, use engineered fill.
    - 4. Under building slabs, use engineered fill.
    - 5. Under footings and foundations, use engineered fill.
  - C. Place soil fill on subgrades free of mud, frost, snow, or ice.

### 3.14 GEOFOAM FILL (NOT USED)

#### 3.15 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
  - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
  - 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - 4. For utility trenches, compact each layer of initial and final backfill soil material at 95

### 3.17 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1/2 inch.
  - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

### 3.18 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Section 334600 "Subdrainage."
- B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
  - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
  - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.
  - 2. Place and compact impervious fill over drainage backfill in 6-inch thick compacted layers to final subgrade.

#### 3.19 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

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- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
  - 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
  - 2. Place base course material over subbase course under hot-mix asphalt pavement.
  - 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
  - 4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
  - 5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

### 3.20 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabson-grade as follows:
  - 1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
  - 2. Place drainage course 6 inches or less in compacted thickness in a single layer.
  - 3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

#### 3.21 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  - 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
  - 2. Determine that fill material classification and maximum lift thickness comply with requirements.
  - 3. Determine, during placement and compaction that in-place density of compacted fill complies with requirements.

- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
  - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
  - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
  - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

### 3.22 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
  - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.
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# 3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
  - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

## SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section includes construction dewatering.
- B. Related Requirements:
  - 1. Section 01 32 33 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
  - 2. Section 31 20 00 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

#### 1.3 ALLOWANCES

A. Dewatering observation wells are part of dewatering allowance.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Purrysburg WTP.
  - 1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review condition of site to be dewatered including coordination with temporary erosioncontrol measures and temporary controls and protections.
  - 3. Review geotechnical report.
  - 4. Review proposed site clearing and excavations.
  - 5. Review existing utilities and subsurface conditions.
  - 6. Review observation and monitoring of dewatering system.

### 1.5 ACTION SUBMITTALS

- A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.
  - 1. Include plans, elevations, sections, and details.

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- 2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
- 3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
- 4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.
- D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

#### 1.8 FIELD CONDITIONS

- A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
  - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
  - 2. The geotechnical report is included elsewhere in Project Manual.
- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

#### PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
  - 1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
  - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
  - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
  - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
  - 5. Remove dewatering system when no longer required for construction.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
  - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.

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- D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 015000 Temporary Facilities and Controls, and Section 311000 Site Clearing during dewatering operations.

#### 3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.
  - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

### 3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
  - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  - 3. Maintain piezometric water level a minimum of 24 inches 60 inches below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

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#### 3.4 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
  - 1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
  - 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
  - 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Survey-Work Benchmarks: Resurvey benchmarks regularly/monthly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.
- C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- D. Prepare reports of observations.

#### 3.5 **PROTECTION**

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19

SECTION 32 12 16 - ASPHALT PAVING

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Hot-mix asphalt patching.
  - 2. Hot-mix asphalt paving.
  - 3. Hot-mix asphalt overlay.
  - 4. Pavement marking paint.
- B. Related Requirements:
  - 1. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
  - 2. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site.
  - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
    - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
    - b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include technical data and tested physical and performance properties.
  - 2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
  - 3. Job-Mix Designs: For each job mix proposed for the Work.

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## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Material Certificates: For each paving material. *Mixes containing recycled materials will perform equal to mixes produced from all new materials.*
- C. Material Test Reports: For each paving material, by a qualified testing agency.
- D. Field quality-control reports.

### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or Georgia DOT.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Georgia DOT for asphalt paving work.

### 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
  - 1. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
  - 2. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
  - 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
  - 4. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
  - 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.
- B. Pavement Marking Paint: Proceed on clean and dry pavement only at a minimum ambient or surface temperature of 40 deg F for oil based material and 60 deg F for water based material; not exceeding 95 deg F.

#### PART 2 - PRODUCTS

### 2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

- B. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
  - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
- D. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

## 2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320, Georgia Department of Transportation 19.5 mm binder.
- B. Asphalt Cement: Georgia Department of Transportation 12/5 mm superpave ASTM D 3381/D 3381M for viscosity-graded material.
- C. Cutback Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30.
- D. Emulsified Asphalt Prime Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- E. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- F. Fog Seal: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- G. Water: Potable.

#### 2.3 AUXILIARY MATERIALS

- A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement.
- B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.
- C. Sand: ASTM D 1073, Grade No. 2 or No. 3.
- D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- E. Joint Sealant: ASTM D 6690, Type I, hot-applied, single-component, polymer-modified bituminous sealant.

- F. Pavement-Marking Paint in accordance with Georgia Department of Transportation standard pavement markings. Select from colors below; distinguish locations if more than one color is required.
- G. GDOT approved thermoplastic striping (arrows, gore, stop bars) as indicated on plans per GDOT English details.

# 2.4 MIXES

- A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent or more than 15 percent by weight.
  - 1. Surface Course Limit: Recycled content no more than 10 percent by weight.
- B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by City of Milledgeville and complying with the following requirements:
  - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - 2. Base Course: GDOT "B" Binder, 19mm.
  - 3. Surface Course: GDOT 9.5 superpave or 12.5 mm superpave as specified in section.
- C. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
  - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

## 3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

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- 1. Mill to a depth of 1-1/2 inches.
- 2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
- 3. Control rate of milling to prevent tearing of existing asphalt course.
- 4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
- 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
- 6. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
- 7. Handle milled asphalt material according to approved waste management site.
- 8. Keep milled pavement surface free of loose material and dust.
- 9. Do not allow milled materials to accumulate on-site.

#### 3.3 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
  - 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
  - 1. Clean cracks and joints in existing hot-mix asphalt pavement.
  - 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
  - 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

## 3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
  - 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.20 gal./sq. yd. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
  - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
  - 2. Protect primed substrate from damage until ready to receive paving.

- D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
  - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
  - 2. Protect primed substrate from damage until ready to receive paving.
- E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

# 3.5 PAVING GEOTEXTILE INSTALLATION

- A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd.
- B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.
- C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

# 3.6 PLACING HOT-MIX ASPHALT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
  - 2. Place hot-mix asphalt surface course in single lift.
  - 3. Spread mix at a minimum temperature of 250 deg F.
  - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
  - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
  - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
  - 2. Complete a section of asphalt base course before placing asphalt surface course.

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C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

#### 3.7 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
  - 1. Clean contact surfaces and apply tack coat to joints.
  - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
  - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
  - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
  - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
  - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

#### 3.8 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent or greater than 100 percent.
  - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.9 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch.
  - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch.
  - 2. Surface Course: 1/8 inch.
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

#### 3.10 SURFACE TREATMENTS

- A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.
- B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
  - 1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

### 3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Additional testing will be at Contractor's expense.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
  - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
  - 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
    - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
    - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

# 3.12 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 024119 "Selective Demolition."

END OF SECTION 321216

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes Concrete Paving. Including the Following:
  - 1. Driveways.
  - 2. Aprons.
  - 3. Curbs and Gutters.
  - 4. Walks.
- B. Related Requirements:
  - 1. Section 03 30 00 "Cast-in-Place Concrete", for general building applications of concrete.
  - 2. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

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## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer of detectable warnings ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
  - 1. Cementitious materials.
  - 2. Steel reinforcement and reinforcement accessories.
  - 3. Fiber reinforcement.
  - 4. Admixtures.
  - 5. Curing compounds.
  - 6. Applied finish materials.
  - 7. Bonding agent or epoxy adhesive.
  - 8. Joint fillers.
- C. Material Test Reports: For each of the following:
  - 1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- D. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing readymixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.

- 2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Engineer and not less than 96 inches by 96 inches.
- 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
- 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

### 1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

### 1.8 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
  - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
  - 2. Do not use frozen materials or materials containing ice or snow.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
  - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

#### 2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
  - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

### 2.3 STEEL REINFORCEMENT

- A. Retain this article if steel reinforcement is required; revise to suit Project.
- B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.
- C. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.
- D. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
- E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.
- G. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 6 deformed bars.
- H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 deformed bars; assembled with clips.
- I. Deformed-Steel Wire: ASTM A 1064/A 1064M.
- J. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- K. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 plain-steel bars.

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- L. Tie Bars: ASTM A 615/A 615M, Grade 60; deformed.
- M. Hook Bolts: ASTM A 307, Grade, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
  - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
  - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- O. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- P. Zinc Repair Material: ASTM A 780/A 780M.

## 2.4 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C 150, gray portland cement Type I.
  - 2. Fly Ash: ASTM C 618, Class C.
  - 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, uniformly graded.
  - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Air-Entraining Admixture: ASTM C 260/C 260M.
- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- E. Water: Potable and complying with ASTM C 94/C 94M.

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## 2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.
  - 1. Euclid Chemical Company, or equal.
- B. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.
  - 1. Euclid Chemical Company, or Equal.

#### 2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry, or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

#### 2.7 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or selfexpanding cork in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

## 2.8 STAMPED DETECTABLE WARNING MATERIALS (NOT USED)

### 2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
  - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

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- B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.][ Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash or Pozzolan: 25 percent.
  - 2. Slag Cement: 50 percent.
  - 3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
  - 1. Air Content: 3-1/2 percent plus or minus 1-1/2 percent for 3/4-inch nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. if specified on plans.
- G. Concrete Mixtures: Normal-weight concrete.
  - 1. Compressive Strength (28 Days): 4000 psi, sidewalk and curb & gutter to be 3000 psi (min.).
  - 2. Maximum W/C Ratio at Point of Placement: 0.45.
  - 3. Slump Limit: 5 inches (125 mm), plus or minus 1 inch (25 mm).

## 2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.
  - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
  - 1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

- 2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
- 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
  - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
  - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

## 3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

### 3.4 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

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- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
- G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

# 3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
  - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
  - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
  - 2. Provide tie bars at sides of paving strips where indicated.
  - 3. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
  - 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
  - 1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
  - 2. Extend joint fillers full width and depth of joint.
  - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

- 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
- 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
- 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch, 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
    - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
  - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
    - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
  - 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

## 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
  - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
  - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

# 3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture. Finish noted on plans.
  - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
  - 2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
  - 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating floatfinished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

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## 3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
  - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

#### 3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
  - 1. Elevation: 1/4 inch.
  - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
  - 3. Surface: Gap below 10-feet long; unleveled straightedge not to exceed 1/2 inch.
  - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
  - 5. Lateral Alignment and Spacing of Dowels: 1 inch.
  - 6. Vertical Alignment of Dowels: 1/4 inch.
  - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
  - 8. Joint Spacing: 3 inches.

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- 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
- 10. Joint Width: Plus 1/8 inch, no minus.

## 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain at least one composite sample for each 50 cu. yd. 2500 sq. ft. or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  - 3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
  - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
  - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
    - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

# 3.11 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.
- B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

# SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cold-applied joint sealants.
  - 2. Hot-applied joint sealants.
  - 3. Cold-applied, fuel-resistant joint sealants.
  - 4. Hot-applied, fuel-resistant joint sealants.
  - 5. Joint-sealant backer materials.
  - 6. Primers.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Paving-Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of joint sealant and accessory.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

### 1.6 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside limits permitted by jointsealant manufacturer or are below 40 deg F.
  - 2. When joint substrates are wet.
  - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

### PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

## 2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.
  - 1. Crafco, or equal.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.
  - 1. Crafco, or equal.
- C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
  - 1. W.R. Meadows, or equal.
- D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
  - 1. W.R. Meadows, or equal.

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- E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.
  - 1. Pecora Corporation, or equal.

## 2.3 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I.
  - 1. Crafco, or equal.
- B. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I or Type II.
  - 1. Crafco, or equal.
- C. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I, II, or III.
  - 1. Crafco, or equal.
- D. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type IV.
  - 1. Crafco, or equal.

## 2.4 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

- A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
  - 1. BASF Corp., or equal.
- B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 12-1/2 or 25, for Use T.
  - 1. Pecora Corp., or equal.

# 2.5 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

- A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D 7116, Type I or Type II.
  - 1. Crafco, or equal.
- B. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D 7116, Type III.
  - 1. Crafco, or equal.

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#### 2.6 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

### 2.7 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
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## 3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of joint-sealant backings.
  - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
  - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
  - 1. Place joint sealants so they fully contact joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
  - 1. Remove excess joint sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

## 3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

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## 3.5 PAVING-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within concrete paving.
  - 1. Joint Location:
    - a. Expansion and isolation joints in concrete paving.
    - b. Contraction joints in concrete paving.
    - c. Other joints as indicated.
  - 2. Joint Sealant: Multicomponent, nonsag, urethane, elastomeric joint sealant.
  - 3. Joint-Sealant Color: Manufacturer's standard.
- B. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving.
  - 1. Joint Location:
    - a. Joints between concrete and asphalt paving.
    - b. Joints between concrete curbs and asphalt paving.
    - c. Other joints as indicated.
  - 2. Joint Sealant: Hot-applied, single-component joint sealant.
  - 3. Joint-Sealant Color: Manufacturer's standard.

END OF SECTION 32 13 73

## SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

## PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Chain-link fences.
  - 2. Swing gates.
- B. Related Requirements:
  - 1. Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place concrete equipment bases/pads for gate operators and controls and post footings.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Fence and gate posts, rails, and fittings.
    - b. Chain-link fabric, reinforcements, and attachments.
    - c. Accessories: Barbed wire.
    - d. Gates and hardware.
- B. Shop Drawings: For each type of fence and gate assembly.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include accessories, hardware, gate operation, and operational clearances.
  - 3. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For each type of factory-applied finish.
- D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

- 1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.
- E. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For factory-authorized service representative.
- B. Product Certificates: For each type of chain-link fence, operator, and gate.
- C. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

## 1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

## 1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

- 1. Failures include, but are not limited to, the following:
  - a. Failure to comply with performance requirements.
  - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - c. Faulty operation of gate operators and controls.
- 2. Warranty Period: 2 years from date of Substantial Completion.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design chain-link fence and gate frameworks.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.
  - 1. Design Wind Load: 80 mph.
    - a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed 10 feet Schedule 40 steel pipe.
    - b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.
- C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

#### 2.2 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
  - 1. Fabric Height: As indicated on Drawings.
  - 2. Steel Wire for Fabric: Wire diameter of 0.148 inch.
    - a. Mesh Size: 2 inches.
    - b. Polymer-Coated Fabric: ASTM F 668, Class 1, with zinc coating applied over zinc coated steel wire.
      - 1) Color: Match existing plant fence.
  - 3. Selvage: Knuckled at both selvages.

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## 2.3 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
  - 1. Fence Height: 72 inches.
    - a. Line Post: 2 inches.
    - b. End, Corner, and Pull Posts: 2.375 inches.
  - 2. Horizontal Framework Members: Intermediate top and bottom rails according to ASTM F 1043.
    - a. Top Rail: 1.66 inches in diameter.
  - 3. Brace Rails: ASTM F 1043.
  - 4. Metallic Coating for Steel Framework:
    - a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating according to ASTM A 653/A 653M.
    - b. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.
    - c. Coatings: Any coating above.
  - 5. Polymer coating over metallic coating.
    - a. Color: Match chain-link fabric, according to ASTM F 934

#### 2.4 TENSION WIRE

- A. Polymer-Coated Steel Wire: 0.177-inch diameter, tension wire according to ASTM F 1664, Class 1 over zinc-coated steel wire.
  - a. Color: Match chain-link fabric, according to ASTM F 934.

## 2.5 SWING GATES

- A. General: ASTM F 900 for gate posts and double swing gate types. Provide automated vehicular gates according to ASTM F 2200.
  - 1. Gate Leaf Width: as shown on the drawings (not less than 36 inches).
  - 2. Framework Member Sizes and Strength: Based on gate fabric height of 72 inches as indicated.
- B. Pipe and Tubing:

- 1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framework.
- 2. Gate Posts: Round tubular steel.
- 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded assembled with corner fittings.
- D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend 12 inches above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
- E. Hardware:
  - 1. Hinges: See Plans for swing.
  - 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
  - 3. Lock: Manufacturer's standard internal device.
  - 4. Padlock and Chain: Manufacturer's standard.
  - 5. Closer: Manufacturer's standard.

## 2.6 FITTINGS

- A. Provide fittings according to ASTM F 626.
- B. Post Caps: Provide for each post.
  - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
  - 1. Top Rail Sleeves: Pressed-steel or round-steel tubing.
  - 2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- H. Barbed Wire Arms: Pressed steel or cast iron, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts for each post unless otherwise indicated, and as follows:

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- 1. Provide line posts with arms that accommodate top rail or tension wire.
- 2. Provide corner arms at fence corner posts unless extended posts are indicated.
- 3. Single-Arm Type: Type I, slanted arm.
- I. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
  - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
    - a. Hot-Dip Galvanized Steel: 0.106-inch diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

## J. Finish:

- 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.
  - a. Polymer coating over metallic coating.
- 2. Aluminum: Mill finish.

## 2.7 BARBED WIRE

- A. Steel Barbed Wire: ASTM A 121, two-strand barbed wire, 0.099-inch diameter line wire with 0.080-inch diameter, four-point round barbs spaced not more than 5 inches o.c.
  - 1. Zinc Coating: Type Z, Class 3.

## 2.8 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

## 2.9 GROUNDING MATERIALS

- A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.
  - 1. Connectors for Below-Grade Use: Exothermic welded type.

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2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. 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.

## 3.3 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.
  - 1. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
    - b. Concealed Concrete: Place top of concrete 2 inches below grade as indicated on Drawings to allow covering with surface material.
    - c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

- d. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
- 3. Mechanically Driven Posts: Drive into soil to depth of 30 inches. Protect post top to prevent distortion.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at 96 inches o.c.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
  - 1. Locate horizontal braces at mid-height of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
  - 1. As indicated on Drawings.
- H. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- I. Intermediate and Bottom Rails: Secure to posts with fittings.
- J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.
- L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach

other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

- 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- N. Barbed Wire: Install barbed wire uniformly spaced, angled toward security side of fence as indicated on Drawings. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
- O. Barbed Tape: Install according to ASTM F 1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

## 3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

## 3.5 GATE-OPERATOR INSTALLATION

- A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.
- C. Vehicle Loop Detector System: Cut grooves in pavement, bury, and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

## 3.6 GROUNDING AND BONDING

- A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Fence and Gate Grounding:
  - 1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
  - 2. Install ground rods and connections at maximum intervals of 1500 feet.

- 3. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
- 4. Ground fence on each side of gates and other fence openings.
  - a. Bond metal gates to gate posts.
  - b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
- C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet on each side of crossing.
- D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.
- E. Grounding Method: At each grounding location, drive a grounding rod vertically until the 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.
  - 1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
  - 2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
- F. Connections:
  - 1. Make connections with clean, bare metal at points of contact.
  - 2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 4. Make above-grade ground connections with mechanical fasteners.
  - 5. Make below-grade ground connections with exothermic welds.
  - 6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

## 3.7 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

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## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 32 31 13

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Seeding.
  - 2. Hydroseeding.
  - 3. Erosion-control material(s).

#### 1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

- 1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

## 1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required maintenance periods.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
  - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  - 2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
    - a. Landscape Industry Certified Technician Exterior.
    - b. Landscape Industry Certified Lawncare Manager.
    - c. Landscape Industry Certified Lawncare Technician.
  - 5. Pesticide Applicator: State licensed, commercial.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:

- 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
- 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
- 3. Accompany each delivery of bulk materials with appropriate certificates.

## 1.8 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
  - 1. Spring Planting: April August.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

## PART 2 - PRODUCTS

## 2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
  - 2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
  - 3. Bermudagrass (Cynodon dactylon) or Centipedegrass (Eremochloa ophiuroides) with 10 percent perennial ryegrass (Lolium perenne).

## 2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

## 2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

## 2.4 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

## 3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.

- 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

## 3.3 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

## 3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at total rate specified in the current Georgia Manual for Erosion and Sedimentation Control.
- C. Rake seed lightly into top 1/4 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1 inch in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
  - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
  - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- F. Protect seeded areas from hot, dry weather or drying winds by applying planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

## 3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
  - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

## 3.6 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.
- D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
  - 1. Use fertilizer that provides actual nitrogen of at least 2 lb/1000 sq. ft. to turf area.

## 3.7 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Engineer:

- 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

## 3.8 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Seeded Turf: 60 days from date of planting completion.
    - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION 32 92 00

## SECTION 33 01 10.59 - DISINFECTION OF WATER UTILITY STORAGE TANKS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Water tank disinfection.
  - 2. Bacteriological testing.

## B. Related Requirements:

- 1. Section 330110.58: Disinfection of Water Utility Piping Systems: Disinfection of water mains and testing.
- 2. Section 33 16 32 -Prestressed Composite Storage Tanks: Fabrication details of prestressed concrete water storage tanks.

## 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C652 Disinfection of Water-Storage Facilities.

## 1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Disinfection Procedure:
  - 1. Submit description of procedure, including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration.
  - 2. Comply with Sections 3 and 4 of AWWA C652.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Certify that disinfectants meet or exceed AWWA C652 requirements.
- E. Test and Evaluation Reports: Indicate results of bacteriological and residual chlorine laboratory test reports.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- G. Qualifications Statement:
  - 1. Submit qualifications for applicator.

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- 1.4 QUALITY ASSURANCE
  - A. Perform Work in compliance with AWWA C652.
- 1.5 DELIVERY, STORAGE, AND HANDLING
  - A. Section 01 60 00 Product Requirements: Requirements for transporting, handling, storing, and protecting products.
  - B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
  - C. Store disinfectants according to manufacturer's recommendations and in a cool, dry place away from combustibles such as wood, rags, oils, and greases.
  - D. Handle disinfectants according to manufacturer's safety precautions.

## PART 2 - PRODUCTS

## 2.1 DISINFECTANTS

A. Chlorine Forms: According to AWWA C652, Section 4.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for application examination.
- B. Inspection:
  - 1. Conduct inspection of tank interior before beginning disinfection.
  - 2. Verify that tank is clean and free of polluting materials.
  - 3. Verify that tank pipe and vent connections are properly made and clear of obstructions.
  - 4. Verify that paint is thoroughly cured according to paint manufacturer's instructions.

#### 3.2 PREPARATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for application preparation.
- B. Furnish personnel working inside tank during disinfection with equipment to comply with Federal and state regulations for Work conducted in a hazardous atmosphere.
- C. Protect aquatic life and vegetation from damage from disinfectant solution purged from tank.

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## 3.3 APPLICATION

- A. Use any one or combination of the following three methods for disinfecting tank according to AWWA C652, Section 4:
  - 1. Chlorination Method 1.
  - 2. Chlorination Method 2.
  - 3. Chlorination Method 3.
- B. Disposal:
  - 1. Neutralize disinfectant solution before disposal.
  - 2. Legally dispose of disinfection solution off Project Site.
- C. Repair damage caused by disinfectant solution and disinfection procedures.

## 3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for inspecting and testing.
- B. Sampling:
  - 1. Collect samples of water from filled tank for bacteriological analysis according to AWWA C652, Section 5.
  - 2. Take inlet and outlet water samples.
- C. Test water samples for bacterial contamination and residual chlorine, according to SCDHEC standards for potable water.
- D. If water samples fail to meet state health standards for potable water, perform following corrective measures until water quality complies with state health standards:
  - 1. Inlet and Outlet Water Sample Failure: Eliminate source of contamination in water supply, repeat disinfection, and retest water quality.
  - 2. Outlet Water Sample Failure: Repeat disinfection and retest water quality.

## END OF SECTION 33 01 10.59

## SECTION 33 05 16 - PRECAST CONCRETE UTILITY STRUCTURES

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Precast concrete utility structures.
  - 2. Drainage system catch basins.
  - 3. Drainage system inlets.
  - 4. Drainage system junction boxes.
  - 5. Pumping station wetwells and valve vaults.
  - 6. Pipe Headwalls.
  - 7. Pipe Flare End Section.
  - 8. Frames and covers.
- B. Related Requirements:
  - 1. Section 03 30 00 Cast-in-Place Concrete: Concrete type for manhole and structure foundation slab construction.
  - 2. Section 31 20 00 Earth Moving: Excavating for structures and foundation slabs, backfilling after structure installation, fill

## 1.2 REFERENCE STANDARDS

- A. American Concrete Institute:
  - 1. ACI 318 Building Code Requirements for Structural Concrete and Commentary.
- B. ASTM International:
  - 1. ASTM A36 Standard Specification for Carbon Structural Steel.
  - 2. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
  - 3. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  - 4. ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
  - 5. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete.
  - 6. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
  - 7. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
  - 8. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
  - 9. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

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- 10. ASTM C857 Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
- 11. ASTM C890 Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
- 12. ASTM C891 Standard Practice for Installation of Underground Precast Concrete Utility Structures.
- 13. ASTM C913 Standard Specification for Precast Concrete Water and Wastewater Structures.
- 14. ASTM C923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
- 15. ASTM C990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
- 16. ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- 17. ASTM C1433 Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.
- C. American Welding Society:
  - 1. AWS D1.1 Structural Welding Code Steel.
  - 2. AWS D1.4 Structural Welding Code Reinforced Steel.
- D. National Precast Concrete Association:
  - 1. NPCA Plant Certification Program.
  - 2. NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

## 1.3 SUBMITTALS

- A. Section 013300 Submittal Procedures: Requirements for submittals.
- B. Product Data:
  - 1. Submit data for frames and covers, steps, component construction, features, configuration, and dimensions.
- C. Shop Drawings:
  - 1. Indicate structure locations, elevations, sections, equipment supports, piping, conduit, sizes and elevations of penetrations and block-outs/knock outs.
  - 2. Indicate design, construction and installation details, typical reinforcement and additional reinforcement at openings.
- D. Submit concrete mix design for each different mix.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for custom fabrications.

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- G. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- I. Qualifications Statements:
  - 1. Submit qualifications for manufacturer.

## 1.4 QUALITY ASSURANCE

- A. Obtain precast concrete utility structures from single source.
- B. Perform structural design according to ACI 318.
- C. Perform Work according to NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.
- D. Conform to following material and fabrication requirements:
  - 1. Single Cell Box Culverts: ASTM C1433.
  - 2. Other Structures: ASTM C913.
- E. Perform welding according to following:
  - 1. Structural Steel: AWS D1.1.
  - 2. Reinforcing Steel: AWS D1.4.
- F. Perform Work according to National Precast Concrete Association (NPCA) standards.
- G. Design precast concrete members under direct supervision of a Professional Structural Engineer experienced in design of precast concrete. Drawings shall bear the stamp of the P.E.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Certified by NPCA Plant Certification Program prior to and during Work of this Section.
- B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 10 years' documented experience.
- C. Welders and Welding Procedures: AWS qualified within previous 12 months for employed weld types.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

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- B. Do not deliver products until concrete has cured 5 days or has attained minimum 75 percent of specified 28-day compressive strength.
- C. Inspection: Accept precast structures on Site in manufacturer's original packaging and inspect for damage.
- D. Comply with precast concrete manufacturer instructions for unloading, storing, and moving precast structures.
- E. Lift structures from designated lifting points.
- F. Storage:
  - 1. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
  - 2. Repair property damaged from materials storage.

#### PART 2 - PRODUCTS

## 2.1 DESIGN REQUIREMENTS

- A. Design structures for minimum loads conforming to ASTM C857 and ASTM C890.
- B. Roof Live Load: Comply with following loading conditions, including impact load:
  - 1. Heavy Traffic:
    - a. ASTM C857, A-16
    - b. Maximum 16,000 lb. each wheel.
  - 2. Medium Traffic:
    - a. ASTM C857, A-12.
    - b. Maximum 12,000 lb. each wheel.
  - 3. Light Traffic:
    - a. ASTM C857, A-8
    - b. Maximum 8,000 lb. each wheel.
  - 4. Walkway Traffic:
    - a. ASTM C857, A-0.3.
    - b. Maximum 300 psf

## 2.2 PRECAST CONCRETE UTILITY STRUCTURES

- A. Manufacturers:
  - 1. Knight Precast
  - 2. Tindall Concrete
  - 3. Hanson Pipe Products
  - 4. Parker Precast

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- B. Precast Concrete Utility Structures: Reinforced precast concrete.1. As shown on the Drawings.
- 2.3 WETWELL VENT
  - A. Manufacturers:
    - 1. Hanson Pipe Products
  - B. Description:
    - 1. 4.75" square SST or aluminum frame, 1/4"x1"x1" covered w/ 1"x1"x1" 6" square grate.

## 2.4 ACCESS HATCHES

- A. Manufacturers:
  - 1. The Bilco Company.
  - 2. U.S.F. Fabrication.
  - 3. Halliday Products.
- B. Access Hatch:
  - 1. All access hatches shall be double or single leaf as shown on the drawings. Automatic doors shall be equipped with a minimum of two stainless steel hinges with stainless steel pins. Each door leaf shall also have spring operators with a positive hold open arm that engages automatically in full open position, and a non-corrosive release handle. Doors shall open with a maximum lift force of 9 lbs. When closed, doors shall not protrude above the operating surface in which they are installed. Include slam lock feature with removable key.
  - 2. When subject to vehicular traffic, cover shall be reinforced to support an AASHTO H-2 wheel load with a maximum deflection of 1/150<sup>th</sup> of the span.
  - 3. Door leaves shall be <sup>1</sup>/<sub>4</sub>-inch aluminum checkered plate reinforced to with structural aluminum channels, capable of withstanding 300 pounds per square foot uniform load with minimal deflection for non-vehicular loading service. When subject to vehicular traffic, cover shall be reinforced to support an AASHTO H-20 wheel load with a maximum deflection of 1/150<sup>th</sup> of the span.
  - 4. The gutter frame provided shall be of 1/4 –inch aluminum with an anchor flange around the perimeter. Frame shall incorporate a 1 1/2" threaded drain fitting and neoprene gasket.
  - 5. The drain coupling shall be located in an appropriate corner of each channel frame away from the access steps. Contractor shall attach and route Sch 80 PVC pipe away from drain port to daylight away from structure. IF daylight is not ready accessible within 10-ft, then contractor shall terminate piping into ½ cubic yard of #57 stone wrapped with filter fabric. Piping shall project through walls with sleeve and Link-Seal in a water-tight (leak proof) installation.
  - 6. Factory finish shall be mill finish.
  - 7. Hardware shall be stainless steel.

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- 8. Any surface or portion of the frame contacting concrete shall receive a bituminous coating.
- 9. The door shall open to 90 degrees and lock automatically in that position. A vinyl grip handle shall be provided to release and close the cover with one hand.
- 10. Doors, which are to receive flooring, shall be smooth plate. Doors which will not receive flooring shall be checkered plate.

## 2.5 MATERIALS

- A. Concrete: As specified in Section 03 30 00 Cast-In-Place Concrete.
- B. Admixtures: As specified in Section 03 30 00 Cast-In-Place Concrete
- C. Concrete Reinforcement: As specified in Section 03 30 00 Cast-In-Place Concrete

## 2.6 FABRICATION

- A. Fabricate precast concrete utility structures conforming to ACI 318 and NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.
- B. Fabricate precast concrete utility structures knock-out panels, and openings to size and configuration as indicated on Drawings.
- C. Construct forms to provide uniform precast concrete units with consistent dimensions.
- D. Clean forms after each use.
- E. Reinforcing:
  - 1. Install reinforcement by tying or welding to form rigid assemblies.
  - 2. Position reinforcement to maintain minimum 1/2 inch cover.
  - 3. Secure reinforcement to prevent displacement while placing concrete.
- F. Position and secure embedded items to prevent displacement while placing concrete.
- G. Deposit concrete in forms and consolidate concrete without segregating aggregate.
- H. Provide initial curing by retaining moisture using one of following methods:
  - 1. Cover with polyethylene sheets.
  - 2. Cover with burlap or other absorptive material and keep continually moist.
  - 3. Apply curing compound according to manufacturer instructions.
- I. Provide final curing according to manufacturer's standard.
- J. Remove forms without damaging concrete.
- K. Tension reinforcement tendons as required to achieve design load criteria.
- L. Exposed Ends at Stressing Tendons: Fill recess with non-shrink grout, trowel flush

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- 2.7 MIXES
  - A. Concrete:
    - 1. Design mix shall be as specified in Section 03 30 00 Cast-In-Place Concrete.
- 2.8 FINISHES
  - A. Reinforcing Steel, Wire and Wire Fabric, Concrete and Steel shall be specified in Section 03 30 00 Cast-In-Place Concrete

## 2.9 ACCESSORIES

- A. Membrane Curing Compound: ASTM C309, Type 2, Class A.
- B. Steps:
  - 1. Formed steel-reinforced polypropylene rungs.
  - 2. Diameter: <sup>3</sup>/<sub>4</sub> inch.
  - 3. Width: 10 inches minimum.
  - 4. Spacing: 15 inches o.c. vertically or as indicated on Drawings.
- C. Inserted and Embedded Items:
  - 1. Structural Steel Sections:
    - a. Comply with ASTM A36.
    - b. Finish: As shown or called for on the plans or in related specification sections.
- D. Bearing Pads:
  - 1. High density plastic, Vulcanized elastomeric compound molded to size, Neoprene (Chloroprene), or Tetrafluoroethylene (TFE); Shore A Durometer; 1/8 inch thick, smooth on both sides.
- E. Joint Sealants and Joint Gaskets:
  - 1. Gasket Joints for Circular Concrete Pipe:
    - a. ASTM C443
    - b. Gaskets: Oil-resistant rubber.
  - 2. External Sealing Bands:
    - a. Comply with ASTM C877.
    - b. Material: Type I, rubber and mastic.
  - 3. Preformed Joint Sealants for Concrete Pipe and Box Sections: Comply with ASTM C990.
  - 4. Elastomeric Joint Sealants:

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- a. Comply with ASTM C920.
- b. Material: Polyurethane.
- c. Grade NS, Class 35.
- F. Pipe Entry Connectors: Comply with ASTM C923.
- G. Grout:
  - 1. Cement Grout: Portland cement, sand, and water mixture with stiff consistency to suit intended purpose.
  - 2. Non-Shrink Grout:
    - a. Description: Premixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing agents.
    - b. Conform to ASTM C1107.
    - c. Minimum Compressive Strength: 2,400 psi in 48 hours, and in 28 days.
- H. Bituminous Coating:
  - 1. Manufacturers:
    - a. Carboline Company; a subsidiary of RPM International
    - b. Duron, Inc.
    - c. Laurence, C.R. Co., Inc.
    - d. Or Approved Equal.
  - 2. Description: Provide damproofing on the exterior side of structures in the field where structure will be below grade. Coating shall be a two-component, self-priming, chemically cured, coal tar epoxy protective coating.
- I. Touch-Up Primer for Galvanized Surfaces:
  - 1. As specified in Section 09 96 00 High-Performance Coatings.

## 2.10 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Testing:
  - 1. Perform following tests for each 100 cu. yd. of concrete placed with minimum one set of tests each week:
    - a. Slump: Comply with ASTM C143.
    - b. Compressive Strength: ASTM C31 and ASTM C39.
    - c. Air Content: Comply with ASTM C231 or ASTM C173.
    - d. Unit Weight: Comply with ASTM C138.
  - 2. Make test results available to Engineer/Owner upon request.
- C. Inspection:

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- 1. Visually inspect completed precast structures for defects.
- 2. Repair defects on surfaces exposed to view to achieve uniform appearance.
- 3. Repair honeycomb by removing loose material and applying grout to produce smooth surface flush with adjacent surface.
- 4. Repair major defects not allowed.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that items provided by other Sections of Work are properly sized and located.
- C. Verify correct size and elevation of excavation.
- D. Verify that subgrade and bedding are properly prepared, compacted, and ready to receive Work of this Section.

## 3.2 PREPARATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation preparation.
- B. Mark each precast structure by indentation or using waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.
- C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.
- D. Do not install structures if Site conditions induce loads exceeding weight capacity of structures.
- E. Inspect precast concrete structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

## 3.3 INSTALLATION

- A. Install underground precast utility structures according to ASTM C891.
- B. Lift precast concrete structures at lifting points designated by manufacturer.
- C. When lowering structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
- D. Install precast concrete base to elevation and alignment as indicated on Drawings.
- E. Install precast concrete utility structures to elevation and alignment as indicated on Drawings.

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- F. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- G. Maintain temporary bracing in place until final support is provided. Protect members from staining.
- H. Provide temporary lateral support to prevent bowing, twisting, or warping of members.
- I. Adjust differential camber between precast members to tolerance before final attachment.
- J. Install bearing pads.
- K. Level differential elevation of adjoining horizontal members with grout to maximize slope of 1:12.
- L. Assembly of Multi-section Structures:
  - 1. Lower each section into excavation.
  - 2. Clean joint surfaces.
  - 3. Install watertight joint seals according to manufacturer instructions using gasket joints, external sealing bands, preformed joint sealants, elastomeric joint sealants, grout, as required.
- M. Remove knockouts or cut structure to receive piping without creating openings larger than required to fit pipe; fill annular space with grout.
- N. Pipe Connections:
  - 1. Connect pipe to structure and seal watertight.
  - 2. Cut pipe flush with interior of structure.
- O. Base/Foundation slab:
  - 1. Grout to achieve slope to exit piping.
  - 2. Trowel smooth.
  - 3. Contour to form continuous drainage channel as indicated on Drawings.
- P. Paint interior with two coats of bituminous interior coating at rate of 12 sq. ft. per gal. for each coat.
- Q. Frame and Cover and Access Hatch:
  - 1. Set level, without tipping, to elevations as indicated on Drawings.
  - 2. Set cover and access hatch 3 inches above finished grade for structures located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.
  - 3. Connect drain from access hatch frame to storm drainage system.
- R. Touch up damaged galvanized coatings.
- S. Backfill excavations for structures as specified in division 31.
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- 3.4 ERECTION TOLERANCES
  - A. Erect members level and plumb within allowable tolerances.
  - B. Conform to PCI MNL-116S.
  - C. Design and erect to the following tolerances:
    - 1. Maximum variation from Plane or Location on Drawings: <sup>1</sup>/<sub>4</sub> inch/10 feet and 3/8 inch in 100 feet, non-cumulative.
    - 2. Maximum Offset from True Alignment Between Members: <sup>1</sup>/<sub>4</sub> inch.
    - 3. Maximum Variation From Dimensions Indicated on Reviewed Shop Drawings: Plus or Minus 1/8 inch.
  - D. Exposed Joint Dimension: 3/8 inch, plus or minus <sup>1</sup>/<sub>4</sub> inch.
  - E. When members cannot be adjusted to conform to design or tolerance criteria, cease work and advise. Execute modifications as directed.

# 3.5 FIELD QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for inspecting and testing.
- B. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

END OF SECTION 33 05 16

# SECTION 33 13 00 - DISINFECTING OF WATER UTILITY DISTRIBUTION

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Disinfection of potable water distribution system.
  - 2. Testing and reporting of results.

#### 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA B300 Hypochlorites.
  - 2. AWWA C651 Disinfecting Water Mains.

# 1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit procedures, proposed chemicals, and treatment levels.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Test and Evaluation Reports: Indicate testing results comparative to specified requirements.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for submittals.
- B. Disinfection Report:
  - 1. Type and form of disinfectant used.
  - 2. Date and time of disinfectant injection start and time of completion.
  - 3. Test locations.
  - 4. Name of person collecting samples.
  - 5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
  - 6. Date and time of flushing start and completion.
  - 7. Disinfectant residual after flushing in ppm for each outlet tested.
- C. Bacteriological Report:

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- 1. Date issued, project name, and testing laboratory name, address, and telephone number.
- 2. Time and date of water sample collection.
- 3. Name of person collecting samples.
- 4. Test locations.
- 5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
- 6. Coliform bacteria test results for each outlet tested.
- 7. Submit bacteriologist's signature and authority associated with testing.

# 1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

# PART 2 - PRODUCTS

# 2.1 DISINFECTION CHEMICALS

- A. Chemicals:
  - 1. Hypochlorite: Comply with AWWA B300.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that piping system has been cleaned, inspected, and pressure tested.
- C. Perform scheduling and disinfecting activity with startup, water pressure testing, adjusting and balancing, and demonstration procedures, including coordination with related systems.

# 3.2 INSTALLATION

- A. Provide and attach required equipment to perform Work of this Section.
- B. Perform disinfection of Site Water Utility Distribution Piping.
- C. Introduce treatment into piping system.
- D. Maintain disinfectant in system for 24 hours.
- E. Flush, circulate, and clean until required cleanliness is achieved using plant water.

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# 3.3 FIELD QUALITY CONTROL

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Disinfection, Flushing, and Sampling:
  - 1. Disinfect pipeline installation according to AWWA C651.
  - 2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
  - 3. Disposal:
    - a. Legally dispose of chlorinated water.
    - b. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.

END OF SECTION 33 13 00

# SECTION 33 16 32 – PRESTRESSED COMPOSITE TANKS

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Prestressed composite tanks with dome roof and geotextile tension-fabric baffle system.
  - 2. Repair of Exterior on existing 4.0MG prestressed composite tank.

#### B. General Description:

- 1. The circular tank shall be an ANSI/AWWA D110 wire-wound prestressed concrete storage tank with a Type II core wall and galvanized steel diaphragm including all reinforcing, concrete work, accessories, disinfection and testing directly related to the tank.
- 2. The tank floor shall be of concrete or shotcrete construction containing no less than 0.6 percent reinforcing steel in each orthogonal direction.
- 3. The wire-prestressed composite wall shall consist of a shotcrete core wall encasing a steel shell diaphragm continuous the full wall height. All prestressing shall be done with high tensile wire, permanently bonded to the tank wall.
- 4. The tank roof shall be a circumferentially prestressed free-span dome of concrete or shotcrete construction containing no less than 0.25 percent reinforcing steel in each orthogonal direction.
- 5. The entire tank, including all portions of the floor, wall, and roof shall be built by the Tank Construction Company, using its own trained personnel and equipment.
- C. Related Requirements:
  - 1. Section 01 81 00 Geotechnical Data
  - 2. Section 03 30 00 Cast-In-Place Concrete
  - 3. Section 09 96 00 High Performance Coatings
  - 4. Section 13 31 24 "Tension-Fabric Geomembrane Baffle Curtain"; for baffle system furnished under this section
  - 5. Section 31 20 00 Earthwork
  - 6. Section 33 01 10.59 "Disinfection of Water Utility Storage Tanks"
  - 7. Section 40 05 13 "Common Requirements for Process Piping"; for process piping installed under this section

# 1.2 **REFERENCES**

- A. ACI 117-10 Specification for Tolerances for Concrete Construction and Materials
- B. ACI 301 Specifications for Structural Concrete for Buildings.

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- C. ACI 305R-10 Guide to Hot Weather Concreting.
- D. ACI 306R-10 Guide to Cold Weather Concreting.
- E. ACI 318 Building Code Requirements for Reinforced Concrete.
- F. ACI 347R-04 Guide to Formwork for Concrete.
- G. ACI 350/350R-06 Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- H. ACI 350.3-06 Seismic Design of Liquid-Containing Concrete Structures and Commentary.
- I. ACI 372R-03 Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.
- J. ACI 506R-05 Guide to Shotcrete.
- K. ACI 506.2-95 Specification for Materials, Proportioning, and Application of Shotcrete.
- L. ACI SP4: Formwork for Concrete.
- M. ANSI/AWWA C652-11 Disinfection of Water Storage Facilities.
- N. ANSI/AWWA D110-04 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
- O. ASCE Standard 7-10 Minimum Design Loads for Buildings and Other Structures.
- P. ASTM A185 Standard Specification for Welded Steel Wire Fabric for Concrete.
- Q. ASTM A227 Steel Wire, Hard-Drawn for Mechanical Springs.
- R. ASTM A366 Specification for Sheet Steel.
- S. ASTM A416 Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
- T. ASTM A586 Zinc-Coated Steel Wire Structural StrandSSPC-PA2—Procedure for Determining Conformance to Dry Coating Thickness Requirements
- U. ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- V. ASTM A653 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by Hot Dip Process.
- W. ASTM A821 Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.
- X. ASTM A882 Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Strand.

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- Y. ASTM A884 Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.
- Z. ASTM A1064 Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- AA. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- BB. ASTM C33 Standard Specification for Concrete Aggregates.
- CC. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- DD. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement.
- EE. ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete.
- FF. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- GG. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- HH. ASTM D1056-07 Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
- II. ASTM D1557-12 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- JJ. ASTM F593-13 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- KK. "Earthquake Induced Sloshing in Tanks with Insufficient Freeboard" by P.K. Malhotra, Structural Engineering International, IASBSE, 3/2006 pp 222-225.

#### 1.3 QUALIFICATIONS

- A. The Tank Construction Company shall have the following qualifications and experience:
  - 1. The Company constructing the tank shall be a firm with at least ten (10) years of experience in the design and construction of AWWA D110 Type II wire-wound circular prestressed composite tanks; and shall give satisfactory evidence that it has the skill, reliability, and financial stability to build and guarantee the tank in accordance with the quality required by these specifications. The Company constructing the tank shall have built completely in its own name in the past five years, and be presently responsible for, a minimum of twenty (20) dome-covered AWWA D110 Type II prestressed composite tanks of one-million-gallon size or larger, which meet these specifications and which are now giving satisfactory service.
  - 2. The Tank Construction Company shall have on its staff a full-time professional engineer, who shall have no less than five (5) years of experience in the design and field construction of circular prestressed composite tanks, and who shall be in responsible

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engineering charge of the work to be done. All working drawings and design calculations shall carry the seal of such registered professional engineer.

- B. Guarantee:
  - 1. The Tank Construction Company shall guarantee workmanship and materials on the complete structural portion of the tank for a five-year period from date of acceptance of the work. In case 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.

# 1.4 SUBMITTALS

- A. Submit to the Engineer complete design calculations and a complete set of detailed working drawings for the tank, in accordance with Section 01 33 00 Submittals.
  - 1. If a sliding waterstop is used in the floor/wall joint, submit load/shear/deflection data to support shear and deflection calculations for base of wall. Tests must have been generated for the particular waterstop configuration proposed.
  - 2. Concrete mix designs.
  - 3. Guarantee document as described above.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURER

- A. The equipment, prestressed composite tanks, shall be manufactured by:
  - 1. The Crom Corporation
  - 2. Precon
  - 3. Or Approved Equal

# 2.2 DESIGN CRITERIA

- A. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, hydrostatic stresses induced by contents, and other applicable loads such as soil backfill and wind.
- B. Backfill loads shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.
- C. 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 core walls, and currently accepted engineering principles and practices for the design of such structures.

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- D. The tank side walls shall be of composite steel-shotcrete, wire-wound prestressed construction. The floor and dome shall be of shotcrete or concrete construction conventionally reinforced. Horizontal sections of the wall shall form true circles without flats, excessive bumps or hollows. Conventional concrete work shall conform to the Section 03 30 00 – Cast-In-Place Concrete.
- E. Prestressing wires at openings shall be displaced equally above and below the opening. The wall thickness at these openings shall be increased to match the depth of the sleeve.
- F. The roof shall be a free span dome with a prestressed ring girder at the top of the walls for support. The high water level (H.W.L.) of the tank shall be permitted to encroach on the dome no higher than the upper horizontal plane of the dome ring girder.
- G. The horizontal prestress "working force" per foot of core wall, or dome ring, shall withstand a "ring tension force" produce by 1.05 times the effective hydrostatic pressure, or 1.05 times the dome dead load plus live load, without inducing tensile stress in the core.

Mix	Compressive	Minimum	Maximum	Maximum	Air	Slump
	Strength (psi)	Cement Content	Aggregate Size	W/C	Content	(in)
		(lbs)	(in)	Ratio	(%)	
Floor	4000	560	3/4	0.45		4.5"+/-
						1.5"
Dome	4000	600	3/8	0.45		4.5"+/-
						1.5"

1. Concrete

- 2. 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% 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:

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Mix	Compressive	Maximum	Air	Slump	Fiber
	Strength	W/C	Content	(in)	Reinforcement
	(psi)	Ratio	(%)		(lbs/cyd)
Core Wall	4000	0.42		4.5"+/-	-
				1.5"	
Covercoat	4000	0.42		4.5"+/-	
				1.5"	

a. Allowable Compressive Stress ( $f_g$ ): 1250 + 75t with 0.45  $f_g$  maximum\*

(t = thickness of core wall)

b. Allowable Compressive Stress 1250 + 75Due to Initial Prestressing with a matrix Force  $(f_{gi})$ : (where f

1250 + 75t with 0.5 f'gi or less with a maximum of 2250 psi (where f'gi is defined as compressive strength at time initial prestressing force is applied)

# 3. Prestressing Wire

- a. The prestressing wire shall conform to the requirements of ASTM A821/A821M, Type B.
- b. Wire Size (diameter): 0.162" (8 gauge), 0.192" (6 gauge)

or larger, but no larger than 0.250"

- c. Working Stress, Wall (f<sub>s</sub>): 115,000 psi
- d. Working Stress, Dome Ring  $(f_s)$ : 120,000 psi
- e. Allowable Tensile 145,600 psi or no Stress Before Losses  $(f_{si})$ : greater than 0.70  $f_s$
- f. Ultimate Tensile Strength (f 's): 231,000 psi or greater for 8 gauge 222,000 psi or greater for 6 gauge

# 4. Reinforcing Steel

- a. Allowable Tensile Stress  $(f_s)$ : 18,000 psi
- b. Yield Strength  $(f_y)$ : 60,000 psi
- c. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A1064 with a minimum yield strength,  $f_y$ , of 65,000 psi

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# 2.3 FLOOR

- A. Concrete membrane floors shall be a minimum of 4 inches thick and have a minimum percentage steel of 0.6%. All concrete over pipe encasements and around sumps shall be a minimum of 8 inches thick. The minimum percentage (0.6%) of reinforcing steel applies to these thickened sections and shall extend a minimum of 2 feet into the adjacent membrane floor.
- B. Floors shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.
- C. Floors shall be continuously water cured until tank construction is completed.

# 2.4 CORE WALL

- A. The core wall shall be constructed of shotcrete, encasing a galvanized steel diaphragm continuous the full wall height without horizontal splices.
- B. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, backfill, and other applicable loads. The wall may taper uniformly on the outside face from top to bottom as required by design computations. In no case shall the core wall be less than 3½ inches thick. Horizontal sections of the wall shall form true circles without flats, excessive bumps, or hollows.
- C. To compensate for bending moments and for shrinkage, differential drying, and temperature stresses, the following reinforcing steel shall be incorporated in the core wall:
  - 1. The top 2 feet of core wall shall have not less than 1 percent circumferential reinforcing.
  - 2. The bottom 3 feet of core wall shall have not less than 1 percent circumferential reinforcing.
  - 3. Inside Face:
    - a. 26 gauge steel shell diaphragm continuous the full wall height without horizontal splices.
    - b. Additional vertical and horizontal reinforcing steel bars as required by design computations.
    - c. The inside face of the core wall shall utilize the diaphragm as effective reinforcing.
    - 4. Outside Face:
      - a. Vertical reinforcing steel: minimum of #4 bars at 12 inches center to center.
      - b. Additional vertical and horizontal reinforcing steel bars as required by design computations.
    - 5. Interior and exterior surfaces of the core wall shall be water cured until prestressing starts.

# 2.5 GALVANIZED STEEL SHELL 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 in. conforming to the requirements of ASTM A653. Weight of zinc coating shall be not less than G90 of Table 1 of ASTM A653. The diaphragm shall be used within and throughout the core wall, providing a positive waterstop. The steel shell diaphragm shall be encased and protected with shotcrete no less than one inch thick at all places. The steel

shell is to be so formed and erected that a mechanical key between shotcrete and diaphragm will be created. The sheets of steel diaphragm shall be continuous from top to bottom of wall; horizontal joints or splices will not be permitted.

- B. All vertical joints in the diaphragm shall be sealed watertight by epoxy injection.
- C. Epoxy injection shall be carried out from bottom of wall to top of wall, using a pressure pumping procedure, after the steel shell has been fully encased, inside and outside, with shotcrete. The epoxy sealant shall be suitable for bonding to concrete, shotcrete, and steel. The sealant shall conform to the requirements of ASTM C 881, Type III, Grade 1, and shall be a 100 percent solids, moisture insensitive, low modulus epoxy system. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77 degrees F.
- D. The steel shell design and its epoxy injection procedure (covered by U.S. Patent 5,150,551) shall have been used in the ten tanks required in the Tank Construction Company's experience record. No nail or other holes shall be made in the steel shell for erection or other purposes except for inserting pipe sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an approved epoxy sealant.
- E. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to this waterstop.

# 2.6 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 polyvinyl chloride.
- 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.

# 2.7 EPOXY

- A. Epoxy Sealants:
  - 1. Epoxy shall conform to the requirements of ASTM C881.
  - 2. Epoxy used for sealing the diaphragm shall be Type III, Grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy.
  - 3. Epoxy used for placing the waterstop shall be Type II, Grade 2, and shall be 100% solids, moisture insensitive, low exotherm epoxy.
  - 4. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°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.
- 2.8 Epoxy resins shall be a two-component, 100% solids, moisture-insensitive epoxy and shall be Type II, Grade 2 shotcrete.
  - A. All shotcrete shall be applied by or under direct supervision of experienced nozzlemen who hold current certification in accordance with ACI CP-60.
  - B. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer. No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray. No less than 1/8-inch thick shotcrete shall separate reinforcing steel and prestressing wire.
  - C. No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.
  - D. The diaphragm shall be encased and protected with no less than 1" of shotcrete in all locations.
  - E. The interior shotcrete corewall shall receive a light broom finish.

# F. Curing:

1. Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is completed.

# 2.9 DOME ROOF

- A. The dome roof shall be constructed of reinforced concrete, circumferentially prestressed. Dome shell reinforcement shall consist of reinforcing steel bars or welded wire fabric meeting ASTM A 185, not galvanized. Bolsters for wire fabric and reinforcing bars shall be plastic tipped. Wire ties shall be galvanized.
- B. The dome shell shall be designed as a free span, spherical thin shell, with a one tenth rise. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have a cross section suitable to accept the applied prestressing forces. All surfaces in the wall/dome ring girder joint shall be coated with an approved bonding epoxy.
- C. The exterior surface of the dome shall receive a light broom finish.
- D. The dome shall be water cured for a minimum 7 days after casting or until dome band prestressing is completed.
- E. The high water level (H.W.L.) in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder. Overflow outlets shall be installed on the dome roof in such numbers as will provide an overflow open area three times the area of the largest tank pipe.

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#### 2.10 HORIZONTAL PRESTRESSING

- A. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire complying with ASTM 821/A821M, Type B placed under high tension. 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.
- B. 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 stress equivalent to that shown on the 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.
- C. Areas to be prestressed will contain not less than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge. 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. Shotcrete shall be used to completely encase each individual wire and protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.
- D. 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 drawings.

#### 2.11 MEASUREMENT OF WIRE STRESS

A. 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. This stress measuring equipment shall include: electronic direct reading stressometer accurate to within 2 percent; calibrated dynamometers; test stand to field verify the accuracy of the stressometer. The initial tension in each wire shall be recorded.

# 2.12 EXTERIOR COVERCOAT

A. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This shotcrete encasement shall completely encapsulate each wire and shall permanently bond the wire to the tank wall. The shotcrete cover shall have a thickness of no less than one inch over the wire. When multiple layers of wire are required, shotcrete cover between layers shall be no less than ½-inch thick.

# 2.13 WALL OPENINGS

A. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe shall be no less than 18 inches above the floor slab, and the prestressing wires required at the pipe elevation shall be distributed above and below the opening, leaving an unbanded strip around the entire tank. Ordinarily, unbanded strips shall have a vertical dimension of no more than 36 inches.

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- B. An axi-symmetric finite element shell analysis will be required for unbanded wall spaces having a vertical dimension greater than 36 inches.
- C. All wall pipes passing through the wall shall be sealed to the steel shell diaphragm by epoxy injection.

# 2.14 COATING MATERIALS:

- A. Exterior of new tank:
  1. 2 coats Themec Series 156 (or equal) applied according to manufacturer instructions.
- B. Interior and Exterior Piping of new tank:
  - 1. Refer to Section 09 96 00 High Performance Coatings.
- C. Exterior of existing tank:
  - 1. Clean Exterior of existing tank to SSPC SP13
  - 2. Crack repair on sidewall and dome with Tnemec Series 215 (or equal)
  - 3. Prime Coat: Tnemec Series 151 (or equal) 1 mil DFT
  - 4. Intermediate Coat: Tnemec Series 156 (or equal) 4-6 mil DFT
  - 5. Finish Coat: Tnemec Series 156 (or equal) 4-6 mil DFT color to match new tank.

# 2.15 TANK ACCESSORIES

- A. The Tank Construction Company shall furnish, install, and guarantee for five (5) years the following tank accessories:
  - 1. Tension-Fabric Geomembrane Baffle Curtain shall be installed in the locations shown and shall conform to the requirements of Section 13 31 24.
  - 2. Wall Manhole: Stainless steel frame with stainless steel cover and stainless steel bolts; all Type 316.
  - 3. Through-Wall Wall Pipes: Type 316 stainless steel wall pipes.
  - 4. Tank Drain: Per drawings.
  - 5. Interior ladder shall be fabricated from fiberglass shall conform to all applicable OSHA standards. The ladder shall have a safety climbing device manufactured from Type 316 stainless steel as required to meet applicable OSHA standards.
  - 6. Exterior ladder shall be fabricated from 6061-T6 and 6063-T6 aluminum and shall conform to all applicable OSHA standards. The ladder shall have an aluminum safety cage and lockable security gate and/or a safety climbing device in accordance with all applicable OSHA standards.
  - 7. Aluminum handrail shall be fabricated in 20 ft typical sections from 6061-T6 aluminum and shall conform to all applicable OSHA standards.

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- 8. Aluminum accessories shall be shop fabricated and fully welded. All welding shall be in accordance with American Welding Society (AWS) standards using gas tungsten arc welding (GTAW) to fuse materials without distortion of the material. Mechanical splices shall only be used at field splice locations.
- 9. Aluminum accessories shall have a "mill" finish.
- 10. Aluminum surfaces in contact with concrete shall be protected with a coat of bituminous paint.
- 11. Roof Hatch: A fiberglass roof hatch shall be furnished and installed. The roof hatch shall be provided with stainless steel hinges and a hasp for locking. The hatch shall have a minimum opening dimension or diameter of 24". The opening shall have a curb at least 4" high and the cover shall overlap it at least 2".
- 12. Vent Screens: All vents shall be equipped with a fixed 24 mesh polyester screen.
- 13. Tank level indication: Visual indication of tank water level shall be provided. A level gauge (with markings of units in feet) shall be used. The level gauge shall be the GSI (Gauging Systems, Inc.) 2530 Target Board or approved equal.

# PART 3 - EXECUTION

# 3.1 TANK CONSTRUCTION

A. Upon completion of the tank erection, the Tank Contractor will remove or dispose of all rubbish and other unsightly material caused by its operation and will leave the premises in good appearance.

#### 3.2 FNISHING OF SHOTCRETE

- A. Underlayers or Exposed Surfaces
  - 1. On completing surfaces, bring shotcrete to an even plane and to well-formed corners by working up to ground wires or other thickness or alignment guides, using lower placing velocity than normal.
  - 2. Screed exposed surfaces or underlayers by working upward against gravity with thinedged screed using a slicing motion to trim off high spots and expose low spots.
  - 3. Avoid pulling and breaking surface with subsequent checking.
- B. Finish Coat
  - 1. Apply coat to remove rough areas after ground wires have been removed.
  - 2. Carefully screen sand for finish coat to remove oversize particles which rebound and mar surfaces.
  - 3. Surface of finish coat shall be of natural texture and coloration, free from spotting, cement or dust streaking, lap lines, uneven surfaces, and rebounded material.

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- 4. Do not hand-patch.
- 5. Check coatings for bond by tapping lightly to test for hollow sounding spots.
- 6. Cut out areas where bond is not fully developed and repair.
- C. Corrosion Protection
  - 1. Inspect core wall and patched surfaces.
  - 2. Test surfaces for chlorides or other chemicals that cause corrosion of prestressing.
  - 3. Remove corrosive chemicals from surfaces prior to sandblasting.
  - 4. Patch surfaces by building out in uniform circular area level with surface.

# 3.3 APPLICATION OF TANK COATING:

A. Surface Preparation and application of tank coatings shall be in accordance with the requirements of Section 09 96 00 – High Performance Coatings and in accordance with coating materials manufacturer printed instructions.

# 3.4 FIELD QUALITY CONTROL

- A. Inspection and Testing:
  - 1. Concrete and Shotcrete Testing:
    - a. Compression Tests:
    - Compression test specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 50 yards of concrete/shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.
    - c. Compression test specimens for concrete/shotcrete shall conform to ASTM C172 for sampling and ASTM C31 for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.
    - d. Compression test shall be performed in accordance with ASTM C39. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.
    - e. Air Content Tests (concrete only, not required for shotcrete):
    - f. Air content tests shall conform to ASTM C231 (Pressure Method for Air Content).
    - g. Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.
    - h. Slump Tests (concrete only):
    - i. Slump tests shall be made in accordance with ASTM C143.
    - j. Slump tests shall be made whenever compression test specimens are made.

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# 3.5 CLEANING & TESTING

- A. General: The tank shall be hydrostatically tested prior to acceptance. For testing purposes, the Owner will furnish one tank full of water at no cost to the Contractor. All water in excess of this quantity will be purchased by the Contractor at the standard service charge.
- B. Cleaning: Prior to filling, all surfaces including pipes, ladders, and steps shall be cleaned by sweeping, scraping, hosing or scrubbing as may be required and directed by the Engineer.
- C. Testing: Following the cleaning procedure, the tank shall be tested for leakage by filling with water. The work shall not be acceptable if there is visible leakage or if the drop in water level is 1/4" or more in any 24 hour period. This maximum permissible drop in water level shall include evaporation, leakage, absorption and all other losses. Failure to meet this test shall be cause for rejection of the tank. Any remedial measures used to meet the test requirements must be approved in writing by the Engineer before incorporation into the work.
- D. Disinfect tank as specified in Section 33 01 10.59 Disinfection of Water Utility Storage Tanks.

END OF SECTION 33 16 32

# SECTION 40 05 06 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Pipe penetrations.
  - 2. Restrained joints.
  - 3. Braided flexible connections.
  - 4. Expansion joints.
  - 5. Expansion loops.
  - 6. Sleeve-type couplings.
  - 7. Wall sleeve.

# B. Related Requirements:

- 1. Section 09 96 00 High-Performance Coatings
- 2. Section 33 13 00 Disinfecting of Water Utility Distribution: Disinfection of potable water piping.
- 3. Section 40 05 13 Common Requirements for Process Piping
- 4. Section 40 42 13 Process Piping Insulation

# 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C219 Bolted, Sleeve-Type Couplings for Plain-End Pipe.
  - 2. AWWA C227 Bolted, Split-Sleeve Restrained and Nonrestrained Couplings for Plain-End Pipe.
- B. American Welding Society:
  - 1. AWS D1.1/D1.1M Structural Welding Code Steel.
- C. ASME International:
  - 1. ASME A13.1 Scheme for the Identification of Piping Systems.
  - 2. ASME B31.3 Process Piping.
  - 3. ASME B31.9 Building Services Piping.
  - 4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX Welding, Brazing, and Fusing Qualifications.
- D. ASTM International:

- 1. ASTM D2000 Standard Classification System for Rubber Products in Automotive Applications.
- 2. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- 3. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
- 4. ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems.
- 5. ASTM E1966 Standard Test Method for Fire-Resistive Joint Systems.
- E. Expansion Joint Manufacturers Association, Inc.:
  - 1. EJMA Standards.
- F. NSF International:
  - 1. NSF 61 Drinking Water System Components Health Effects.
  - 2. NSF 372 Drinking Water System Components Lead Content.
- G. UL:
  - 1. UL 263 Fire Tests of Building Construction and Materials.
  - 2. UL 1479 Fire Tests of Through-Penetration Firestops.
  - 3. UL 2079 Tests for Fire Resistance of Building Joint Systems.

# PART 2 - PRODUCTS

# 2.1 PIPE PENETRATIONS

- A. Flashing:
  - 1. Metal Flashing:
    - a. Material: Galvanized steel.
    - b. Thickness: 26 gage.
  - 2. Metal Counterflashing:
    - a. Material: Galvanized steel.
    - b. Thickness: 22 gage.
  - 3. Flexible Flashing Materials:
    - a. Material: Butyl sheet, PVC sheet, or Compatible with service conditions.
    - b. Thickness: 47 mils.
  - 4. Caps:
    - a. Material: Steel.
    - b. Minimum Thickness: 22 gage, and 16 gage at fire-resistive elements.

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- B. Sleeves:
  - 1. Sleeves for Pipes through Non-fire-rated Floors:
    - a. Material: 304 stainless steel.
    - b. Thickness: Schedule 10
  - 2. Sleeves for Pipes through Non-fire-rated Beams, Walls, Footings, and Potentially Wet Floors:
    - a. 18-gage galvanized steel.
  - Sealant:
     a. As specified in Section 07 92 00 Joint Sealants.
- C. Mechanical Sleeve Seals:
  - 1. Manufacturers:
    - a. Flexicraft Industries, PipeSeal
    - b. GPT Industries (Link-Seal)
    - c. Or Approval Equal
  - 2. Description:
    - a. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
    - b. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

# 2.2 RESTRAINED JOINTS

- A. Flange Coupling Adapter (Non-restrained)
  - 1. Manufacturer:
    - a. EZ Flange Adapter (EBAA Iron, Inc.)
    - b. Uni-Flange, series 400 (0R series 420)
    - c. Ford Meter Box Company, Inc. (Nappco, Inc.)
    - d. Star Pipe Series 400
    - e. Or Approved Equal.
  - 2. Description:
    - a. The uniflange assembly shall be used only in instances shown on the drawings. If the CONTRACTOR proposes to use uniflanges at other locations, he shall first obtain approval from the ENGINEER.
    - b. The uniflange shall consist of a Ductile Iron ASTM A536 Grade 65-45-12 flange with ANSI B16.1 Class 125 & 250 or ANSI B16.5 Class 150 & 300 drillings.
    - c. The standard gasket of Buna S for water and wastewater shall be supplied.
    - d. The uniflange class shall be suitable for the pressure service. (2"-12" = 250 psi, 14"-24" = 150 psi, >24" = 100 psi)
- B. Flange Coupling Adapter (Restrained)

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- 1. Manufacturer:
  - a. SERIES 2100 MEGAFLANGE adapter, as produced by EBAA Iron, Inc.,
  - b. StarFlange Series 3200
  - c. Or Approved Equal.
- 2. Description:
  - a. Restrained flange adapters shall be used in lieu of threaded, or welded, flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
  - b. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
  - c. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
  - d. Megaflanges shall be fully restrained and shall incorporate a wedge style grip in lieu of set screws.
  - e. Allowable working pressures shall have a minimum as follows: 3"-16" = 350psi, 18"-24" = 250 psi, 30"-48" = 150psi.
- C. Adapter with Wedge Restraints for Mechanical Joint pipe.
  - 1. Manufacturer:
    - a. Megalug Series 1100 by Ebba Iron, Inc.
    - b. Uni-Flange Series 1400, by Ford Meter Box Company
    - c. StarGrip 3000 by Star Pipe Products
    - d. Or Approved Equal.
  - 2. Description:
    - a. Restraint for standardized mechanical joints shall be incorporated into the design of the follower gland and shall impart multiple points of wedge action against the pipe, increasing its resistance as the pressure increases.
    - b. The restrained joint shall incorporate a wedge style restraint system, in lieu of set screws. Restraints with set screws will not be acceptable.
    - c. The assembled joint shall maintain its flexibility after burial and shall maintain its integrity by a controlled and limited expansion of each joint during the wedging action.
    - d. Restraining glands shall be manufactured of high strength ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12.
    - e. Wedges shall be contoured to properly fit on the pipe, and shall be manufactured of ductile iron, heat treated to a minimum hardness of 370 BHN. Dimensions of the glands shall be such that they can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53 of latest revision.
    - f. Twist-off heads shall be incorporated in the design of the wedge actuating screws to ensure proper torque.
    - g. The mechanical joint restraining device shall have a water working pressure rating of 250 psi minimum with a safety factor of at least 2:1 against separation when tested in a dead-end situation
    - h. Allowable working pressures shall be as follows: 3"-16" = 350psi, 18"-36" = 250psi.

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## 2.3 BRAIDED FLEXIBLE CONNECTIONS

- A. Manufacturers:
  - 1. Flexicraft Industries
  - 2. Flex-Weld, Inc.
  - 3. Hyspan Precision Products, Inc.
  - 4. Or Approved Equal.
- B. Steel Piping:
  - 1. Inner Hose: Corrugated stainless steel as indicated.
  - 2. Exterior Sleeve: Braided or stainless steel as indicated.
  - 3. Pressure Rating: Minimum 150 psig at 50 degrees F and sufficient for service condition.
  - 4. Fittings: Flanged, Threaded with union, or As specified for pipe joints.
  - 5. Size: Use pipe-sized units.
  - 6. Maximum Offset: 3/4inch on each side of installed center line.
- C. Copper Piping:
  - 1. Inner Hose: Corrugated Bronze.
  - 2. Exterior Sleeve: Braided bronze.
  - 3. Pressure Rating: Minimum 150 psig at 70 degrees F and sufficient for service condition.
  - 4. Fittings: Threaded with union, Soldered, or As specified for pipe joints.
  - 5. Size: Use pipe-sized units.
  - 6. Maximum Offset: 3/4 inch on each side of installed center line.

# 2.4 EXPANSION JOINTS

- A. Manufacturers:
  - 1. Flexicraft Industries
  - 2. Flex-Weld, Inc.
  - 3. Hyspan Precision Products, Inc.
  - 4. Or Approved Equal
- B. Performance and Design Criteria:
  - 1. Bellow Design: According to Section C of EJMA Standards.
- C. Stainless-Steel Compensator Type:
  - 1. Pressure Rating: 200 psig WOG at 250 degrees F.
  - 2. Maximum Compression: 1-3/4 inches.
  - 3. Maximum Extension: 1/4 inch.
  - 4. Joint: Flanged, Threaded, or As specified for pipe joints.
  - 5. Size: Use pipe-sized units.
  - 6. Application: Steel piping 3 inches and smaller.

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- D. External Ring-Controlled Stainless-Steel Bellows Type:
  - 1. Pressure Rating: 200 psig WOG at 250 degrees F.
  - 2. Maximum Compression: 1-1/4 inches.
  - 3. Maximum Extension: 3/8 inch.
  - 4. Maximum Offset: 5/16 inch.
  - 5. Joint: Flanged.
  - 6. Size: Use pipe-sized units.
  - 7. Accessories: Internal flow liner.
  - 8. Application: Steel piping 3 inches and larger.
- E. Double-Sphere Rubber Type:
  - 1. Body: Neoprene and nylon.
  - 2. Working Pressure: 150 psig.
  - 3. Maximum Temperature: 200 degrees F.
  - 4. Maximum Compression: 1 inch.
  - 5. Maximum Elongation: 5/8 inch.
  - 6. Maximum Offset: 1/2 inch.
  - 7. Maximum Angular Movement: 30 degrees.
  - 8. Joint: Tapped steel flanges, Galvanized flanges, or Galvanized unions.
  - 9. Size: Use pipe-sized units.
  - 10. Accessories: Control rods.
  - 11. Application: Steel piping 2 inches and larger.
- F. Bronze Compensator Type:
  - 1. Description: Bronze with anti-torque device, limit stops, and internal guides.
  - 2. Pressure Rating: 200 psig WOG at 250 degrees F.
  - 3. Maximum Compression: 3 inches.
  - 4. Maximum Extension: 1/4 inch.
  - 5. Size: Use pipe-sized units.
  - 6. Application: Copper piping.

#### 2.5 EXPANSION LOOPS

A. Provide expansion loops as indicated on Shop Drawings.

#### 2.6 SLEEVE-TYPE COUPLINGS

- A. Manufacturers:
  - 1. Dresser Piping Specialties
  - 2. Fernco Inc.
  - 3. US Pipe Fabrication
- B. Description:

- 1. Comply with AWWA C219.
- 2. Middle Ring: Steel.
- 3. Followers: Steel.
- 4. Gaskets:
  - a. Material: Buna-N, EPDM, or Compatible with service conditions.
  - b. Comply with ASTM D2000.
- 5. Bolts: Steel.
- C. Finishes:
  - 1. Buried Couplings: Factory epoxy coated.

# 2.7 WALL SLEEVE

- A. Manufacturers:
  - 1. Water Works Supply Corporation.
  - 2. American
  - 3. Or Approved Equal.
- B. Description:
  - 1. Wall and floor pipe penetrations of ductile iron piping systems shall be made by means of a sleeve capable of being bolted directly to the formwork to prevent misalignment. Seal of annular space shall be by means of a confined rubber gasket, so as not to be affected by vibration and capable of withstanding up to 100 psig. Sleeve shall be manufactured from Ductile Iron with an integrally cast water stop.

# 2.8 INSULATION

A. As specified in Section 40 42 13 - Process Piping Insulation.

# 2.9 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Section 09 96 00 – High-Performance Coatings.

#### 2.10 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
  - 1. Provide shop inspection and testing of completed assemblies.
- B. Certificate of Compliance:

# 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

2. Specified shop tests are not required for Work performed by approved manufacturer.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that field dimensions are as indicated on Shop Drawings.
- C. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.
- D. Verify that openings are ready to receive sleeves.
- E. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 inches from pipe ends.
- F. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

# 3.2 PREPARATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation preparation.
- B. Cleaning: Thoroughly clean end connections before installation.
- C. Close pipe and equipment openings with caps or plugs during installation.
- D. Surface Preparation: Clean surfaces to remove foreign substances.

# 3.3 INSTALLATION

- A. According to ASME B31.3 for process piping and ASME B31.9 for building services piping.
- B. Coating: Finish piping appurtenances as specified in Section 09 96 00 High-Performance Coatings for service conditions.
- C. Pipe Penetrations:
  - 1. Flashing:

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- a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
- b. Flash floor drains with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
- c. Fasten flashing to drain clamp device.
- 2. Sleeves:
  - a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
  - b. Set sleeves in position in forms and provide reinforcement around sleeves.
  - c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
  - d. Extend sleeves through floors 1/2 inches above finished floor level and calk sleeves.
  - e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with insulation and calk airtight.
  - f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
  - g. Install stainless-steel escutcheons at finished surfaces.
- D. Firestopping:
  - 1. Placement: Place intumescent coating in sufficient coats to achieve rating required.
  - 2. Fire-Rated Surfaces:
    - a. Seal opening at floor, wall, partition, ceiling and roof.
    - b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
    - c. Size sleeve, allowing minimum of 1 inch void between sleeve and building element.
    - d. Pack void with backing material.
    - e. Seal ends of sleeve with UL-listed, fire-resistive silicone compound to meet fire rating of structure penetrated.
  - 3. Non-rated Surfaces:
    - a. Seal opening through non-fire-rated floor, wall, partition, ceiling and roof.
    - b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
    - c. Size sleeve to allow minimum of 1 inch void between sleeve and building element.
    - d. Install type of firestopping material recommended by manufacturer.
    - e. Occupied Spaces:
      - 1) Install escutcheons, floor plates, or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
      - 2) Occupied spaces include rooms with finished ceilings and rooms where penetration occurs below finished ceiling.
    - f. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.

- g. Interior Partitions:
  - 1) Seal pipe penetrations at where indicated.
  - 2) Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.
- E. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on Shop Drawings.
- F. Expansion Joints:
  - 1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Drawings.
  - 2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.
- G. Air Release and Vacuum Breakers: Provide vacuum breakers on all tanks and process equipment.
- H. Backflow Preventers:
  - 1. Install with nameplate and test cock accessible.
  - 2. Install according to local code requirements.
  - 3. Do not install in vertical position.
- I. Insulation: As specified in Section 40 42 13 Process Piping Insulation and as indicated on Drawings.

# 3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for inspecting and testing.
- B. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. After installation, inspect for proper supports and interferences.
- D. Repair damaged coatings with material equal to original coating.

# 3.5 CLEANING

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for cleaning.
- B. Keep equipment interior clean as installation progresses.

# END OF SECTION 40 05 06

# SECTION 40 05 13 - COMMON REQUIREMENTS FOR PROCESS PIPING

# PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Requirements common to pipe and tube of all material types used on the Project.
  - 2. Accessories.

#### B. Related Requirements:

- 1. Section 09 96 00 High-Performance Coatings
- 2. Division 31 Earthwork
- 3. Section 40 05 06 Couplings, Adapters, Specials for Process Piping
- 4. Section 40 05 07 Hangers and Supports for Process Piping
- 5. Section 40 42 13 Process Piping Insulation

#### 1.2 COORDINATION

- A. Section 01 31 00 Project Management and Coordination.
- B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

#### 1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.
- C. Shop Drawings: Indicate layout of piping systems, including equipment, fittings, critical dimensions, sizes, and material lists.
- D. Submit manufacturer's certification and certified test reports that the pipe and linings and coatings were manufactured and tested in accordance with the ASTM and ANSI/AWWA Standards specified. Submittal shall be at least seven (7) days prior to each shipment of pipe.
- E. Material Certificates
- F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizing methods and calculations used.
- G. Qualifications Statements:

- 1. Submit qualifications for manufacturer, installer, and licensed professional.
- 2. Submit manufacturer's approval of installer.

# 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, invert and centerline elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

# 1.5 QUALITY ASSURANCE

- A. Perform Work according to all applicable Federal, State and Local standards and these specifications.
- B. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.
- C. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

# 1.6 QUALIFICATIONS

A. Manufacturer: For each pipe material type, a company specializing in manufacturing products of the material shall be used. The manufacturer shall have successfully manufactured and delivered products of the diameters used in this project for a minimum of 15 projects over the past 5 years.

# 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver materials in manufacturer's packaging; include handling instructions.
- C. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in a manner as to prevent damage to the exterior surface or internal coasting or lining of the pipe. If any part of the coasting or lining is damaged, the repair shall be made by the
- D. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

- E. Store piping and appurtenances according to manufacturer instructions.
- F. Protect piping and appurtenances from oxidation by storing off ground.
- G. Stored pipe shall be kept safe from damage and away from traveled ways. The interior of all pipe, fittings and other appurtenances shall be kept free from water, dirt, or foreign matter at all times.

# 1.8 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

# PART 2 - PRODUCTS

# 2.1 ACCESSORIES

- A. Couplings, Adapters, Specials for Process Piping: As specified in Section 40 05 06 Couplings, Adapters, Specials for Process Piping
- B. Hangers and Supports for Process Piping: As specified in Section 40 05 07 Hangers and Supports for Process Piping.
- C. Process Piping Insulation: As specified in Section 40 42 13 Process Piping Insulation.

#### 2.2 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
- B. All pipe and fittings to be installed under this Contract shall be of new manufacture.
- C. The manufacturer is responsible for the performance of all inspection requirements as specified.
- D. Owner Inspection:
  - 1. The manufacturer is responsible for performance of all inspection requirements as specified. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with these Specifications by the Owner, by an independent testing laboratory selected by the Owner, or by other representative of the Owner.
- E. Certificate of Compliance:

- 1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
- 2. Specified shop tests are not required for Work performed by approved fabricator.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that field dimensions are as indicated on the Drawings.
- C. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

# 3.2 PREPARATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation preparation.
- B. Ream ends of threaded pipes and file smooth.
- C. Cleaning: Thoroughly clean pipe and fittings before installation.
- D. Surface Preparation:
  - 1. Touch up shop-primed surfaces with primer as specified in Section 09 96 00 High-Performance Coatings.
  - 2. Solvent-clean surfaces that are not shop primed.
  - Clean surfaces of metallic pipe to remove loose rust, mill scale, and other foreign substances by power wire brushing or commercial sand blasting; SSPC SP 6/NACE No.
     Do not sand blast or power wire brush thermoplastic pipe.
  - 4. Prime surface as specified in Section 09 96 00 High-Performance Coating.

# 3.3 INSTALLATION

- A. Buried Service: Install pipe as specified in the Section appropriate to the pipe material.
- B. Exposed Service Install according to ASME B31.3.
- C. Provide required upstream and downstream clearances from devices as indicated.

- D. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.
- E. Support piping as specified in Section 400507 Hangers and Supports for Process Piping.
- F. Provide expansion joints as specified in Section 40 05 06 Couplings, Adapters, and Specials for Process Piping and pipe guides as specified in Section 40 05 07 Hangers and Supports for Process Piping to compensate for pipe expansion due to temperature differences.
- G. Dielectric Fittings: Provide between dissimilar metals.
- H. Field Cuts: According to pipe manufacturer's recommendations.
- I. Finish primed surfaces according to Section 09 96 00 High-Performance Coating.
- J. Run pipelines straight and true, parallel to building lines with a minimum use of offsets and couplings. Provide only such offsets as may be required to provide necessary headroom or clearance and to provide necessary flexibility in pipe lines.
- K. Changes in direction of pipelines shall be made only with fittings or pipe bends. Changes in size shall be made only with fittings. Miter fittings, face or flush bushings, or street elbows shall not be used. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- L. Provide flanges or unions at all final connections to equipment, traps and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
- M. Use full and double lengths of pipe wherever possible.
- N. Unless otherwise indicated, install all supply piping, including shut off valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at inlet to control valve or pump. Install supply piping from outlet of control valve at full size to connection of equipment served.
- O. All pipe shall be cut to exact measurement and installed without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings. Particular care shall be taken to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment, or building elements with piping connections or piping supports.

# 3.4 TOLERANCES

A. Laying Tolerances: Unless otherwise specified, laying tolerances will be within 5/8".

# 3.5 FIELD QUALITY CONTROL

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Inspection:
  - 1. Inspect for damage to pipe lining or coating and for other defects that may be detrimental as determined by Architect/Engineer.
  - 2. Repair damaged piping or provide new, undamaged pipe.
  - 3. After installation, inspect for proper supports and interferences.
- C. Damage:
  - 1. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by Architect/Engineer.
  - 2. Repair damaged piping or provide new undamaged pipe.
- D. Pressure Testing:
  - 1. Unless otherwise specified or indicated on the drawings, all pipe shall be pressure tested prior to acceptance.
  - 2. Conduct pressure testing in according to AWWA C600 and following:
    - a. Test Pressure: As shown in Process Piping Schedule. Where test pressure is not defined in schedule, the test pressure shall be not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
    - b. Conduct hydrostatic test for at least two hours.
    - c. Slowly fill with water section to be tested; expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
    - d. Observe joints, fittings, and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
    - e. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate. Maintain pressure within plus or minus 5 psi of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
    - f. Compute maximum allowable leakage by following formula:
      - 1) L = SD x sqrt(P)/C.
      - 2) L = testing allowance, in gph.
      - 3) S =length of pipe tested, in feet.
      - 4) D = nominal diameter of pipe, in inches.
      - 5) P = average test pressure during hydrostatic test, in psig.
      - 6) C = 148,000.
      - 7) When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
    - g. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
- h. Correct visible leaks regardless of quantity of leakage.
- E. After installation, inspect for proper supports and interferences.

# 3.6 CLEANING

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for cleaning.
- B. Keep pipe interior clean as installation progresses.
- C. All piping shall be cleaned, flushed, and tested prior to use.
- D. All water lines shall be flushed out under full treated water pressure; potable water piping shall be flushed with potable water; air piping shall be thoroughly blown out with air. All filters, control valves and gages shall be removed from lines or bypassed during the blowout period.
- E. Following the blow through, all dirt legs and other low points in lines shall be disassembled and all residual material thoroughly removed. All stop valves shall be removed and cleaned.
- F. The Contractor shall provide all water required for cleaning, and flushing at no additional cost to the Owner.

END OF SECTION 40 05 13

### SECTION 40 05 19 - DUCTILE IRON PROCESS PIPE

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Ductile-iron pipe and fittings.
  - 2. Accessories.

### B. Related Requirements:

- 1. Section 09 96 00 High-Performance Coating
- 2. Section 33 11 16 Site Water Utility Distribution Piping
- 3. Section 40 05 06 Couplings, Adapters, and Specials for Process Piping
- 4. Section 40 05 07 Hangers and Supports for Process Piping
- 5. Section 40 05 13 Common Requirements for Process Piping
- 6. Section 40 05 53 Identification for Process Piping

# 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
  - 2. AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems.
  - 3. AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings.
  - 4. AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - 5. AWWA C150/A21.50 Thickness Design of Ductile-Iron Pipe.
  - 6. AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast.
  - 7. AWWA C153/A21.53 Ductile-Iron Compact Fittings.
  - 8. AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances.
- B. ASME International:
  - 1. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
  - 2. ASME B31.3 Process Piping.
- C. ASTM International:
  - 1. ASTM A48/A48M Standard Specification for Gray Iron Castings.
- D. SSPC The Society for Protective Coatings:
  - 1. SSPC SP 6/NACE No. 3 Commercial Blast Cleaning.

### PART 2 - PRODUCTS

### 2.1 DUCTILE-IRON PIPE AND FITTINGS

- A. Manufacturers:
  - 1. US Pipe.
  - 2. American.
  - 3. Or Approved Equal.

#### B. Piping:

- 1. Comply with AWWA C151.
- 2. Diameter and Class: As indicated below:

Pipe Size (in)	Pressure Class
12" and Smaller	350
14" – 24"	250
30" and Larger	150

#### C. Joints:

- 1. Pressure Rating: Same as that of connected piping.
- 2. Mechanical:
  - a. Comply with AWWA C110 and AWWA C111.
  - b. Glands: Ductile iron with asphaltic coating.
  - c. Use Tee-head or non-hex head bolts and head nuts for joint makeup and gasket seating. Bolts & Nuts shall be carbon steel coated with corrosion inhibiting fluoropolymer composite material.
  - d. Mechanical joint fittings hall be furnished with sufficient quantities of accessories as required for each joint.
  - e. All mechanical joints shall be restrained.
- 3. Push On: Comply with AWWA C111.
- 4. Flanged: Comply with AWWA C115 with gaskets and bolts conforming to AWWA C115, Appendix A.
- 5. Gaskets for mechanical and push-on type joints shall conform to ANSI A21.11 and AWWA C111, Gaskets shall be SBR, neoprene, or EPDM.
- 6. Gaskets for flange joints shall conform to ANSI A21.15 and AWWA C115. Gaskets shall be neoprene or EPDM.
- 7. Gaskets for joints above 250 psi shall be Toruseal gaskets as manufactured by American specially designed for a working pressure of 350 psi.

#### D. Fittings:

1. Comply with AWWA C153, ductile iron.

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2. Pressure Rating, Pipes 12 Inches and Smaller: 250 psig.

### 2.2 FINISHES

- A. Interior Coating
  - 1. Cement-mortar lining, AWWA C104; standard thickness.
  - 2. Glass-lined SR-14 or equal for grit and scum piping.
  - 3. Ceramic epoxy for gravity and pumped raw wastewater.
  - 4. Ductile Iron Pipe and Fittings used for air service shall be unlined pipe
- B. Outside Coating:
  - 1. Buried: Asphaltic; 1-mil thick, minimum, in accordance with AWWA C151 / ANSO A21.51.
  - 2. Exposed: As specified in Section 099600 High-Performance Coatings.

### 2.3 ACCESSORIES

- A. Dielectric Fittings: Provide between dissimilar metals.
- B. Pipe Identification Labels
  - 1. Identification for Process Piping: As specified in Section 400553 Identification for Process Piping.

# PART 3 - EXECUTION

- 3.1 EXAMINATION
  - A. As specified in Section 40 05 13 Common Requirements for Process Piping

# 3.2 INSTALLATION

- A. Buried Service: Install pipe as specified in:
  - 1. Section 33 11 16 Site Water Utility Distribution Piping.
  - 2. Section 40 05 13 Common Requirements for Process Piping.
  - 3. AWWA C600 Installation of Ductile Iron Water Mains and their Appurtenances.

# B. Exposed Service: Install pipe as specified in:

- 1. Section 40 05 13 Common Requirements for Process Piping.
- 2. Install according to ASME B31.3.
- 3. Fittings:
  - a. Clean gasket seats thoroughly and wipe gaskets clean prior to installation.
  - b. Install fittings according to manufacturer instructions.

- c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer recommendations.
- 4. Provide required upstream and downstream clearances from devices as indicated.
- C. Tap ductile-iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.
- D. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means acceptable to the Engineer.
- E. The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe.
- F. Where pipe is laid on a grade of ten (10) percent or greater, the laying shall start at the bottom and shall proceed upward with the bell ends of the pipe upgrade.

# 3.3 JOINING OF PIPE

- A. Flanged Joints
  - 1. Flanges conforming to AWWA C110 can be joined with Class 125 B16.1 flanges shown in ANSI B16.1 but not with Class 250 B16.1 flanges.
  - 2. Flange joints should be fitted so that the contact faces bear uniformly on the gasket. The joint should be made with relatively uniform bolt stress.
  - 3. Set flange bolts beyond finger tightness with an indicating torque wrench to insure equal tension in all bolts. Tighten bolts such that those 180 degrees apart or directly opposite are torqued in sequence.
- B. Push-On Joint
  - 1. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends upstream.
  - 2. Pipe 8 inches in diameter and larger shall be socketed by fork tools or jacks.
  - 3. Pipe cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. The spigot ends of field cut pipe shall be tapered back 1/8 inch at an angle of about 30 degrees to the barrel of the pipe with a coarse file or portable grinder. All sharp or rough edges that may injure the rubber gasket shall be removed in this operation.
  - 4. Whenever it is desirable to deflect push-on joint pie, the amount of deflection shall not exceed the maximum limits according to Table 4 in AWWA C600.
- C. Mechanical Joints:
  - 1. Mechanical joints shall be in accordance with AWWA C600 and the manufacturer's instructions.
  - 2. Bell ends shall be laid upstream.
  - 3. Bolts shall be tightened to the specified torque. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to obtain greater leverage.

- 4. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.
- 5. Bolts shall not be over-stressed to compensate for poor assembly.

# 3.4 PLACEMENT OF FITTINGS

1. Pipeline fittings, plugs, and caps shall be furnished and installed of the type indicated and at the location shown on the Drawings or as directed by the Engineer. It shall be the responsibility of the Contractor to furnish and install all proper size pipe bends for both horizontal and vertical deflections that are required to construct the pipeline to the line and grade as shown on the construction drawings or as set by the Engineer.

# 3.5 FIELD QUALITY CONTROL

- A. Test Pipe (other than air lines) per Section 40 05 13 Common Requirements for Process Piping.
- B. <u>Pressure Testing Air</u>
  - 1. All pressure pipelines conveying process air, flume air or primary air shall be tested by the CONTRACTOR in a manner satisfactory to and witnessed by the ENGINEER.
  - 2. The section under test shall be isolated by airtight plugs or valves from the air blowers and the diffuser headers which shall be tested separately.
  - 3. The pressure and leakage test shall first consist of filling the test section with compressed air to the pressure defined in the Process Piping Schedule or 12 psig (whichever is greater). The air inlet point shall be sealed and with no further introduction of air, the pipeline shall maintain the test pressure for one hour. A pressure gage supplied by the CONTRACTOR and scaled to twice the test pressure shall be used to indicate the pressure.
  - 4. If the pipeline fails the above test, the CONTRACTOR shall locate and correct all leaks and retest the pipe section until it satisfactorily passes the test.

# 3.6 DISINFECTION OF POTABLE WATERLINES

- A. Following the testing procedure and after all corrections and adjustments have been made, all potable waterlines, both hot and cold water systems, shall be disinfected in strict accordance with the following procedure:
  - 1. Water shall be introduced with a chlorine concentration of at least 50 mg/L. Chlorine shall be added with either a solution feed chlorinator or a hypochlorite feeder. Chlorine application shall continue until the system is filled with the chlorine solution.
  - 2. The chlorinated water shall remain in the system for a minimum of 24 hr while all valves along the system are operated to insure their disinfection. Following the 24 hr period, a residual chlorine test shall be conducted on a fresh sample taken at a point farthest from the point the solution was introduced. If less than 25 mg/L of chlorine is indicated, the system shall be drained and the disinfection procedure repeated.
  - 3. After a chlorine residual of at least 25 mg/L is obtained, the system shall be flushed until the chlorine concentration is equal to or less than 1 mg/L.

4. Disinfection shall conform to ANSI/AWWA C-651, latest revision. The ENGINEER and OWNER shall be notified 48 hr in advance of the disinfection procedure. Also, the flushed solution shall be disposed of as directed by the ENGINEER and OWNER.

END OF SECTION 40 05 19

### SECTION 40 05 51 - COMMON REQUIREMENTS FOR PROCESS VALVES

# PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Valves.
  - 2. Valve actuators.

#### B. Related Requirements:

- 1. Section 03 30 00 Cast-in-Place Concrete
- 2. Section 09 96 00 High-Performance Coatings
- 3. Section 40 05 51 Common Requirements for Process Valves
- 4. Section 40 05 53 Identification for Process Piping
- 5. Section 40 05 57 Actuators for Process Valves and Gates

#### 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C541 Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
  - 2. AWWA C542 Electric Motor Actuators for Valves and Slide Gates.
  - 3. AWWA C550 Protective Interior Coatings for Valves and Hydrants.
- B. ASTM International:
  - 1. ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings.
  - 2. ASTM B584 Standard Specification for Copper Alloy Sand Castings for General Applications.
- C. Manufacturers Standardization Society:
  - 1. MSS SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions.
- D. National Electrical Manufacturers Association:
  - 1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NFPA:
  - 1. NFPA 70 National Electrical Code (NEC).

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- F. NSF International:
  - 1. NSF 61 Drinking Water System Components Health Effects.
  - 2. NSF 372 Drinking Water System Components Lead Content.

### G. UL:

1. Equipment Directory.

### 1.3 COORDINATION

- A. Section 01 31 00 Project Management and Coordination.
- B. Coordinate Work of this Section with piping, equipment, and appurtenances.

### 1.4 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Product Data:
  - 1. Submit manufacturer information for actuator with model number and size indicated.
  - 2. Submit valve cavitation limits.
- C. Shop Drawings: Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, and control system schematics.
- D. Valve Schedule: Indicating the service, size, and connections, make, model number and any special features such as chain wheel operators, etc.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Certification of Valves Larger than 12 Inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.
- G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.
- H. Manufacturer Instructions: Submit installation instructions and special requirements.
- I. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.
- J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.
- K. Qualifications Statement:
  - 1. Submit qualifications for manufacturer and licensed professional.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of valves and actuators.

### 1.6 QUALITY ASSURANCE

- A. Maintain clearances as indicated on Drawings and Shop Drawings.
- B. Ensure that materials of construction of wetted parts are compatible with process liquid.
- C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.
- D. The manufacturer shall be required to furnish at the time of delivery an affidavit of compliance stating the valve and all materials used conform in every respect to the applicable performance of the appropriate AWWA Standard, and these supplementary specifications and that all tests have been performed with test requirements having been met. Test requirements shall be performed and test records furnished to the engineer prior to shipment.

### 1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum twenty years' documented experience

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Prepare valves and accessories for shipment according to latest edition of AWWA C500, Section 31 and:
  - 1. Seal valve ends to prevent entry of foreign matter into valve body.
  - 2. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign matter.
- D. Store materials according to manufacturer instructions.
- E. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

# 1.9 TOOLS AND SPARE PARTS

- A. Provide to the OWNER, one operating wrench for every 10 valves of each type (but not less than 2 wrenches per type), not equipped with hand wheels or levers.
- B. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

# 1.10 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

# 1.11 WARRANTY

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for warranties.
- B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

# PART 2 - PRODUCTS

# 2.1 VALVES

- A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.
- B. General:
  - 1. All packing, gaskets, discs, seats, diaphragms, lubricants, etc., shall conform to recommendations of the valve manufacturer for the intended service.
  - 2. All valves shall be manufacturer's standard of the design which the manufacturer recommends for the service intended.
  - 3. Each valve shall bear the maker's name or trademark or reference symbol to indicate the service conditions for which it is guaranteed.
  - 4. All valves for use with copper tubing shall have solder type connections.
  - 5. All screw end valves shall be threaded according to the American Standard for Pipe Threads No. B2.1.
  - 6. Flange end valves shall have connecting end flanges in accordance with the B16.1, Class 125 Series of the American Standards Association for type valves covered in the Standard, and in accordance with the Manufacturer's Standardization Society Standard

Practice for bronze valves corresponding to the maximum pressure and service for which the valve is to be used.

- C. Valve Ends: Compatible with adjacent piping system.
- D. Operation:
  - 1. Open by turning counterclockwise; close by turning clockwise.
  - 2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.
- E. Valve Marking and Labeling:
  - 1. Marking: Comply with MSS SP-25.
  - 2. Labeling: As specified in Section 40 05 53 Identification for Process Piping.
  - 3. Provide buried valves with valve boxes, covers, and extensions as specified in Section 33 11 16 Site Water Utility Distribution Piping.
- F. Valve Construction:
  - 1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
  - 2. Bonnets:
    - a. Flanged to body and of same material and pressure rating as body.
    - b. Furnish glands, packing nuts, or yokes as specified in valve Sections.
  - 3. Stems and Stem Guides:
    - a. Materials and Seals: As specified in valve Sections.
    - b. Bronze Valve Stems: According to ASTM B584.
    - c. Space stem guides 10 feet o.c.
    - d. Submerged Stem Guides: Type 304 stainless steel.
  - 4. Nuts and Bolts: As specified in Section 05 50 00 Metal Fabrications.
- G. Valve Type:
  - 1. Plug Valves: As specified in Section 40 05 62 Plug Valves.
  - 2. Ball Valves: As specified in Section 40 05 63 Ball Valves.
  - 3. Butterfly Valves: As specified in Section 40 05 64 Butterfly Valves.
  - 4. Swing and Disc Check Valves: As specified in Section 40 05 65 Swing and Disc Check Valves.
  - 5. Pressure-Regulating Valves: As specified in Section 40 05 66 Pressure-Regulating Valves.
  - 6. Pressure-Relief Valves: As specified in Section 40 05 67 Pressure-Relief Valves.
  - 7. Air release valves for Water Service: As specified in Section 40 05 78 Air Release Valves for Water Service.

#### 2.2 VALVE ACTUATORS

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- A. Description: Manual, pneumatic and electric motor actuators.
- B. Provide actuators per specification Section 40 05 57 Actuators for Process Valves and Gates

#### 2.3 INSULATION

A. As specified in Section 40 42 13 - Process Piping Insulation or as indicated on Drawings.

### 2.4 FINISHES

- A. Valve lining and coating: Comply with AWWA C550.
- B. Exposed Valves: As specified in Section 09 96 00 High-Performance Coatings.
- C. Do not coat flange faces of valves unless otherwise specified.

# 2.5 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.
- C. Certificate of Compliance:
  - 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
  - 2. Specified shop tests are not required for Work performed by approved manufacturer.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 01 31 00 Project Management and Coordination: Requirements for installation examination
- B. Verify that piping system is ready for valve installation.

# 3.2 INSTALLATION

- A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.
- B. Firmly support valves to avoid undue stresses on piping.
- C. Valves shall be installed with the stems positioned in the horizontal or above the centerline of the pipe unless otherwise shown on the Drawings.
- D. Operators shall be positioned so that they do not interfere with pedestrian traffic.
- E. Valve operators which are 7 ft 0 in. or more above the operating floor or platform shall be chain wheel operated.
- F. Where necessary for operations as described above, valves shall be bevel or spur gear operated. Valves 6 inches in diameter and larger shall be gear operated.
- G. Coat studs, bolts and nuts with anti-seizing lubricant.
- H. Clean field welds of slag and splatter to provide a smooth surface.
- I. Install valves with stems upright or horizontal, not inverted.
- J. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.
- K. All buried valves shall have a 2" operating nut and handwheels for all exposed valves.
- L. Install 3/4-inch ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.
- M. Install valves with clearance for installation of insulation and to allow access.
- N. Provide access where valves and fittings are not accessible.
- O. Pipe Hangers and Supports: As specified in Section 400507 Hangers and Supports for Process Piping.
- P. Comply with Division 40 Process Interconnections for piping materials applying to various system types.
- Q. Install insulation as specified in Section 40 42 13 Process Piping Insulation and as indicated on Drawings.

#### 3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

- B. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Valve Field Testing:
  - 1. Test for proper alignment.
  - 2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
  - 3. Architect/Engineer will witness field testing.

END OF SECTION 40 05 51

### SECTION 40 05 53 - IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

# PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Nameplates.
  - 2. Tags.
  - 3. Stencils.
  - 4. Pipe markers.
  - 5. Ceiling tacks.
  - 6. Labels.
  - 7. Lockout devices.
- B. Related Requirements:
  - 1. Section 09 96 00 High-Performance Coatings
  - 2. Division 40 Process Integration
  - 3. Division 43- Process Gas and Liquid Handling, Purification and Storage Equipment
  - 4. Division 46 Water and Wastewater Equipment

# 1.2 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers:
  - 1. ASME A13.1 Scheme for the Identification of Piping Systems.

#### 1.3 SUBMITTALS

- A. Section 013300 Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturer's catalog literature for each product required.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color-coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Samples: Submit one tag, label, and pipe markers for each size used on Project.
- E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirement.

G. Qualifications Statement:

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1. Submit qualifications for manufacturer.

### 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for closeout procedures.
- B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for maintenance materials.
- B. Extra Stock Materials: Furnish one container of spray-on adhesive.
- C. Tools: Furnish special tools and other devices required for Owner to reinstall tags.

#### 1.6 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
- 1.7 QUALIFICATIONS
  - A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

# PART 2 - PRODUCTS

### 2.1 NAMEPLATES

- A. Manufacturers:
  - 1. Craftmark Pipe Markers
  - 2. Kolbi Pipe Marker Co.
  - 3. Seton Identification Products
  - 4. Or Approved Equal
  - A. Description: Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with oval head stainless steel screws or

drive pins. Nameplates shall at a minimum contain manufacturers name and address, year of manufacture, serial number, speed (if applicable) and other applicable information.

- 2.2 TAGS
  - A. Plastic Tags:
    - 1. Manufacturers:
      - a. Brady ID
      - b. Craftmark Pipe Markers
      - c. Kolbi Pipe Marker Co.
      - d. Seton Identification Products
      - e. Or Approved Equal
    - 2. Description:
      - a. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
      - b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square.
  - B. Metal Tags:
    - 1. Manufacturers:
      - a. Brady ID
      - b. Craftmark Pipe Markers
      - c. Kolbi Pipe Marker Co.
      - d. Seton Identification Products
      - e. Or Approved Equal
    - 2. Description:
      - a. Aluminum or Stainless-steel construction; stamped letters.
      - b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square with finished edges.
  - C. Information Tags:
    - 1. Manufacturers:
      - a. Brady ID
      - b. Craftmark Pipe Markers
      - c. Kolbi Pipe Marker Co.
      - d. Seton Identification Products
      - e. Or Approved Equal
    - 2. Description:

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- a. Clear plastic with printed DANGER, CAUTION, WARNING, and message.
- b. Minimum Tag Size: 3-1/4 by 5-5/8 inch.
- c. Furnish grommet and self-locking nylon ties.
- 3. Tag Chart: Typewritten, letter-size list of applied tags and location, [in anodized aluminum frame.

#### 2.3 STENCILS

- A. Manufacturers:
  - a. Kolbi Pipe Marker Co.
  - b. Seton Identification Products
  - c. Or Approved Equal
- B. Description:
  - 1. Clean-cut symbols.
  - 2. Letters:
    - a. Up to 2-inch Outside Diameter of Insulation or Pipe: 1/2-inch-high letters.
    - b. 2-1/2- to 6-inch Outside Diameter of Insulation or Pipe: 1-inch-high letters.
    - c. Over 6-inch Outside Diameter of Insulation or Pipe: 1-3/4-inch-high letters
- C. Stencil Paint: As specified in 09 96 00 High-Performance Coatings; semigloss enamel.
- D. Color-Coding and Lettering Size: Conform to ASME A13.1.

# 2.4 PIPE MARKERS

- A. Color-Coding and Lettering Size: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
  - 1. Manufacturers:
    - a. Brady ID
    - b. Craftmark Pipe Markers
    - c. Seton Identification Products
    - d. Or Approved Equal
  - 2. Description:
    - a. Factory-fabricated, flexible, semirigid plastic.
    - b. Preformed to fit around pipe or pipe covering.
    - c. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Tape Pipe Markers:

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- 1. Manufacturers:
  - a. Brady ID
  - b. Craftmark Pipe Markers
  - c. Kolbi Pipe Marker Co.
  - d. Seton Identification Products
  - e. Or Approved Equal
- 2. Description: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- D. Plastic Underground Pipe Markers:
  - 1. Manufacturers:
    - a. Kolbi Pipe Marker Co.
    - b. Seton Identification Products
    - c. Or Approved Equal
  - 2. Description:
    - a. Brightly colored, continuously printed plastic ribbon tape.
    - b. Minimum 6 inches wide by 4 mil thick.
    - c. Manufactured for direct burial service.

# 2.5 LABELS

- A. Manufacturers:
  - a. Brady ID
  - b. Seton Identification Products
  - c. Or Approved Equal
- B. Description:
  - 1. Aluminum or Laminated Mylar construction.
  - 2. Minimum Size: 1.9 by 0.75 inches.
  - 3. Adhesive backed, with printed identification and bar code.

#### 2.6 LOCKOUT DEVICES

- A. Lockout Hasps:
  - 1. Manufacturers:
    - a. Brady ID
    - b. Master Lock Company, LLC

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- c. Or Approved Equal
- 2. Description:
  - a. Anodized aluminum or Reinforced nylon construction.
  - b. Furnish hasp with erasable label surface.
  - c. Minimum Size: 7-1/4 by 3 inches.

### B. Valve Lockout Devices:

- 1. Manufacturers:
  - a. Brady ID
  - b. Master Lock Company, LLC
  - c. Or Approved Equal
- 2. Description:
  - a. Nylon or Steel construction.
  - b. Furnish device preventing access to valve operator and accepting lock shackle.

# PART 3 - EXECUTION

# 3.1 PREPARATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation preparation.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Prepare surfaces as specified in Section 09 96 00 High-Performance Coatings for stencil painting.

### 3.2 INSTALLATION

- A. Apply stencil painting as specified in Section 09 96 00 High-Performance Coatings.
- B. Install identifying devices after completion of coverings and painting.
- C. Identify equipment with nameplates.
- D. Identify inline pumps and other small devices with tags.
- E. Identify control panels and major control components outside panels with plastic nameplates.
- F. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

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- G. Labels:
  - 1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
  - 2. For unfinished covering, apply paint primer before applying labels.

#### H. Tags:

- 1. Install tags using corrosion-resistant chain.
- 2. Number tags consecutively by location.
- I. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- J. Identify valves in main and branch piping with tags.
- K. Piping:
  - 1. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers and/or stenciled painting.
  - 2. Use tags on piping 3/4-inch diameter and smaller.
  - 3. Identify service, flow direction, and pressure.
  - 4. Install in clear view and align with axis of piping.
  - 5. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- L. Ceiling Tacks:
  - 1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
  - 2. Locate in corner of ceiling panel closest to equipment.

END OF SECTION 40 05 53

# SECTION 40 05 57 - ACTUATORS FOR PROCESS VALVES AND GATES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Manual actuators.
  - 2. Electric motor actuators.
- B. Related Requirements:1. Section 09 96 00 High-Performance Coatings

### 1.2 REFERENCE STANDARDS

- A. American Bearing Manufacturers Association:
  - 1. ABMA 9 Load Ratings and Fatigue Life for Ball Bearings.
  - 2. ABMA 11 Load Ratings and Fatigue Life for Roller Bearings.
- B. American Water Works Association:
  - 1. AWWA C500 Metal-Seated Gate Valves for Water Supply Service.
  - 2. AWWA C542 Electric Motor Actuators for Valves and Slide Gates.
- C. NFPA:
  - 1. NFPA 70 National Electrical Code.

#### 1.3 COORDINATION

- A. Section 01 31 00 Project Management and Coordination: Requirements for coordination.
- B. Coordinate Work of this Section with installation of valves and accessories.

### 1.4 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturer information for actuator with model number and size indicated.
- C. Shop Drawings:

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- 1. Indicate parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams, control system, and control system schematics on assembly drawings.
- 2. Submit actuator Shop Drawings with valve and gate submittal.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer Instructions: Submit special procedures and placement requirements.
- F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Qualifications Statements:
  - 1. Submit qualifications for manufacturer and installer.
  - 2. Submit manufacturer's approval of installer.

# 1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations and types of actuators.

# 1.6 QUALITY ASSURANCE

- A. Valve Actuators in NEC Class I, Group D, Division 1 for areas where flammable gases, vapors or liquids can exist all of the time or some of the time under normal operating conditions.
- B. Valve Actuators in NEC Class I, Group D, Division 2 for areas where flammable gases, vapors or liquids are not likely to exist under normal operating conditions.
- C. Locations: Comply with NFPA 70.

# 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

# 1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
  - 3. Provide additional protection according to manufacturer instructions.

### 1.9 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

### 1.10 WARRANTY

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for warranties.
- B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

# PART 2 - PRODUCTS

# 2.1 MANUAL ACTUATORS

- A. Gate Valves: Gave valves shall be fitted with cast iron hand wheels of suitable size or gear and hand wheel operators in accordance with AWWA C500.
- B. Butterfly Valves: Butterfly valves 3 inches and smaller shall be lever and locking ratchet operated. Butterfly valves 4 inches and larger shall be equipped with gear and hand wheel operators. The operators shall be furnished by the manufacturer of the valve, in accordance with AWWA C504, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operator shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be used.
- C. Plug and Ball Valves: Plug and ball valves 3 inches and smaller shall be lever and locking ratchet operated. Plug and ball valves 4 inches and larger shall be provided with gear and hand wheel operators.
- D. Provide gear and power actuators with position indicators.

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- E. Gear-Assisted Manual Actuators:
  - 1. Drive Type: Worm gear except where otherwise shown or specified
  - 2. Provide totally enclosed gears.
  - 3. Gearing: Designed for 100 percent overload.
  - 4. Bearings:
    - a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
    - b. Permanently lubricated bronze.
    - c. Minimum L10 Life: 100,000 hours.
  - 5. Maximum Operating Force: 60 lbf.
  - 6. Handwheel: Minimum 12-inch diameter.
  - 7. Packing: Accessible for adjustment without requiring removal of actuator from valve.
- F. Chain Actuators:
  - 1. Description:
    - a. Chain actuators for shutoff valves mounted 7 feet and greater above operating floor level.
    - b. Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above operating floor level.
  - 2. Chain Wheels: Sprocket rim type.
  - 3. Furnish chain storage if chains may interfere with pedestrian traffic.
- G. Buried Valves:
  - 1. Comply with AWWA C500.
  - 2. Floors:
    - a. Furnish extension stems to grade, and square nuts or floor stands with position indicators.
    - b. Cast-iron/Steel pipe extensions with valve boxes, covers, and operating keys.
    - c. Floor Boxes: Hot-dip galvanized cast iron or steel, with bronze cover.
    - d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.
  - 3. Valve Boxes:
    - a. Material: Cast iron.
    - b. 12 Inch Diameter Valves and Smaller: Two-piece, screw type.
    - c. Valves Larger than 12 Inch Diameter: Three-piece, screw type.
    - d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

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# 2.2 ELECTRIC MOTOR ACTUATORS

#### A. Manufacturers:

1. Auma Actuators, Inc.; Canonsburg, PA

#### B. Description:

- 1. Motor, reduction gearing, torque switches, limit switches, auxiliary hand wheel, starter, mechanical position indicator, and accessories. Micro-processor based controls with LCD display utilizing an absolute encoder and bluetooth capability may be provided in lieu of limit switches and mechanical based position indicator.
- 2. Comply with AWWA C542.
- 3. Open-close operation or modulation, as specified, or as shown on the Drawings.
- 4. Valve closing time will be 60 seconds, unless otherwise noted.
- 5. Actuators will be capable of operating in an ambient temperature range of -20 to +175 degrees F.
- 6. All actuators in open/close service will be furnished with integral, motor controls consisting of reversing starters, control transformer, phase discriminator, monitor relay, , "open-stop-close" pushbuttons, "local-off-remote" selector switch in addition to red and green indicating lights. For modulating service a positioner shall be provided and capable of accepting a 4~20 mADC signal from the controller and positioning the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer mounted inside the actuator. The positioner shall be field adjustable to fail in the "open", "closed" or "last" position on loss of 4~20 mADC command signal.
- C. Enclosure:
  - 1. Minimum NEMA 250 Type 4. When specified, motor and all electrical enclosure shall be available to meet NEMA 6 submersible, or NEMA 7 hazardous requirements.
  - 2. Mounting: Attached actuator housing using flanged motor adapter.
- D. Motors:
  - 1. As specified in Section 40 05 93 Common Motor Requirements for Process Equipment.
  - 2. Type:
    - a. Reversing or modulating, as specified, or as shown on the Drawings.
    - b. Totally enclosed, non-ventilated, high starting torque, low starting current.
    - c. Full-voltage starting.
  - 3. Electrical Characteristics:
    - a. Connections: As specified in Division 26 Electrical.
    - b. Torque: A running torque per valve manufacturer's recommendation.
    - c. Sufficient horsepower to open or close a valve against the maximum specified differential pressure when voltage to the motor is  $\pm 10\%$  of nominal voltage with a factor of safety of 1.5.
    - d. Voltage: 480 V, three phase, 60 Hz.

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- e. Lubrication: Pre-lubricated.
- f. Bearings Type: Anti-friction
- g. Motor Rating: 15 minute duty for open/close and 30 minute duty for modulating.
- E. Reduction Gearing:
  - 1. Description: Single- or double-reduction unit of spur or helical gears and worm-gearing.
  - 2. Lubrication: Grease or oil.
  - 3. Bearings:
    - a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
    - b. Minimum L10 Life: 100,000 hours.
- F. Limit Switches:
  - 1. Type: Heavy duty, open contact.
  - 2. Actuation: Rotor cam.
  - 3. Compartment: Totally enclosed and equipped with a heater and thermostat to prevent build-up of moisture and contamination.
  - 4. Switches shall be SPDT and rated 10A 5A at 120 250 VAC or as specified.
  - 5. Actuating Point: Adjustable at any point of valve between fully open and fully closed.
  - 6. Adjustment: Capable of quick adjustment requiring no more than five (5) turns of the adjustment spindle. If using an absolute encoder, the limit switches shall be capable of being set via the integral pushbutton devices or wireless via Bluetooth and viewed via the LCD graphic display.
  - 7. Contacts: One set of normally open and one set of normally closed contacts will be furnished and available for use by the plant control system at each end of travel where indicated. Contact shall be of silver and capable of reliably switching a low voltage DC source from the control system furnished by other.
- G. Torque Limiting Switches:
  - 1. Torque limiting switches shall be provided.
  - 2. Torque limiting switches shall be responsive to the mechanical torque developed in seating, backseating, or by obstruction.
  - 3. Accuracy: Within  $\pm 5\%$
  - 4. Calibration: The use of torque wrenches for calibration shall not be required. Calibrated by use of a dynamometer in order to accurately predict the output of the actuator.
  - 5. A calibration tag stating the maximum torque output of each torque switch at 100% setting shall be permanently affixed to the torque switch dial. If using an absolute encoder, the torque switches shall be capable of being set via the integral pushbutton devices or wireless via Bluetooth and viewed via the LCD graphic display.
- H. Hand Wheel Operation:
  - 1. A permanently attached hand wheel shall be provided for emergency manual operation.
  - 2. A seized or inoperable motor shall not prevent manual operation.
  - 3. The hand wheel shall not rotate during electrical operation.
  - 4. Maximum Torque Required: 60 lb-ft.

- 5. Maximum Force Required: 60 lbs.
- 6. Inscription: An arrow and either the work OPEN or CLOSE shall be cast in the hand wheel to indicate the direction to turn hand wheel.
- 7. Minimum Diameter: 8 inches.

#### 2.3 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assemblies.
- C. Certificate of Compliance:
  - 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
  - 2. Specified shop tests are not required for Work performed by approved manufacturer.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that field dimensions are as indicated on Shop Drawings.

#### 3.2 INSTALLATION

- A. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.
- B. Extend chain actuators to 5-1/2 feet above operating floor level.

# 3.3 FIELD QUALITY CONTROL

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. After installation, inspect for proper supports and interferences.
- C. Repair damaged coatings with material equal to original coating as specified in Section 099600 - High-Performance Coatings.

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END OF SECTION 40 05 57

SECTION 40 05 62 - PLUG VALVES

#### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes: Eccentric plug valves.
- B. Conform to the requirements of Section 40 05 51 Common Requirements for Process Valves
- C. Related Requirements:
  - 1. Division 40 Process Interconnections

### 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C517 Resilient-Seated Cast-Iron Eccentric Plug Valves.
- B. ASME International:
  - 1. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
  - 2. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
  - 3. ASME B16.42 Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
  - 4. ASME B1.20.1 Pipe Threads, General Purpose, Inch.
- C. ASTM International:
  - 1. ASTM A536 Standard Specification for Ductile Iron Castings.
  - 2. ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings.

#### PART 2 - PRODUCTS

# 2.1 ECCENTRIC PLUG VALVES

- A. Manufacturers:
  - 1. Dezurik
  - 2. Milliken; Henry Pratt Company
  - 3. Or approved equal
- B. Description:

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- 1. Type:
  - a. Non-lubricated.
  - b. Eccentric.
  - c. 90 Degree Turn
  - d. Resilient faced Plug
- 2. Working Pressure: 175 psig for valves through 12" and 150 psig for valves for 14" through 72".
- 3. Ports:
  - a. Configuration: Rectangular
  - b. Minimum Port Area: 100 percent of nominal pipe area for valves.
- 4. Stem Bearings: Self-lubricating.
- 5. Stem Seals:
  - a. Type: V-ring.
  - b. Material: Buna-N
- 6. End Connections:
  - a. Flanged: Comply with ANSI 125/150 lb. Standard
  - b. Mechanical Joint
- C. Operation:
  - 1. As specified in Section 40 05 57 Actuators for Process Valves and Gates.
- D. Materials:
  - 1. Body:
    - a. Cast iron, ASTM A126 Class B.
    - b. Lining: As recommended by valve manufacturer for service conditions.
  - 2. Plug:
    - a. Cast iron, ASTM A126 Class B.
    - b. Lining: Buna N
  - 3. Seats: 1/8", welded, 90% pure Nickel.
  - 4. Stem Bearings: Type 316L stainless steel.
  - 5. Seals: Buna-N.
  - 6. Connecting Hardware: Type 316 stainless steel.
- E. Finishes: As specified in Section 40 05 51 Common Requirements for Process Valves.

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# 2.2 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
- B. As specified in Section 40 05 51 Common Requirements for Process Valves.
- C. Testing: Test gate valves according to AWWA C509.

# PART 3 - EXECUTION

- 3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL
  - A. As specified in Section 40 05 51 Common Requirements for Process Valves
  - B. According to AWWA C517.
  - C. Horizontal Piping: Stem horizontal.
  - D. Vertical Piping: Plug at top when closed.
  - E. Plugs: On top when open and on pressure side when closed.

### END OF SECTION 40 05 62
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#### SECTION 40 05 63 - BALL VALVES

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Rubber-seated ball valves.
  - 2. Plastic ball valves.
- B. Related Requirements:
  1. Section 40 05 51 Common Requirements for Process Valves

#### 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C507 Ball Valves, 6 In. Through 60 In.
- B. ASME International:
  - 1. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
  - 2. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
  - 3. ASME B16.42 Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
- C. ASTM International:
  - 1. ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  - 2. ASTM D3222 Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
  - 3. ASTM D4101 Standard Specification for Propylene Injection and Extrusion Materials.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
  - 1. MSS SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

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## PART 2 - PRODUCTS

## 2.1 RUBBER-SEATED BALL VALVES

- A. Manufacturers:
  - 1. Henry Pratt Company; Aurora, IL.
  - 2. Valtorc Kennesaw, Ga.
  - 3. Apollo Matthews, NC
  - 4. Approved Equal.
- B. Smaller Than 4 Inches:
  - 1. Comply with MSS SP 110.
  - 2. Working Pressure: 150 psig at 90 deg. F.
  - 3. Maximum Process Fluid Temperature: 90 deg. F.
  - 4. Body:
    - a. Type: Two piece.
    - b. Material: 316L stainless steel.
  - 5. Ball: Stainless steel.
    - a. Valves for Hydrogen Peroxide service shall be provided with cavity relief and tight seat direction shall be stamped on the body of the valve
  - 6. Port: Regular.
  - 7. Seats: TFE.
  - 8. Stem: Blowout proof.
  - 9. End Connections: Threaded, with union.
  - 10. Operator: Hand lever.
  - 11. Finishes: As specified in Section 40 05 51 Common Requirements for Process Valves.

## 2.2 PLASTIC BALL VALVES

- A. <u>Manufacturers</u>:
  - 1. NIBCO
  - 2. Chemtrol True Union
- B. Description:
  - 1. Working Pressure: 232 psig at 68 deg. F.
  - 2. Ports: Full size.
  - 3. End Connections:
    - a. Socket Union
    - b. Threaded Pipe Union.

- C. Operator: Manual unless otherwise specified or shown.
- D. Materials:
  - 1. Body and Ball: PVC, CPVC, PP as specified, shown on drawings, or recommended by the manufacturer for the service conditions specified.
  - 2. Seats: PTFE.
- 2.3 SOURCE QUALITY CONTROL
  - A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
  - B. As specified in Section 40 05 51 Common Requirements for Process Valves.
  - C. Testing: Test ball valves according to AWWA C507.

## PART 3 - EXECUTION

- 3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL
  - A. As specified in Section 40 05 51 Common Requirements for Process Valves
  - B. According to AWWA C507

## END OF SECTION 40 05 63

#### SECTION 40 05 64 - BUTTERFLY VALVES

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Rubber-seated butterfly valves.
- B. Related Requirements:
  1. Section 40 05 51 Common Requirements for Process Valves

#### 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C504 Rubber-Seated Butterfly Valves.

#### B. ASME International:

- 1. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- 2. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
- 3. ASME B16.42 Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
- C. ASTM International:
  - 1. ASTM A536 Standard Specification for Ductile Iron Castings.
  - 2. ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  - 3. ASTM D3222 Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
  - 4. ASTM D4101 Standard Specification for Propylene Injection and Extrusion Materials.

## PART 2 - PRODUCTS

#### 2.1 RUBBER-SEATED BUTTERFLY VALVES

- A. Manufacturers:
  - 1. McWane-Clow (Series 4500 Birmingham, AL
  - 2. Henry Pratt Company; Aurora, IL
  - 3. Mueller (Lineseal III 3211) Chattanooga, TN

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- 4. DeZurik (AWWA C504) Sartell, MN
- B. Description:
  - 1. Comply with AWWA C504, Class 150.
  - 2. Minimum Working Pressure: 200 psig.
  - 3. Shaft: Bearings shall be non-metallic and permanently lubricated.
  - 4. Seats:
    - a. Mounting: On body for valves 24 inches and smaller.
    - b. Type: Field replaceable for valves larger than 30 inches.
  - 5. Packing: V-type packing with a minimum of 4 sealing rings.
  - 6. End Connections: Flanged end valves of short body design with 125 lb. flanged ends faced and drilled per ANSI B16.1 standard for cast iron flanges.
- C. Operator:
  - 1. As specified in Section 40 05 57 Actuators for Process Valves and Gates
  - 2. Gear Actuators for Manual Valves: Comply with AWWA C504.
- D. Materials:
  - 1. Body: Cast iron, ASTM A126.
  - 2. Stem: Stainless steel.
  - 3. Disc: Cast iron, ASTM A48, Class 4C.
  - 4. Seats:
    - a. Type: Resilient and replaceable.
    - b. Material: Buna N for water, or as required for other services
  - 5. Seating Surfaces: Type 316 stainless steel.
  - 6. Bearings: Aluminum Bronze, ASTM B148, C954
  - 7. Connecting Hardware: Type 316 stainless steel.
- E. Finishes: As specified in Section 09 96 00 High-Performance Coatings.

## 2.2 SOURCE QUALITY CONTROL

- A. Section 01 40 00 Quality Requirements: Requirements for testing, inspection, and analysis.
- B. As specified in Section 40 05 51 Common Requirements for Process Valves.
- C. Testing: Test butterfly valves according to AWWA C504.

## PART 3 - EXECUTION

## 3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

- A. As specified in Section 40 05 51 Common Requirements for Process Valves
- B. According to AWWA C504.

END OF SECTION 40 05 64

SECTION 40 05 67.13 - REDUCED-PRESSURE ZONE BACKFLOW PREVENTERS FOR PROCESS SERVICE

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Reduced-pressure zone backflow preventers.
- B. Related Requirements:

#### 1.2 DEFINITIONS

A. Outside Screw and Yoke (OS&Y) Valve: A valve in which the operating screw is driven by a threaded nut that is built into the handle.

#### 1.3 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA C606 Grooved and Shouldered Joints.

#### B. ASME International:

- 1. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- C. ASSE International:
  - 1. ASSE 1013 Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.
- D. NSF International:
  - 1. NSF 61 Drinking Water System Components Health Effects.
  - 2. NSF 372 Drinking Water System Components Lead Content.

#### 1.4 COORDINATION

- A. Section 01 31 00 Project Management and Coordination: Requirements for coordination.
- B. Coordinate Work of this Section with installation of process piping.

## 1.5 SUBMITTALS

- A. Section 013300 Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturer catalog information.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions: Submit special procedures and setting dimensions.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- F. Qualifications Statement:
  - 1. Submit qualifications for manufacturer.

## 1.6 CLOSEOUT SUBMITTALS

- A. Section 017000 Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of reduced-pressure zone backflow preventers.
- 1.7 QUALITY ASSURANCE
  - A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.
- 1.8 QUALIFICATIONS
  - A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.
- 1.9 DELIVERY, STORAGE, AND HANDLING
  - A. Section 016000 Product Requirements: Requirements for transporting, handling, storing, and protecting products.
  - B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
  - C. Store materials according to manufacturer instructions.
  - D. Protection:
    - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

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- 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
- 3. Provide additional protection according to manufacturer instructions.

### 1.10 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

### 1.11 WARRANTY

- A. Section 017000 Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish one-year manufacturer's warranty for reduced-pressure zone backflow preventers.

### PART 2 - PRODUCTS

### 2.1 REDUCED-PRESSURE ZONE BACKFLOW PREVENTERS

- A. Manufacturers:
  - 1. Watts Model LF909 North Andover, MA
  - 2. Approved Equal.
- B. Description:
  - 1. Comply with ASSE 1013.
  - 2. Configuration:
    - a. Two independently operating, spring-loaded check valves.
    - b. Diaphragm-type differential pressure-relief valve located between check valves.
    - c. Third check valve will open under back pressure in case of diaphragm failure.
  - 3. Materials:
    - a. Body: Epoxy Coated Cast iron.
    - b. Internal Components: Stainless steel.
    - c. l.
  - 4. Connections: Flanged, ASME B16.1, Class 125.
  - 5. Furnish assembly with two gate valves, strainer, and four test cocks.
  - 6. Size: as shown on the drawings
  - 7. Maximum Operating Pressure: 200 psig.
- C. Accessories:

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- 1. End Valves: Gate, OS&Y.
- 2. Air gap.

#### PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

#### 3.2 PREPARATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for installation preparation.
- B. Thoroughly clean end connections before installation.
- C. Close pipe and equipment openings with caps or plugs during installation.
- D. Cleaning: Clean surfaces to remove foreign substances.

#### 3.3 INSTALLATION

A. According to manufacturer instructions and local code requirements.

### 3.4 FIELD QUALITY CONTROL

- A. Section 017000 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. After installation, inspect for interferences and proper supports.
- C. Repair damaged coatings with material equal to original coating.

#### 3.5 CLEANING

A. Keep interior of backflow preventers clean as installation progresses.

#### 3.6 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 05 67.13

#### SECTION 40 70 23 – PROCESS CONTROL NARRATIVES

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Process control narratives for multiple treatment facility processes.
- B. Related Requirements:
  - 1. Division 26 Electrical
  - 2. Division 43 Process Gas and Liquid Handling, Purification, and Storage Equipment

## 1.2 **REFERENCES**

- A. International Society of Automation (ISA)
- B. National Institute of Standards and Technology (NIST)

#### 1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

#### 1.4 FAULT RESPONSE

#### A. Communication Failure

- 1. In the event of a communication failure between a PLC and the HMI, the continued operation of the equipment will depend on the equipment control mode prior to the communications failure, as defined below:
  - a. If the equipment was operating in REMOTE-AUTO mode prior to the communications failure, the PLC will continue to operate the equipment based on the Operators defined process setpoints. The state of the equipment can be changed if the Operator switches the equipment to LOCAL mode at the equipment's local control panel and start/stops equipment, using field mounted controls.
  - b. If the equipment was operating in REMOTE-MANUAL mode prior to the communications failure, the equipment will revert to REMOTE-AUTO mode upon loss of communication continuing operation, using the last known setpoints.
  - c. If the equipment was operating in LOCAL-MANUAL mode, it is the Operator's responsibility to manually operate this device or place it back into REMOTE-AUTO or it will not function via PLC control.
  - d. When running in LOCAL-MANUAL mode, the device will continue operating in its current state (running/stopped) until a hard-wired interlock stops the equipment.
- 2. An alarm will be displayed at the HMI, indicating the failed communication link.

#### B. Equipment Failure

- 1. In the event of a plant power failure, the SCADA will store the active setpoints and duty statuses, allowing the Operator to restart the plant with the prior configuration.
- 2. Any failed equipment will issue an alarm. In most cases, level transmitters will defer operation of designated pumps to associated float bulbs. Vendor package control panels that lose communication with their parent PLC will trigger a communication alarm, and continue to operate locally, if possible.
- 3. In the event of a level transmitter failure, the PLC will force the level sensor value to 0 (empty well reading) and a transmitter failure alarm will be displayed at the HMI.
- 4. All other transmitter failures will result in an alarm being displayed at the HMI. The transmitter will need to be inspected and repaired.
- 5. An actuator fault can be a jam, electrical fault, or loss of communication. In motors, additional faults are overcurrent, leakage, over-speed, and/or vibration.
- 6. Most actuators (particularly gate actuators) are configured to remain in their current position in the event of a fault. In most cases this will allow the current duty device to continue operating, while giving the Operator enough time to attend to the faulted actuator, and shut down the related process equipment, if necessary. In many cases, this means gates are failing to the open position.
- 7. By failing to the open position, gates are less likely to cause upstream flooding under normal flow conditions. However, if pipes are damaged or clogged, preventing proper flow, flooding may occur in the event of a fault.
- C. Interlocks
  - 1. Safety interlocks are designed to prevent damage to equipment and injury to plant personnel. Hard-wired interlocks, such as high temperatures and pump overloads will stop the equipment and prevent it from running, until the alarm condition has been reset in the field. Software (PLC generated) interlocks, such as pump watchdogs or valve failure alarms, must be reset by the Operator at the HMI, before the equipment is allowed to be operated again in any REMOTE mode.
  - 2. Any alarm listed in this document's alarm tables, containing a reset location of Field, indicates it is a hardwired interlock, while any alarm with a reset location of SCADA, indicates it is a software interlock.

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION

### 3.1 PROPOSED CLEARWELL

- A. 4 million gallon clearwell:
  - 1. One Level Indicator
- B. Finished water is pumped from the transfer pump station into the clear well and then flows to the high-pressure pumping station. This will be a 4-20 ma signal device sending data to the current SCADA system.

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END OF SECTION 40 70 23

#### SECTION 43 23 34 – PLANT WATER PACKAGED BOOSTER PUMPS

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

A. Section Includes:1. Multiplex, variable-speed booster pumps.

#### 1.3 DEFINITIONS

A. VFD: Variable-frequency drive(s).

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.

#### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Comply with ASME B31.9 for piping.

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- C. UL Compliance for Packaged Pumping Systems:
  - 1. UL 508, "Industrial Control Equipment."
  - 2. UL 508A, "Industrial Control Panels."
  - 3. UL 778, "Motor-Operated Water Pumps."
  - 4. UL 1995, "Heating and Cooling Equipment."
- D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

### 1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## PART 2 - PRODUCTS

## 2.1 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

- A. Manufacturers
  - 1. Grundfos Dosing, USA Marietta, GA
  - 2. Goulds Water technology Xylem Seneca Falls, NY
  - 3. Patterson Pump Gorman Rupp Toccoa, GA
  - 4. Approved Equal
- B. Description: Factory-assembled and -tested, fluid-handling system for plant service water, with pumps, piping, valves, specialties, and controls, and mounted on a common base.
- C. Capacities and Characteristics:
  - 1. Minimum Pressure Rating: 150 psig.
  - 2. Booster-Pump Capacity: 35 gpm.
  - 3. Minimum Inlet Pressure: 30 psig.
  - 4. Maximum Inlet Pressure:60 psig.
  - 5. Discharge Pressure: 150psig.
  - 6. Low-Suction-Pressure Shutoff: 20 psig.
  - 7. High-Discharge-Pressure Shutoff: 200 psig.
  - 8. Header Size: 2 inch NPS.
- D. Pumps:
  - 1. Type: inline vertical, centrifugal pump.
  - 2. Suction/discharge base, pump head, motor stool: 316 stainless steel
  - 3. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
  - 4. Shaft: 316 or 431 Stainless Steel

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- 5. Impeller wear rings: 304 Stainless Steel
- 6. Shaft journals and chamber bearings: Silicon Carbide
- 7. O-rings: EPDM
- E. The shaft seal shall be a balanced o-ring cartridge type with the following features:
  - 1.
  - 2. Collar, Drivers, Spring: 316 Stainless Steel
  - 3. Shaft Sleeve, Gland Plate: 316 Stainless Steel
  - 4. Stationary Ring: Silicon Carbide
  - 5. Rotating Ring: Silicon Carbide
  - 6. O-rings: EPDM
  - 7. The Silicon Carbide shall be imbedded with graphite.
- F. Motors
  - 1. Each motor shall be of the Integrated Variable Frequency Drive design consisting of a motor and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.
  - 2. The VFD shall be of the PWM (Pulse Width Modulation) design using current IGBT (Insulated Gate Bipolar Transistor) technology.
  - 3. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.
  - 4. The VFD shall utilize an energy optimization algorithm to minimize energy consumption. The output voltage shall be adjusted in response to the load, independent of speed.
  - 5. The VFD shall automatically reduce the switching frequency and/or the output voltage and frequency to the motor during periods of sustained ambient temperatures that are higher than the normal operating range. The switching frequency shall be reduced before motor speed is reduced.
  - 6. An integral RFI filter shall be standard in the VFD.
  - 7. The VFD shall have a minimum of two skip frequency bands which can be field adjustable.
  - 8. The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
  - 9. The integrated VFD motor shall include protection against input transients, phase imbalance, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. Three-phase integrated VFD motors shall be capable of providing full output voltage and frequency with a voltage imbalance of up to 10%.
  - 10. The integrated VFD motor shall have, as a minimum, the following input/output capabilities:
    - a. Speed Reference Signal: 0-10 VDC, 4-20mA
    - b. Digital remote on/off
    - c. Fault Signal Relay (NC or NO)
    - d. Fieldbus communication port (RS485)
  - 11. The motor shall be Totally Enclosed Fan Cooled (TEFC) with a standard NEMA C-Face, Class F insulation with a temperature rise no higher than Class B.

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- 12. The cooling design of the motor and VFD shall be such that a Class B motor temperature rise is not exceeded at full rated load and speed at a minimum switching frequency of 9.0 kHz.
- 13. Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

## 2.2 PUMP SYSTEM CONTROLLER

- A. The controller shall be microprocessor based. The controller user interface shall have a color display with a minimum screen size of 3-1/2" x 4-5/8" for viewing system status parameters and for field programming.
- B. The controller shall have built in data logging capability. Logged vales shall be graphically displayed on the controller and able to be exported. A minimum of 3600 samples per logged value with the following parameters available for logging:
  - 1. Estimated flow-rate
  - 2. Speed of pumps
  - 3. Inlet pressure
  - 4. Discharge pressure
  - 5. Power consumption
- C. The controller shall display the following as status readings:
  - 1. Current value of the discharge pressure
  - 2. Most recent existing alarm (if any)
  - 3. System status with current operating mode
  - 4. Status of each pump with current operating mode and rotational speed as a percentage (%)
- D. The controller shall have as a minimum the following hardware inputs and outputs:
  - 1. Three analog inputs (4-20mA or 0-10VDC)
  - 2. Three digital inputs
  - 3. Two digital outputs
  - 4. Ethernet connection
  - 5. Field Service connection to PC for advanced programming and data logging
- E. The controller shall have water shortage protection. When inlet pressure sensor are used for water shortage protection, there shall be two indication levels. One level is for warning indication only and the other level is for complete system shut-down. System restart after shut-down shall be manual or automatic (user selectable).
- F. The controller shall be able to adjust the ramp time of a change in set point on both an increase or decrease change in set point.
- G. The pump system controller shall store up to 24 warning and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:
  - 1. High System Pressure

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- 2. Low system pressure
- 3. Low suction pressure (warning and alarm)
- 4. Individual pump failure
- 5. VFD trip/failure
- 6. Loss of sensor signal (4-20 mA)
- 7. Loss of remote set-point signal (4-20mA)
- 8. System power loss
- H. The pump system controller shall be mounted in a UL Type 3R rated enclosure. The entire control panel shall be UL 508 listed as an assembly. The control panel shall include a main disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions.
- I. The controller shall be capable of displaying instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours).
- J. The controller shall have the ability to communicate common field-bus protocols, (BACnet, Modbus, Profibus, and LON), via optional communication expansion card installed inside controller.
- K. The controller shall have Ethernet connection with a built in server allowing for connection to a network with read/write access to controller via web browser and internet.

#### 2.3 FABRICATION

- A. Piping: Stainless-steel pipe and fittings.
- B. Valves:
  - 1. Shutoff Valves two-piece, full-port ball valve, in each pump's suction and discharge piping.
  - 2. Check Valves Silent type in each pump's discharge piping.
  - 3. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.
- C. Dielectric Fittings: With insulating material isolating joined dissimilar metals.
- D. Base: Structural steel.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

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## 3.2 INSTALLATION

- A. Equipment Mounting:
  - 1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

#### 3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect plant water piping to booster pumps.
  - 1. Install shutoff valves on piping connections to booster-pump suction and discharge headers.
  - 2. Install union, flanged, or grooved-joint connections on suction and discharge headers at connection to domestic-water piping.
  - 3. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers.
  - 4. Install piping adjacent to booster pumps to allow service and maintenance.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Perform visual and mechanical inspection.
  - 2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pumps and controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

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## 3.5 ADJUSTING

- A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust pressure set points.
- 3.6 DEMONSTRATION
  - A. Train Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 43 23 34

## SECTION 43 23 57 - PROGRESSING CAVITY PUMPS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes progressing cavity pumps, control panel and accessories.

#### 1.2 REFERENCE STANDARDS

- A. American Bearing Manufacturers Association:
  - 1. ABMA 9 Load Ratings and Fatigue Life for Ball Bearings.
  - 2. ABMA 11 Load Ratings and Fatigue Life for Roller Bearings.
- B. American Gear Manufacturers Association:
  - 1. AGMA 6001 Design and Selection of Components for Enclosed Gear Drives.
  - 2. AGMA 6013 Standard for Industrial Enclosed Gear Drives.

#### C. ASME International:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

## 1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Product Data:
  - 1. Submit manufacturer information regarding construction and fabrication materials, wiring diagrams, performance charts, and other details.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- E. Manufacturer Reports: Certify that pumps have been installed according to manufacturer instructions.

#### 1.4 WARRANTY

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish one-year manufacturer's warranty for progressing cavity pumps.

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PART 2 - PRODUCTS

### 2.1 PROGRESSING CAVITY PUMPS

- A. <u>Manufacturers</u>:
  - 1. Moyno, Inc. Springfield, OH
  - 2. Netzsch Pumps Exton, PA.
  - 3. Approved Equal
- B. Description: Progressing cavity pump with single-helical rotor operating within double-helical stator.
- C. Pump Designation:
  - 1. NaOCL-MP-6.
  - 2. NaOCL-MP-7.
- D. Performance and Design Criteria:
  - 1. Minimum Flow Rate: 30 gph (0.5 gpm).
  - 2. Average Flow Rate: 639 gph (10.6 gpm)
  - 3. Maximum Flow Rate: 1015 gpm (16.9 gpm)
  - 4. Operating Pressure: 100 psig.
  - 5. Service Liquid: 0.8% Sodium Hypochlorite Solution (NaOCL).
  - 6. Specific Gravity: 1.08.
  - 7. Viscosity: 6.26 X 10<sup>-5</sup> lbf-s/sq. ft..
  - 8. Operating Temperature Range: 55 to 95 degrees F.
- E. Description:
  - 1. Rotor: Hastelloy or titanium.
  - 2. Stator: Viton bonded to hastelloy or titanium casing.
  - 3. Drive Shafts:
    - a. Material: Hastelloy or titanium.
- F. Housings:
  - 1. All wetted parts: hastelloy or titanium.
  - 2. Furnish inspection covers and oil fill and drain connections with plugs.
  - 3. End Connections:
    - a. Suction: 3" Flanged, ASME B16.1, 150#.
    - b. Discharge: 2.5" Flanged, ASME B16.1, 150#.
- G. Gear Reducers:
  - 1. Comply with AGMA 6113, Class II.
  - 2. Minimum Efficiency: 95 percent.
  - 3. Bearings:
    - a. Type: Ball; comply with ABMA 9.

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- 4. Minimum L-10 Life: 100,000 hours.
- 5. Motor Coupling:
  - a. Description: Steel, lubricated, removable.
  - b. Guard: Comply with OSHA.
- H. Pump Bearings:
  - 1. Permanently lubricated.
  - 2. Type: Ball; comply with ABMA 9.
- I. Seals:
  - 1. Type: Single Mechanical Seal. John Crane type 5610
  - 2. Design: John Crane type 5610.
  - 3. Face Materials
    - a. Rotary: Silicon Carbide
    - b. Stationary: Silicon Carbide.
  - 4. Elastomer: Fluorelastomer
  - 5. Accessory Materials: Hastelloy.
- J. Operation:
  - 1. Electrical Characteristics:
    - a. 3 hp.
    - b. Voltage:460V, three phase, 60 Hz.
- K. Accessories:
  - 1. Fasteners: Type 316 stainless steel.
  - 2. Pedestal Supports: Saddle type, allowing suction housing to rotate 360 degrees.
  - 3. Base: Factory-mount pumping assembly on steel base.
  - 4. Drain Connection: Furnish drain connection at a low point in pump suction housing.

### 2.2 CONTROLS & CONTROL PANEL

- A. Hypochlorite Metering Pump Control Panel (FCP-NaOCL-MP2):
  - 1. Furnish and install one pump control center in NEMA 4X stainless steel enclosure for 460volt, 3 phase service.
  - 2. Include main disconnect with distribution block.
  - 3. Pumps shall be controlled by a remote Programmable Logic Controller (PLC).
  - 4. For each pump there shall be included individual 20 amp motor circuit breakers, Schneider Electric Altivar 3HP, 480V, 3 phase Variable Frequency Drives (VFD) and hand off automatic selector switches.
  - 5. Provide duplex weather proof convenience outlet
  - 6. Provide terminal strips for interface wiring between control panel and pumps.

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PART 3 - EXECUTION

- 3.1 INSTALLATION
  - A. Install according to manufacturer instructions.

## 3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days of 8 hours each on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.
- C. Equipment Acceptance:
  - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
  - 2. Make final adjustments to equipment under direction of manufacturer's representative.
- D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

END OF SECTION 43 23 57

## SECTION 43 25 13 - SUBMERSIBLE CENTRIFUGAL PUMPS

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Submersible wastewater pumps.
- B. Related Requirements:
  - 1. Section 26 05 03 Equipment Wiring Connections: Execution requirements for electrical connections to equipment specified by this Section.
  - 2. Section 33 05 16 Precast Concrete Utility Structures for Wetwell and Valve Vault
  - 3. Section 40 05 13 Common Work Results for Process Piping: Piping components, appurtenances, and identification requirements common to process piping systems.
  - 4. Section 46 05 13 Common Motor Requirements for Water and Wastewater Equipment: Execution requirements for motors supplied with equipment specified by this Section.

#### 1.2 REFERENCE STANDARDS

- A. ASTM International:
  - 1. ASTM A48 Standard Specification for Gray Iron Castings.
  - 2. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes.
- B. National Electrical Manufacturers Association:
  - 1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.
- C. Shop Drawings:
  - 1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
  - 2. Include manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.
- D. Manufacturer's Certificate: Certify that pump and accessories meet or exceed specified requirements.

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- 1. Certify installation is completed according to manufacturer's instructions.
- E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

## 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for closeout procedures.
- B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

## 1.5 WARRANTY

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year manufacturer's warranty for pumps and components.

## PART 2 - PRODUCTS

## 2.1 SUBMERSIBLE SLUDGE PUMPS

- A. Manufacturers:
  - 1. Flygt Xylem, Inc. Rye Brook, NY
  - 2. ABS Sulzer Meriden, CT
- B. Description:
  - 1. Submersible non-clog pumps, each equipped with submersible electric motor.
  - 2. Pump Location: Lift Station.
    - a. Pump Designation:
      - 1) WW-P-3
      - 2) WW-P-4
- C. Impeller and Volute:
  - 1. Impeller:
    - a. Gray cast iron, ASTM A48, Class 30.
    - b. Dynamically balanced.

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- c. Double-shrouded, non-clogging design having long throughlet without acute turns.
- d. Semi-open, multi-vane design, capable of passing minimum 3-inch solid sphere.
- e. Capable of handling solids, fibrous materials, sludge, and other matter found in normal sewage applications.
- 2. Impeller and Shaft Fit: Sliding fit with one key, or impeller bolt.
- 3. Volute:
  - a. Single piece, cast iron, ASTM A-48, Class 35B.
  - b. Non-concentric, spiral design.
  - c. Smooth fluid passages capable of passing solids through impeller.
- D. Mechanical Seal System:
  - 1. Shaft: AISI, Type 431 or ASTM A276, Type 420 stainless steel.
  - 2. Shaft Seal: Tandem mechanical type.
    - a. Upper Tandem Set of Seals:
      - 1) Operating in oil chamber located just below stator housing.
      - 2) One stationary silicon-carbide ring and one positively driven rotating carbon ring.
    - b. Lower Tandem Set of Seals: Stationary silicon-carbide ring and positively driven rotating silicon-carbide ring.
  - 3. Oil Chamber for Shaft-Sealing System: Drain and inspection plug, with positive anti-leak seal, accessible from outside.
- E. Bearings:
  - 1. Rotate shaft on two permanently lubricated bearings with an L-10 bearing life of 50,000 hours when operating within any usable portion of the pump curve.
  - 2. Upper Bearing: Single-row roller bearing.
  - 3. Lower Bearing: Two-row angular-contact ball bearings.
- F. Cable Entry Seal:
  - 1. Plug-in Type. Single cylindrical elastomer grommet, flanked by stainless-steel washers with close tolerance fit against cable outside diameter and entry inside diameter, and compressed by entry body containing strain-relief function, separate from function of sealing cable. Epoxy fill to seal interior passages
  - 2. Bear assembly against shoulder in pump top.
  - 3. Separate cable entry junction chamber and motor by stator-lead sealing gland or terminal board, which isolates motor interior from foreign material gaining access through pump top.
- G. Performance and Design Criteria:
  - 1. Performance Criteria

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a.	Design Flow Rate (gpm)	
b.	Design Flow Total Dynamic Head (feet)	
c.	Minimum Efficiency at Design Flow Rate (%)	
d.	Minimum Flow Rate (gpm)	
e.	Minimum Flow Total Dynamic Head (feet)	
f.	Minimum Efficiency at Minimum Flow Rate (%)	
g.	Maximum Flow Rate (gpm)	
h.	Maximum Flow Total Dynamic Head (feet)	
i.	Minimum Efficiency at Maximum Flow Rate (%)	69
j.	Motor Horsepower	7.5
k.	Service Liquid	Belt Filter Press Underflow
1.	Specific Gravity	
m.	Temperature Range (°F)	
n.	Maximum Pump Speed (rpm)	

- 2. Discharge Connection Elbow: Permanently installed in chamber with discharge piping.
- 3. Connection: Automatic to discharge connection elbows when lowered into place, and easily removed for inspection or service.
- 4. Guide Bracket:
  - a. Integral part of pump unit.
  - b. Entire weight of pump unit guided by not less than two guide bars, and pressed tightly against discharge connection elbow with replaceable rubber grommet.
- 5. Discharge Interface Seal: Diaphragm.
- 6. Do not permit any portion of pump to bear directly on floor of sump.
- 7. Capable of continuous submergence underwater without loss of watertight integrity to depth of 65 feet.
- H. Operation:
  - 1. Electrical Characteristics: As specified in Section 26 05 03 Equipment Wiring Connections and following:
    - a. Voltage: 460 V, three phase, 60 Hz.
  - 2. Pump Motor: As specified in Section 46 05 13 Common Motor Requirements for Water and Wastewater Equipment and following:
    - a. Squirrel-cage.
    - b. Induction.
    - c. Shell-type design.
    - d. Housed in air-filled, watertight chambers.
    - e. Non-overloading throughout entire pump performance range based on 1.0 service factor.
    - f. Continuous duty, capable of sustaining minimum of 10 starts per hour.
    - g. Indefinite operation without overheating when unsubmerged and operating in air.
    - h. Stators:
      - 1) Dipped and baked three times in Class F varnish.
      - 2) Heat-shrink-fitted into stator housings.
      - 3) Thermal sensors to monitor stator temperatures.
    - i. Include three thermal switches embedded in end coils of stator winding, for one switch in each stator phase.

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- j. Stator Windings and Leads: Insulated with moisture-resistant Class F insulation capable of resisting temperature of 311 degrees F.
- k. Cooling System:
  - 1) Water jacket encircling stator housing.
  - 2) Furnish cooling media channels.
- 1. Junction Chamber:
  - 1) Terminal board.
  - 2) Sealed from motor by elastomeric compression seal (O ring).
  - 3) Connection cable conductors and stator leads with threaded, compressedtype binding post permanently affixed to terminal board.
- 3. Control Panel:
  - a. Rating: NEMA 250, 4X.
  - b. Material: 304 Stainless Steel.
  - c. Single-point power connection and grounding lug.

### 2.2 CONTROLS & CONTROL PANEL

- A. Drainage Sump Pumping Station Control Panel (FCP-721):
  - 1. Furnish and install one automatic pump control center in NEMA 4X stainless steel enclosure for 460volt, 3 phase service.
  - 2. Pumps shall be controlled by a Programmable Logic Controller (PLC) and the level monitor system specified below as a standard duplex pumping station.
  - 3. For each pump there shall be included individual motor circuit breakers, Variable Frequency Drives (VFD) ,three phase overload protectors, manual reset, hand off automatic selector switches, running lights, ammeters and elapsed time meters.
  - 4. Provide phase failure / undervoltage relay to de-energize motors and include auxiliary contacts for remote indication
  - 5. Provide alarm system consisting of an alarm light and horn, with silencing switch
  - 6. Provide 24 volt control circuit transformer with disconnect and overload protection
  - 7. Provide duplex weather proof convenience outlet
  - 8. Provide terminal strips for interface wiring between control panel and pumping station
  - 9. Controls shall automatically alternate the operation of the pumps
  - 10. Provide two 20 amp, one pole breakers in the control panel as spares with four required for service.
  - 11. Provide an ultrasonic level controller for pump control
    - a. <u>Manufacturers</u>:
      - 1) HydroRanger 200 Siemens.
    - b. Description:
      - 1) Accuracy: Plus or minus 0.25 percent.
      - 2) Output Signal: 4 to 20 mA dc proportional for zero to full scale.
  - 12. Provide liquid level sensors consisting essentially of a mercury switch encapsulated in corrosion resistant casing. The switch cable shall enter the casing through a watertight compression type fitting suitable for use in corrosive environments. The casing shall contain an eccentric weight which is positioned to insure that the mercury switch tilts in the proper direction. The entire float switch assembly shall be designed for use in raw sewage. Provide one float for high-level alarm and one float for low-level shut-off.

#### **EXPANSION TO 30 MGD-PHASE I**

## PURRYSBURG, SOUTH CAROLINA

## 2.3 ACCESSORIES

- A. Access Frame and Guides:
  - 1. Complete with hinged and hasp-equipped covers, upper guide holder and protective grating panel.
  - 2. Sufficient size to permit removal or replacement of the pumping equipment
  - 3. Each door shall have a safety handle to maintain the door in the open position
  - 4. Doors shall be of checkered aluminum plate
  - 5. Cover guide bar holders shall be as required by the pump manufacturer
  - 6. Cover shall include a protective grating panel with a 1-inch minimum depth aluminum "I" bar grating with Safety Orange powder-coated finish. Grating shall be hinged, and shall be supplied with a positive latch to maintain unit in an upright position. Grating support 300 lbs. psf loading
  - 7. Provide padlock hasp for owner-supplied padlock
  - 8. Covers shall be delivered to the precast wetwell supplier for installation in the wetwell top slab as specified in Section 330516 Precast Concrete Utility Structures.
- B. Lifting Chain
  - 1. Minimum length equal to wetwell depths plus 5 feet.
  - 2. Material: 304 Stainless Steel
  - 3. Load Rating: Sufficient to permit raising and lowering the pump.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Section 017000 Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify layout and orientation of pumps, accessories, and piping connections.

### 3.2 INSTALLATION

- A. Install pumps and accessories where indicated on Drawings and according to manufacturer's instructions.
- B. Provide and connect piping, accessories, and power and control conduit and wiring to make system operational, ready for startup.
- C. Flush piping with clean water.

## 3.3 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
#### PURRYSBURG WTP

## EXPANSION TO 30 MGD-PHASE I

# PURRYSBURG, SOUTH CAROLINA

- B. Pre-operational Checks:
  - 1. Check pump and motor alignment.
  - 2. Check for proper motor rotation.
  - 3. Check pump and drive units for proper lubrication.
- C. Startup and Performance Testing:
  - 1. Operate pump using clean water at design point for continuous period of one hour, under supervision of manufacturer's representative and in presence of Engineer.
- D. Verify pump performance by performing time-drawdown test or time-fill test.
- E. Check pump and motor for high bearing temperature and excessive vibration.
- F. Check for motor overload by taking ampere readings.
- G. Equipment Acceptance:
  - 1. Adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests.
  - 2. Make final adjustments to equipment under direction of manufacturer's representative.
  - 3. Document adjustments, repairs, and replacements in manufacturer's field services certification.
- H. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one trip of two days (for each pumping station location) on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.
- I. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

### 3.4 DEMONSTRATION

- A. Section 01 70 00 Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 25 13

# EXPANSION TO 30 MGD – PHASE 1

# FOR

## BEAUFORT JASPER WATER AND SEWER AUTHORITY

# PURRYSBURG, SC

# GMC PROJECT NO. CGRE180057

## <u>APPENDIX</u>

1. MR Systems Quotation #Q19-6566, Rev 0



**Bill of Materials and Labor** 

#### May 15, 2019

Qty	Tag/Lo	oop Description
	<u>s</u>	COPE OF WORK: MD Systems lies is placed to effect this present to Coorthurn Nills Coursed to provide on ultracenia
		INR Systems, Inc is pleased to other this proposal to Goodwyn Millis Cawood to provide an ultrasonic level transmitter for the new clearwell as an allowance item for Phase 1 of the Purrsyburg WTP
		Expansion project. Below are details of the estimate we are providing.
4	In L E sener	Instrumentation
1		Ultrasonic Level Transducer
I		Manufacturer & Model: Siemens XPS-15 Transducer / LUT/20 Transmitter
		Service: New Clearwell Level
		Accessories:
2		Instrument Tags: Two (2), #316 SST, Engraved with Tag and Range
1		AC Power and Analog Surge Protector; Phoenix Contact Boxtrab
1		Solar Hood for Transmitter, Aluminum, Painted White
		Transducer Cable, 10 meter - Included with Ultrasonice Transducer above.
1		Mounting Bracket
	D	ocumentation
		Field Instrument Submittal
		Field Instrument O&M and Calibration Data
		High Service Pump Station PLC Panel (LCP-H) Drawing Revisions
	S	tartup Services
		MR Systems will commission the new ultrasonic level sensor/transmitter and provide startup services
		to integrate the new clearwell level to the existing High Service Pump Station PLC and Plant HMI.
		Revised panel drawings for the High Service Pump Station PLC (LCP-H) will be provided showing the new Clearwell Level
	E	xclusions & Clarifications
		1) Installation of the ultrasonic level sensor, transmitter, and solar hood shall be performed by OTHERS.
		2) Installation and supply of conduit and wire shall be performed by OTHERS.
	P	Project Labor
One Lot	•	Project Engineering, Electrical Design, Mechanical Design, Drafting & Administrative Labor
		(including Travel & Living expenses) as required to perform final system design and to prepare
		Submittals and Record Drawings as required by the Contract Documents.

**HMI Software Applications Development & Graphics Design Labor** (including Travel & Living expenses) as required by the Contract Documents.

1185 Beaver Ruin Rd • Norcross, GA 30093 • 678-325-2800

One Lot



#### May 15, 2019

### Bill of Materials and Labor

Qty	Tag/Loop	Description
One Lot		<b>PLC Control Strategy Design &amp; Programming Labor</b> (including Travel & Living expenses) to be performed as required by the Contract Documents.
One Lot		<b>Field Service</b> (including Travel & Living expenses) to provide installation supervision calibrations, startup, training, etc. as required by the Contract Documents.
Ν/Α		<i>Electrical Installation or Terminations</i> (including Travel & Living expenses) to provide installation of conduit, wire, etc. as required by the Contract Documents.
1 Year		Onsite Comprehensive Warranty (including Travel & Living expenses)
One Lot		Freight

## Subtotal of Labor and Materials: \$10,549

## State Sales Tax - NOT INCLUDED: \$

### Total Project Cost: \$10,549

#### General Notes:

### A \* Sales Representation \*

Mr. Chris Taylerson, of Heyward, Inc. in Charlotte, NC, is our local Sales Representative and will contact you prior to the bid with pricing. Chris may be reached at 704-583-2305 (Office) or 704-591-0980 (Cell)

#### B \* Technical Questions \*

For technical or scope of supply questions contact Sothorn Khel, P.E., of MR Systems, Inc. Sothorn may be reached at 678-325-2824 (Office) or 770-519-0597 (Cell).

#### C \* Installation of Conduit and Wire \*

This quotation **DOES NOT INCLUDE** the supply or physical installation of conduit or wire unless specifically noted above.

#### D \* Equipment Installation \*

This quotation **DOES NOT INCLUDE** physical installation of field instruments, pipe, tubing, fittings, isolation valves, instrument stands, instrument mounts, control panels, antennas, masts, wooden poles, or other devices or other equipment unless specifically noted above.



#### May 15, 2019

### **Bill of Materials and Labor**

Qty	Tag/	Loop Description
	E	* Wiring Terminations * This quotation DOES NOT INCLUDE field or panel terminations of signal or power wires
	F	* Fiber Optics Cable * This quotation DOES NOT INCLUDE the supply or physical installation of Fiber Optic Cable.
	G	* Fiber Optic Cable Termination * This quotation DOES NOT INCLUDE termination or testing of fiber optics cable.
	н	* Coaxial Cable Installation * This quotation DOES NOT INCLUDE the physical installation of coaxial cable or other related components.
	I	* Installation of Communications Towers or Poles * This quotation DOES NOT INCLUDE the supply or physical installation of Communication Towers or Poles.
	J	* <b>Contractor License Information</b> * MR Systems' South Carolina Electrical Contractor's License Number is M108855, EL5 (Unlimited).
	к	* <b>Professional Engineering Authorization</b> * As required by the South Carolina Board of Labor, Licensing and Regulation, System Integrators are required to hold a Certificate of Authorization to practice professional engineering in order to perform system integration. MR Systems' Certificate of Authorization Number is C01888.
	L	* <b>Terms and Conditions</b> * MR Systems, Inc. General Terms & Conditions of Sale apply to any order resulting from this quotation. Please refer to the link provided below for a copy of our General Terms and Conditions of Sale.
		https://www.mrsystems.com/sellersterms/
Revision Notes:		

Rev. 0

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