METROPOLITAN WATER DISTRICT OF SALT LAKE & SANDY

Little Cottonwood Water Treatment Plant
Aquifer Storage and Recovery
Pilot Testing - Phase 1
SIB and Infrastructure

BIDDING DOCUMENTS

April 2023

HANSEN ALLEN & LUCE INC
ENGINEERS

Aquifer Storage and Recovery Pilot Testing
Phase 1
SIB and Infrastructure

DISTRICT PROJECT NO.: LC063

CONSULTANT PROJECT NO.: 262.08.200

APRIL 2023

OWNER

Metropolitan Water District of Salt Lake & Sandy
3430 East Danish Road
Cottonwood Heights, Utah 84093

ENGINEER

Hansen, Allen & Luce, Inc.
859 W. South Jordan Parkway, Suite 200
South Jordan, Utah 84095
801-566-5599



Bids will be received at the office of the Metropolitan Water District of Salt Lake & Sandy, located at 3430 East Danish Road, Cottonwood Heights, Utah, until 12:00 pm on Wednesday, May 10, 2023.

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BIDDING DOCUMENTS

NOTICE INVITING BIDS

RECEIPT OF BIDS: Sealed Bids will be received through the Utah Public Procurement Place (https://bids.sciquest.com/apps/Router/PublicEvent?CustomerOrg=StateOfUtah) on behalf of the Metropolitan Water District of Salt Lake & Sandy (MWDSLS), OWNER of the WORK until 12:00 pm, on May 10, 2023, for construction of the Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure. Any Bids received after the specified time will not be considered. Refer to Instructions to Bidders for documents required for a complete Bid.

OBTAINING CONTRACT DOCUMENTS: The Contract Documents are entitled "Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure". All Contract Documents may be obtained through the Utah Public Procurement Place beginning Thursday, April 13, 2023.

DESCRIPTION OF WORK: Construction of two Surface Infiltration Basins (SIBs), grit basin, equipping of an Aquifer Storage and Recovery (ASR) well, HDPE piping, flow control and valve vaults, electrical and controls equipment, and associated site improvements.

SITE OF WORK: Little Cottonwood Water Treatment Plant, 3430 East Danish Road, Cottonwood Heights, Utah 84093.

PRE-BID CONFERENCE: A mandatory Pre-bid Conference, including site visit, will be conducted on April 19, 2023, at 1:30 pm at Metropolitan Water District of Salt Lake & Sandy, 3430 East Danish Road, Cottonwood Heights, UT 84093. Prospective Bidders are required to attend. The purposes of the Pre-bid Conference and site visit are to discuss the scope of the project, bidding requirements, and to acquaint the Bidders with site conditions. Detailed technical questions may be submitted in writing and will be formally answered, if warranted, by addenda later. Oral statements may not be relied upon and will not be legally binding.

COMPLETION OF WORK: All WORK shall be completed by February 12, 2024. Time is of the essence.

OPENING OF BIDS: The Bids will be opened electronically. The names of the Bidders responding to the Request for Bids and their bid amounts will be available immediately thereafter.

AWARD OF CONTRACT: The contract will be awarded as described in Instructions to Bidders.

BID GUARANTEE: Each Bid shall be accompanied by a bid bond in the amount of five percent (5%) of the total bid price payable to the Metropolitan Water District of Salt Lake & Sandy as a guarantee that the Bidder, if his Bid is accepted, will promptly execute the contract, provide evidence of insurance, and furnish necessary performance bonds and payment bonds.

PROJECT ADMINISTRATION: All questions relative to this project prior to the opening of Bids shall be directed to the OWNER for the project.

Metropolitan Water District of Salt Lake & Sandy
3430 East Danish Road
Cottonwood Heights, Utah 84093
Contact: Ammon Allen, P.E., Engineering Supervisor
801-942-9687
allen@mwdsls.org

It shall be understood, however, that no interpretations of the drawings or specifications will be made except in writing signed by the Engineer, nor will any "or equal" products be considered for approval prior to award of a contract.

OWNER'S RIGHTS RESERVED: The OWNER reserves the right to reject any or all Bids, to waive any informality in a Bid, and to make awards in the interest of the OWNER.

- END NOTICE INVITING BIDS -

INSTRUCTIONS TO BIDDERS

FORM OF BID: The Bid shall consist of the following documents on the forms contained herein:

1. 00300 Bid
2. 00310 Bid Schedule
3. 00320 Bid Bond
4. 00330 Information Required of Bidder

DELIVERY OF BID: The Bid shall be delivered by the time and to the place stipulated in the Notice Inviting Bids. It is the Bidder's sole responsibility to see that his Bid is received in proper time.

WITHDRAWAL OF BIDS: Bids shall be unconditionally accepted without alteration or correction, excepting that Bidder may withdraw his Bid through the Utah Procurement Place prior to the scheduled closing time for receipt of Bids.

OPENING OF BIDS: The Bids will be opened electronically.

MODIFICATIONS AND ALTERNATIVE BIDS: Unauthorized conditions, limitations, or provisions attached to a Bid may render it non-responsive and may cause its rejection. The completed Bid forms shall be without interlineations, alterations, or erasures. Alternative Bids will not be considered unless called for. Bids received by means other than those described in the Notice Inviting Bids will not be considered. Modified bids will not be considered.

DISCREPANCIES IN BIDS: In the event there is more than one bid item in a bid schedule, the Bidder shall furnish a price for all bid items in the schedule; failure to do so may render the Bid non-responsive and subject to rejection. In the event there are unit price bid items in a bid schedule and the "amount" indicated for a unit price bid item does not equal the product of the unit price and quantity, the unit price shall govern and the "amount" will be corrected accordingly, and the Bidder shall be bound by said correction. In the event there is more than one bid item in a bid schedule and the total indicated for the schedule does not agree with the sum of the prices bid on the individual items, the prices bid on the individual items shall govern and the total for the schedule will be corrected accordingly, and the Bidder shall be bound by said correction.

BID SECURITY: Each Bid shall be accompanied by an approved bid bond in the amount stated in the Notice Inviting Bids. Said bond shall be made payable to the OWNER. Said bond shall be given as a guarantee that the Bidder, if awarded the WORK, will execute the Agreement within 10 calendar days after receipt of the Agreement from the OWNER, and will furnish the necessary insurance certificates, Payment Bond and Performance Bond; each of said bonds to be in the amount stated in the Bid Documents. Bidder shall use the bid bond bound herein or one conforming substantially to it in form and the Surety shall be licensed to issue surety bonds in the State of Utah.

BIDDER'S EXAMINATION OF CONTRACT DOCUMENTS AND SITE:

1. It is the responsibility of each Bidder before submitting a Bid, to:

   a. Examine the Contract Documents thoroughly.

   b. Visit the site to become familiar with local conditions that may affect cost, progress, performance, or furnishing of the WORK.

   c. Consider federal, state and local laws and regulations that may affect cost, progress, performance or furnishing of the WORK.

   d. Study and carefully correlate the Bidder's observations with the Contract Documents.

   e. Notify the ENGINEER of all conflicts, errors, or discrepancies in the Contract Documents.

2. Reference is made to the Supplementary General Conditions for identification of:

   a. Those reports of exploration and tests of subsurface conditions at the site which have been utilized by the ENGINEER in preparation of the Contract Documents.

   b. Those drawings of physical conditions in or relating to existing surface and subsurface conditions (except Underground Utilities as defined in Article 1 of the General Conditions) which are at or contiguous to the site and which were utilized in the preparation of the Contract Documents. Copies of such reports and drawings are available for inspection at the office of the OWNER.

3. Information and data reflected in the Contract Documents with respect to underground facilities at/or contiguous to the site are based upon information and data furnished by the owners of such underground facilities or others. The OWNER has no responsibility for the accuracy or completeness thereof including any damages whatsoever that may be incurred by the Bidder through his reliance thereon, unless it is expressly provided otherwise in the Supplementary General Conditions.

4. Before submitting a Bid, the Bidder shall conduct such examination, investigations, studies and tests as are necessary to satisfy himself as to: the nature and location of the physical conditions; surface, subsurface and underground facilities; the general and local conditions particularly those bearing upon transportation, disposal, handling and storage of materials, availability of labor, availability of utilities, local weather conditions, the character of equipment and facilities required preliminary to and during the prosecution of the WORK; any and all other conditions that may in any way affect the cost, progress, performance or furnishing of materials in

accordance with the Contract Documents. All such examination, investigation, studies, tests and the like shall be at the Bidder's expense.

Upon reasonable request in advance, the OWNER shall provide each Bidder reasonable access to the site to conduct such explorations, examination, investigation and tests as each Bidder may determine necessary for the submission of a Bid. The Bidder shall fill all holes, clean and restore the site to its former condition upon the completion of such activities.

The submission of a Bid hereunder shall be considered prima facie evidence that the Bidder has made such examination as is set forth in the above paragraph and is knowledgeable as to the location and site conditions surrounding the WORK and the conditions to be encountered in performing the WORK and as to the requirements, conditions and terms of the Contract Documents.

The OWNER has no responsibility for: (1) any oral representations made by any of its officers or agents during or prior to the execution of the Agreement; (2) information contained in any reports, subsurface studies, or other information which may be made available for the Bidder's information and which are not included as Contract Documents; or (3) any understanding or representations by the OWNER or by others which are not expressly stated in the Contract Documents, unless such responsibility is expressly assumed by the OWNER or its representatives in the Contract Documents. Such information shall be deemed to be for the information of the Bidder and the Bidder shall have the obligation of evaluating any such information as to its accuracy and effect. The OWNER will not be liable or responsible for any such information or any conclusions that may be drawn therefrom by the Bidder.

The lands upon which the WORK is to be performed and right-of-ways and easements for access thereto together with other lands designated for use by the Bidder in performing the WORK are identified in the Contract Documents. All additional lands and access thereto that are required for temporary construction facilities or storage of materials and equipment are to be provided by the Bidder. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by the OWNER unless otherwise provided in the Contract Documents.

5. The submission of a Bid shall constitute an incontrovertible representation by the Bidder that the Bidder has complied with every requirement of this Article, and that without exception the Bid is premised upon performing and furnishing the WORK required by the Contract Documents in compliance with such techniques, sequences, or procedures of construction as may be indicated in or required by the Contract Documents; and that such techniques, sequences or procedures described in the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance and furnishing the WORK.

QUANTITIES OF WORK:

1. The quantities of WORK or material stated in the Bid Schedule are supplied only to give an indication of the general scope of the WORK; the OWNER does not expressly or by implication agree that the actual amount of WORK or material will correspond therewith. The OWNER reserves the right after award of the contract to increase or decrease the quantities of any unit price item of the WORK by an amount up to and including 25 percent of the quantity of any bid item, or to omit portions of such WORK as may be deemed necessary or expedient by the ENGINEER or OWNER, without a change in the unit price. Such right to revise and omit shall include the right to delete any bid item in its entirety, or to add additional bid items in quantities up to and including an aggregate total amount not to exceed 25 percent of the total Contract Price.

2. The Bidder nor the ultimate CONTRACTOR on the Project shall at no time after the submittal of a Bid make or have any claim for damages or anticipated profits or loss of profit or otherwise because of any difference between the quantities of WORK actually done and material furnished and those stated in said unit price items of the Bid.

COMPETENCY OF BIDDERS: In selecting the lowest responsible Bidder, consideration will be given to the general competency of the Bidder for the performance of the WORK covered by the Bid. To this end, each Bid shall be supported by a statement of the Bidder's experience as of recent date on the form entitled "Information Required of Bidder," contained herein. In addition, the Bidder’s previous experience with the OWNER including, but not limited to, workmanship, ability to meet deadlines, contract change orders, and/or claims or related legal issues may be a factor in determining the Bidder’s general competency. No Bid for the WORK will be accepted from a Bidder who does not hold an active Utah contractor's license, in good standing, applicable to the type of WORK bid upon at the time of opening Bids.

No contract award will be made to a Bidder whose firm and subcontractors have not satisfactorily completed at least three similar projects in past five years including mass grading, HDPE piping, well equipping, cast in place concrete vaults, and erection of prefabricated metal buildings.

In addition, the project superintendent meeting this experience criteria shall be dedicated to the project. After award of the contract, no substitution of the project superintendent will be allowed without the written approval by the OWNER.

DISQUALIFICATION OF BIDDERS: More than one Bid from an individual, firm partnership, corporation, or association under the same or different names will not be considered. Reasonable grounds for believing that any Bidder is interested in more than one Bid for the WORK contemplated will cause the rejection of all bids in which such Bidder is interested. If there is reason for believing that collusion exists among the bidders, all Bids will be rejected.

RETURN OF BID GUARANTEES: Upon request of any Bidder, the OWNER will release any surety bid bond, accompanying a bid that was not considered in making the award. All other bid guarantees will be held and maintained until the Agreement has been executed.

AWARD OF CONTRACT: Award of the contract, if it be awarded, will be based primarily on the lowest overall cost to the OWNER, and will be made to a responsive and responsible Bidder whose Bid complies with all the requirements prescribed. Any such award will be made by written notice and within 60 calendar days after opening of the Bids, unless a longer waiting period is expressly allowed in the Notice Inviting Bids. Unless otherwise indicated, an award will not be made for less than all the bid items in an individual bid schedule. In the event the entire WORK is contained in more than one bid schedule, the OWNER may award schedules individually or in combination.

EXECUTION OF CONTRACT: The Bidder to whom the award is made shall execute a written contract with the OWNER on the Agreement form provided, shall secure all insurance and shall furnish all certificates and bonds required by the Contract Documents within 10 calendar days after receipt of the Conditional Notice of Award from the OWNER. Failure or refusal to execute the Agreement as herein provided or to conform to any of the stipulated requirements in connection therewith shall be just cause for annulment of the award and enforcement of the bid guarantee. If the successful Bidder refuses or fails to execute the Agreement, the OWNER may award the contract to the second lowest responsible Bidder, or reject all Bids and readvertise the Project for rebidding. If the second lowest responsible Bidder refuses or fails to execute the Agreement, the OWNER may award the contract to the third lowest responsible Bidder. On the failure or refusal of such second or third lowest Bidder to execute the Agreement, each such Bidder's guarantees shall be subject to enforcement.

ISSUANCE OF NOTICE TO PROCEED: The OWNER intends to execute the Agreement and issue the Notice to Proceed specifying the Project start date within ten calendar days after its receipt of the executed Agreement, bonds and insurance certificates from the successful Bidder. If the Contract Time is expressed as a completion date, rather than a number of calendar days, then any delay by the OWNER beyond the ten days in issuing the Notice to Proceed shall extend the completion date by the number of days of the delay.

SUBSTITUTE AND "OR-EQUAL" ITEMS: The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute of "or-equal" items. Whenever it is specified or described in the Bidding Documents that a substitute or "or-equal" item of material or equipment may be furnished or used by Bidder if acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of the Agreement. The procedure for submission of any such application by Bidder and consideration by ENGINEER is set forth in the General Conditions and the Supplementary General Conditions.

PRE-BID CONFERENCE: A mandatory Pre-Bid Conference, including site visit, will be held at **1:30 pm on April 19, 2023** at Metropolitan Water District of Salt Lake & Sandy, 3430 East Danish Road, Cottonwood Heights, UT 84093. Representatives of OWNER and ENGINEER will be present to discuss the Project. Prospective Bidders are required to attend**.** ENGINEER will transmit to all prospective Bidders of record such Addenda as ENGINEER considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective. Those bidders not attending the pre-bid conference shall have their bids rejected.

OWNER PURCHASED ITEMS: None.

OWNER PROVIDED SERVICES: The OWNER will provide the following services for the Project.

1. OWNER will provide programming / HMI / SCADA.

- END OF INSTRUCTIONS TO BIDDERS -

BID

TO: METROPOLITAN WATER DISTRICT OF SALT LAKE & SANDY

The undersigned Bidder hereby proposes to furnish all plant machinery, labor, services, materials, equipment, tools, supplies, transportation, utilities, supervision and all other items and facilities necessary to perform all work required under the OWNER's Contract Documents entitled "Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure" and all addenda issued by said OWNER prior to opening of the Bids.

The undersigned Bidder acknowledges receipt of the following addenda:

Addendum No.	Addendum Date

Bidder agrees that, within 10 calendar days after receipt of Notice of Award from OWNER, he will: (1) execute the Agreement in the required form; (2) secure the required insurance and bonds; and (3) furnish the required insurance certificates, all as described in the Contract Documents. Bidder agrees that if he fails to timely execute the contract, or secure the required insurance or bonds or provide the required certificates, all as described in the Contract Documents, then the bid guarantee furnished by Bidder shall be subject to enforcement. OWNER may enforce the bid guarantee by making demand upon the surety without further notice to or demand upon Bidder for all of OWNER's damages (including attorney's fees, costs of administration and delay damages) resulting from Bidder's failure to timely execute the contract, secure the required insurance and bonds and provide the required certificates, all as described in the Contract Documents. If Bidder shall timely execute the Agreement, secure the required insurance and bonds, and furnish the required insurance certificates all as described in the Contract Documents, the bid bond shall become void. It is further understood that this Bid may not be withdrawn for a period of 60 days after the date set for the opening thereof, unless otherwise required by law.

Bidder further agrees to complete all WORK required under the contract within the time described by the Contract Documents, and to accept in full payment therefore the price(s) named in the attached Bid Schedule(s).

Dated: _____ Bidder: _____

By: _____
(Signature)

Title: _____

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BID SCHEDULE

PART 1 – GENERAL

1.01 BIDDER

A. Name and Address _____

B. Telephone Number _____

C. Facsimile Number _____

D. Tax Identification Number _____

E. Bidder holds license number _____,

issued by the Utah State Department of Commerce, Occupational and Professional Licensing Division, on the ___ day of _____, 20___. Bidder is licensed to practice as a _____ contractor. License renewal date is the ___ day of _____, 20___.

1.02 CONSTRUCTION CONTRACT

A. Name of Project: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure.

B. MWDSLS Project Number: LC063.

Quote Number: _____.

1.03 SCHEDULES TO BE ADDED TO THE AGREEMENT

A. This Bid Schedule contains the schedules of prices which will be incorporated into the Agreement by reference.

1.04 TAXES

A. The Bidder agrees that all sales, consumer, use, and other similar taxes are included in the stated bid prices for the WORK unless provision is made herein for the Bidder to separately itemize the estimated amount of tax.

1.05 SCHEDULES OF PRICES

A. Bid Schedule A: Bid items for ALL work to construct the SIBs, grit basin, HDPE piping, flow control and valve vaults, electrical and controls equipment, and associated site improvements.

B. Bid Schedule B: Bid items for ALL work related to the equipping of the ASR well.

C. See Specification Section 01 22 00 for detail on each bid item.

D. **Schedule A Unit Price Base Bid:**

BID SCHEDULE A – SIBs

Item No.	Description	Quantity Unit	Unit Price	Amount
A1.	Mobilization	1 LS	$	$
A2.	Site Preparation and SWPPP	1 LS	$	$
A3.	Construction Surveying and Staking	1 LS	$	$
A4.	Materials Quality Control and Testing	1 LS	$	$
A5.	Furnish and Install 16-Inch HDPE DR 32.5 Waterline	1,788 LF	$	$
A6.	Furnish and Install 24-Inch HDPE DR 32.5 Waterline	1,299 LF	$	$
A7.	Surface Infiltration Basin (SIB) #1 Excavation & Material Disposal	1 LS	$	$
A8.	Surface Infiltration Basin (SIB) #2 Excavation & Material Disposal	1 LS	$	$
A9.	Existing Construction Debris Excavation & Material Disposal	1 LS	$	$
A10.	Drain Holes	9 EA	$	$
A11.	SIB Overflow Piping	1 LS	$	$
A12.	Drainage Berm (3'-0" High)	1 LS	$	$

A13.	SIB Rip Rap Apron	1 LS	$	$
A14.	UBC Access Road (12'-0" Wide x 6" Thick)	1 LS	$	$
A15.	Furnish and Install ASR Valve Vault Structure	1 LS	$	$
A16.	Furnish and Install SIB Valve Vault Structure	1 LS	$	$
A17.	Furnish and Install SIB Valve Vaults Electrical and Controls	1 LS	$	$
A18.	Furnish and Install Control Panel, SCADA Programming, and Integration	1 LS	$	$
A19.	Furnish and Install SIB and Monitoring Well Level Sensors	1 LS	$	$
A20.	Furnish and Install 16-inch HDPE DR 32.5 ASR Waste Line	26 LF	$	$
A21.	3x3 Precast ASR Waste Line Catch Basin	1 LS	$	$
A22.	Site Restoration	1 LS	$	$
A23.	SWPPP Construction General Permit and Fugitive Dust Permit Fee Allowance	1 LS	$500.00	$500.00
	Schedule A Total Unit Price Base Bid Total (Sum of Items A1 through A23)			$
	$ (Price in Words)			

E. **Schedule B Unit Price Base Bid:**

BID SCHEDULE B – ASR WELL EQUIPPING

Item No.	Description	Quantity Unit	Unit Price	Amount
B1.	Mobilization	1 LS	$	$
B2.	Site Preparation and SWPPP	1 LS	$	$
B3.	Construction Surveying and Staking	1 LS	$	$
B4.	Materials Quality Control and Testing	1 LS	$	$
B5.	Well House Pad	1 LS	$	$
B6.	Furnish Well House Prefabricated Building	1 LS	$	$
B7.	Install Well House Prefabricated Building	1 LS	$	$
B8.	Building Permit Fee Allowance	1 LS	$500.00	$500.00
B9.	Furnish Well House Pumping Equipment	1 LS	$	$
B10.	Install Well House Pumping Equipment	1 LS	$	$
B11.	Furnish and Install Well House Electrical and HVAC Equipment	1 LS	$	$
B12.	Furnish and Install Well House Piping	1 LS	$	$
B13.	Furnish and Install Well House Controls	1 LS	$	$
	Schedule B Total Unit Price Base Bid Total (Sum of Items B1 through B13)			$

$ _____

(Price in Words)

Grand Total Schedule A + Schedule B	$
$ (Price in Words)	

- END OF BID SCHEDULE -

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BID BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____

as Principal, and _____

as Surety, are held and firmly bound unto the Metropolitan Water District of Salt Lake & Sandy

(hereinafter called "OWNER") in the sum of _____ dollars, (not less than five percent of the total amount of the bid) for the payment of which sum, will and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, Principal has submitted a Bid to OWNER to perform all WORK required under the OWNER's Contract Documents entitled "Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure" (hereafter called the "Project").

NOW THEREFORE, if Principal is awarded a contract by OWNER for the construction of the Project and, within the time and in the manner required under the heading "Instructions to Bidders" enters into the written contract entitled "Agreement" bound with said Contract Documents, furnishes the required certificates of insurance, and furnishes the required Performance Bond and Payment Bond within 10 calendar days after receipt of such contract from OWNER, then this obligation shall be null and void, otherwise it shall remain in full force and effect. In the event suit is brought upon this bond by OWNER and judgement is recovered, Surety shall pay all costs incurred by OWNER in such suit, including a reasonable attorney's fee to be fixed by the court.

SIGNED AND SEALED, this ___ day of _____, 20___.

(SEAL)	(SEAL)
_____	_____
(Principal)	(Surety)
By: _____	By: _____
(Signature)	(Signature)

(SEAL AND NOTARIAL ACKNOWLEDGMENT OF SURETY)

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INFORMATION REQUIRED OF BIDDER

The Bidder shall furnish the following information. Failure to comply with this requirement may render the Bid non-responsive and subject to rejection. Additional sheets may be attached as required.

A. BIDDER INFORMATION

1. Bidder's name: _____
2. Bidder's and address: _____

   _____
3. Bidder's telephone number: _____
4. Bidder's Email address: _____
5. Contractor's License Primary Classification: _____

   Utah State License No.: _____

   Supplemental Classification Held, if any: _____
6. Number of years as a contractor in construction work of this type: _____
7. Name and title of officers of Bidder's firm: _____

   _____

   _____

   _____

   _____
8. Name of person who inspected site of proposed work for your firm:

   Name: _____

   Date of Inspection: _____
9. Name and telephone number of surety company and agent who will provide the required bonds on this contract: _____

   _____
10. ATTACH TO THIS BID the experience resume of the person who is designated Project Superintendent.

11. ATTACH TO THIS BID a description of the Bidder's plan or layout for performing the WORK and plan for construction.

12. ATTACH TO THIS BID a list of construction contracts complete by the Bidder during the last five years involving similar type and comparable value that meets the intent of the "Competency of Bidders" in the Instructions to Bidders. The list shall include the following information as a minimum:

- Name, address and telephone number of project Owner
- Name of project
- Location of project
- Brief description of the work involved
- Name, address, and telephone number of engineer
- Date of completion of contract
- Contract amount
- Name of Owner's project engineer.

B. LIST OF SUBCONTRACTORS

1. The CONTRACTOR shall perform at least 60% of the WORK with his own forces, such that less than 40% of the WORK shall be performed by Subcontractors. Failure to comply with this requirement may render the Bid non-responsive and subject to rejection.

2. Bidder shall list the name and location of the place of business for each subcontractor who will perform work below.

Work to be Performed	Subcontractor Name and Address	Value of Subcontracted Work	
		Dollars	Percent of Bid
Earthwork		$	
HDPE Pipe Supplier		$	
HDPE Fusion Welder		$	
Electrical Subcontractor		$	
Instrumentation Subcontractor		$	

- END OF INFORMATION REQUIRED OF BIDDER –

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CONTRACTUAL DOCUMENTS

AGREEMENT

An Agreement made as of the ___ day of _____, 20___, by and between Metropolitan Water District of Salt Lake & Sandy ("OWNER") and _____ a Utah corporation qualified to do business and doing business in the State of Utah ("CONTRACTOR").

TERMS:

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

ARTICLE 1
WORK

CONTRACTOR shall complete all WORK as specified or indicated in the Contract Documents for the Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure. The WORK is generally described as follows:

> Furnishing all labor, supervision, services, materials, equipment, and supplies (except for such materials, equipment, and services as may be stipulated in the Contract Documents to be furnished by the OWNER); furnishing and removing all plant machinery, temporary structures, tools, supplies, transportation, utilities, and all other items, facilities and equipment, and to do everything required by this Agreement and the Contract Documents; accepting all responsibility for and paying for all loss and damage arising out of the nature of the WORK, or from the action of the elements, or from any unforeseen difficulties which may arise during the prosecution of the WORK until its acceptance by OWNER, and for all risks of every description connected with the WORK; also for all expenses resulting from the suspension or discontinuance of work, except as in the Contract Documents are expressly stipulated to be borne by OWNER.

ARTICLE 2
ENGINEER

The Project has been designed by Hansen, Allen & Luce, Inc. who is hereinafter called ENGINEER and who will assume all duties and responsibilities and have the rights and authority assigned to ENGINEER in the Contract Documents in connection with completion of the WORK in accordance with the Contract Documents.

ARTICLE 3
CONTRACT TIME

3.1 The WORK shall be substantially complete, in accordance with paragraph 14.08 and 14.09 of the General Conditions, on or before February 16, 2024.

3.2 Liquidated Damages: OWNER and CONTRACTOR recognize that time is of the essence of this Agreement and that the OWNER will suffer financial loss if the WORK is not completed within the time specified in paragraph 3.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by OWNER if the WORK is not completed on time. Accordingly, instead of requiring any proof of loss, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) CONTRACTOR shall pay OWNER the amount specified in the Supplementary General Conditions for each day that expires after the time specified in paragraph 3.1 until the WORK is substantially complete. If, after Substantial Completion, CONTRACTOR neglects, refuses or fails to complete the remaining WORK within 45 days or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER the amount specified in the Supplementary General Conditions for each day that expires after the 45 days until the WORK is complete and ready for final payment.

ARTICLE 4
CONTRACT PRICE

OWNER shall pay CONTRACTOR for completion of the WORK in accordance with the Contract Documents, at those prices stated in the CONTRACTOR's Bid. The total contract price is $_____.

ARTICLE 5
PAYMENT PROCEDURES

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

5.1 Progress Payments: OWNER shall make progress payments on the basis of CONTRACTOR's Applications for Payment, as recommended by ENGINEER, on or about the fifteenth day of each month during construction. Progress payments for lump sum bids will be based on a schedule of values or lump sum price breakdown. Progress payments for unit price bids will be based on the actual number of units completed.

5.2 Final Payment: Upon final completion and acceptance of the WORK, OWNER shall pay the remainder of the Contract Price as recommended by ENGINEER, as provided in Article 14 of the General Conditions.

5.3 Retainage: The OWNER shall retain 5% of the balance due to the CONTRACTOR in an interest bearing account. Upon final completion of the Project, to the satisfaction of the OWNER, the retainage, with interest, shall be paid to the CONTRACTOR.

ARTICLE 6
INTEREST

All monies not paid when due as provided in Article 14 of the General Conditions shall be placed in an interest-bearing account for the benefit of the CONTRACTOR.

ARTICLE 7
CONTRACTOR'S REPRESENTATION

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

7.1 CONTRACTOR has familiarized itself with the nature and extent of the Contract Documents, WORK, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance or furnishing of the WORK.

7.2 CONTRACTOR has studied carefully all exploration reports and tests of subsurface conditions and drawings of physical conditions which are identified in the Supplementary General Conditions, as provided in paragraph 4.02 of the General Conditions, and accepts the Technical Data contained in such reports and drawings upon which CONTRACTOR is entitled to rely.

7.3 CONTRACTOR has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests, reports and studies (in addition to or to supplement those referred to in paragraph 7.2 above) which pertain to the subsurface or physical conditions at or contiguous to the site or otherwise may affect the cost, progress, performance or furnishing of the WORK as CONTRACTOR considers necessary for the performance or furnishing of the WORK at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of paragraph 4.02 of the General Conditions; and no additional examinations, investigations, explorations, tests, reports, studies or similar information or data are or will be required by CONTRACTOR for such purposes.

7.4 CONTRACTOR has reviewed and checked all information and data shown or indicated in the Contract Documents with respect to existing Underground Utilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Utilities.

7.5 CONTRACTOR has correlated the results of all observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Contract Documents.

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

ARTICLE 8
CONTRACT DOCUMENTS

The Contract Documents for the Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure, which comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK, consist of the following:

1. This Agreement
2. Performance and Payment Bonds
3. Notice of Award
4. Notice to Proceed
5. General Conditions
6. Supplementary General Conditions
7. Notice Inviting Bids
8. Instructions to Bidders
9. Information Required of Bidder
10. Technical Specifications
11. Drawings
12. Addenda
13. CONTRACTOR's Bid
14. Change Orders (if any)
15. Purchase Orders.

The CONTRACTOR (1) acknowledges that he has received a copy of each document, specified above, (2) acknowledges that he has read and understands each document specified above and (3) agrees to every term, condition and contract obligation set forth in each document specified above.

There are no Contract Documents other than those listed above in this Article 8. The Contract Documents may only be amended, modified or supplemented as provided in paragraphs 3.03 of the General Conditions.

ARTICLE 9
MISCELLANEOUS

9.1 Terms used in this Agreement are defined in Article 1 of the General Conditions.

9.2 No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation, monies that may become due and monies that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and

unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

9.3 In the event any legal action or other proceeding is brought for the enforcement of this Agreement and/or the Contract Documents, or for damages, because of an alleged dispute, breach, default or misrepresentation in connection with any of the provisions thereof, the successful or prevailing party shall be entitled to recover reasonable attorneys' fees and other costs incurred in the action or proceeding, in addition to any other relief to which it may be entitled.

9.4 Any notice to be given hereunder shall be deemed given when sent by registered or certified mail, postage prepaid to the parties at their respective addresses stated below or at any other address when notice of such change of address has been given as provided in this Article.

9.5 The District may, at reasonable times, inspect the part of the plant or place of business of a contractor or any subcontractor which is related to the performance of any contract awarded or to be awarded by the District.

CONTRACTOR:	OWNER:
_____	METROPOLITAN WATER DISTRICT OF SALT LAKE & SANDY
UTAH LICENSE # _____	3430 EAST DANISH ROAD COTTONWOOD HEIGHTS, UT 84093
By: _____	By: _____
Its: _____	Title: _____

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PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____, as CONTRACTOR, and _____ as Surety, are held firmly bound unto the Metropolitan Water District of Salt Lake & Sandy hereinafter called "OWNER," in the sum of $_____ for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, CONTRACTOR has been awarded and is about to enter into the annexed Agreement with OWNER to perform all work required under the OWNER's Contract Documents entitled "Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure".

NOW THEREFORE, if CONTRACTOR shall perform all the requirements of the Agreement required to be performed on his part, at the times and in the manner specified therein, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

PROVIDED, that any alterations in the work to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of the Agreement, shall not in any way release CONTRACTOR or Surety thereunder, nor shall any extensions of the time granted under the provisions of the Agreement release either the CONTRACTOR or Surety, and notice of such alterations or extensions of the work, materials or time to complete made under the Agreement is hereby waived by Surety. This Bond is furnished in compliance and in accordance with 14-1-18, et. seq., Utah Code Ann., as amended, and 63G-6a-11 Utah Code Ann., as amended.

SIGNED AND SEALED, this ___ day of _____, 20___.

(SEAL)	(SEAL)
_____	_____
(Contractor)	(Surety)
By: _____	By: _____
(Signature)	(Signature)

(SEAL AND NOTARIAL ACKNOWLEDGMENT OF SURETY)

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PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____ as CONTRACTOR, and _____, as Surety, are held firmly bound unto the Metropolitan Water District of Salt Lake & Sandy hereinafter called "OWNER," in the sum of $_____ for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, CONTRACTOR has been awarded and is about to enter into the annexed Agreement with OWNER to perform all work required under the OWNER's Contract Documents entitled "Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure".

NOW THEREFORE, if said CONTRACTOR, or subcontractor, fails to pay for any materials, equipment, or other supplies, or for rental of same, used in connection with the performance of work contracted to be done, or for amounts due under applicable State law for any work or labor thereon, said Surety will pay for the same in an amount not exceeding the sum specified above, and, in the event suit is brought upon this bond, a reasonable attorney's fee to be fixed by the court. This bond shall inure to the benefit of any persons, companies, or corporations entitled to file claims under applicable State law.

PROVIDED, that any alterations in the work to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of the Agreement, shall not in any way release CONTRACTOR or Surety thereunder, nor shall any extensions of time granted under the provisions of said contract release either CONTRACTOR or the Surety, and notice of such alterations or extensions of the work, materials or time to complete made under the Agreement is hereby waived by Surety. This bond is furnished in compliance and in accordance with 14-1-18, et. seq., Utah Code Ann., as amended, and 63G-6a-11 Utah Code Ann., as amended.

SIGNED AND SEALED, this ___ day of _____, 20___.

(SEAL)	(SEAL)
_____	_____
(Contractor)	(Surety)
By: _____	By: _____
(Signature)	(Signature)

(SEAL AND NOTARIAL ACKNOWLEDGMENT OF SURETY)

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CONDITIONAL NOTICE OF AWARD

To: _____

Project: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure

Owner: Metropolitan Water District of Salt Lake & Sandy

You are hereby notified that the OWNER has conditionally accepted your Bid for the above-referenced Project in the amount of $_____, pending authorization from the District's Board of Trustees on June 12, 2023.

You must execute the Agreement, and furnish the required Performance Bond, Payment Bond, and Certificates of Insurance within ten calendar days from the date of this notice to you.

An acknowledged copy of this Notice of Award must be returned to the OWNER within ten calendar days of this notice to you.

Dated this ___ day of _____, 20___.

Metropolitan Water District of Salt Lake & Sandy

By: _____
[Type name]

Title: _____

ACCEPTANCE OF NOTICE

Receipt and acceptance of this Notice of Award is hereby acknowledged by:

_____

This ___ day of _____, 20___.

By: _____

Title: _____

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NOTICE TO PROCEED

To: *[CONTRACTOR]* _____

Project: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure

OWNER: Metropolitan Water District of Salt Lake & Sandy

You are hereby notified to commence WORK on the above-referenced Project as of _____ ___, 20___. You are to complete the WORK on or before February 16, 2024.

An acknowledged copy of this Notice to Proceed must be returned to the OWNER within ten calendar days of this notice.

Dated this ___ day of _____, 20___.

Metropolitan Water District of Salt Lake & Sandy

By: _____
[Type name]

Title: _____

ACCEPTANCE OF NOTICE

Receipt and acceptance of this Notice of Award is hereby acknowledged by:

_____

This ___ day of _____, 20___.

By: _____

Title: _____

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APPLICATION FOR PAYMENT

DATE _____

SHEET ___ OF ___

PAYMENT APPLICATION NUMBER _____

PERIOD FROM _____ TO _____, 20___.

PROJECT: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure

MWDSLS PROJECT NO.: LC063

CONTRACTOR: _____

ADDRESS: _____

ENGINEER: Hansen, Allen, & Luce, Inc.

1	ORIGINAL CONTRACT PRICE:	$_____
2	NET CHANGE ORDERS APPROVED TO DATE: (Attach Summary Sheet)	$_____
3	REVISED CONTRACT AMOUNT: (Sum of Lines 1 & 2)	$_____
4	TOTAL VALUE OF WORK COMPLETED TO DATE: (Attached Payment Breakdown)	$_____
5	PERCENT PROJECT COMPLETE: (Divide Line 4 by 3 and multiply by 100)	_____%
6	MATERIALS ON HAND: (80% of Value, Listing Attached)	$_____
7	SUBTOTAL (Sum of Lines 4 and 6):	$_____
8	LESS AMOUNT RETAINED (5%):	$_____
9	SUBTOTAL (Line 7 - Line 8):	$_____
10	LESS PREVIOUS PAYMENTS:	$_____
11	CURRENT PAYMENT DUE: (Difference between Line 9 & 10)	$_____

Application for Payment (continued)

CONTRACTOR'S Certification:

The undersigned CONTRACTOR certifies that (1) all previous progress payments received from OWNER for work done under the Contract referred to herein have been applied to discharge in full all obligations of CONTRACTOR incurred in connection with work covered by prior Applications for Payment numbered ___ inclusive; and (2) title to all materials and equipment incorporated in said WORK or otherwise listed in or covered by this Application for Payment will pass to OWNER at time of payment free and clear of all liens, claims, security interests and encumbrances (except such as covered by bond acceptable to OWNER).

Dated: _____

_____
CONTRACTOR

By: _____

ENGINEER's Recommendation:

This Application (with accompanying documentation) meets the requirements of the Contract Documents and payment of the CURRENT PAYMENT DUE is recommended.

ENGINEER

Dated: _____

_____
Project Representative

Dated: _____

_____
Project Manager

OWNER

Dated: _____

_____
Project Manager

Dated: _____

_____
Assistant General Manager

CHANGE ORDER

Order No._____

Date:_____

NAME OF PROJECT: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure

DISTRICT PROJECT NUMBER: LC063

CONTRACTOR: _____

CONTRACT DATE: _____

The following changes are hereby made to the CONTRACT DOCUMENTS:

Total Change to CONTRACT PRICE: Increase (Decrease) $_____

Original CONTRACT PRICE: $_____

Current CONTRACT PRICE adjusted by previous CHANGE ORDER(S): $_____

The new CONTRACT PRICE including this CHANGE ORDER is $_____

The CONTRACT TIME is increased (decreased) by ___ calendar days.

The date for substantial completion of the WORK is ___ _____, 20___.

The CONTRACTOR agrees to furnish all labor and materials and perform all work as necessary to complete the change order items for the price named herein, which includes all supervision and miscellaneous costs. This change order constitutes full and mutual accord and satisfaction for all time and all costs related to this change. By acceptance of this change order the CONTRACTOR agrees that the change order represents an equitable adjustment to the Contract, and further agrees to waive all right to file a claim arising out of or as a result of this change. This document becomes part of the Contract Documents, and all provisions will apply hereto, upon approval by the OWNER.

Recommended: _____
ENGINEER Date

Recommended: _____
Project Representative Date

Recommended: _____
Metropolitan Water District of Salt Lake & Sandy Date
Project Manager

By signing below, the District's general manager certifies that the expenditure of this change order amount is properly authorized by the District's board of trustees consistent with the District's budget and financial management policies and the instructions of the board of trustees.

Final Approval:

Approved: _____

CONTRACTOR Date

Approved: _____

Metropolitan Water District of Salt Lake & Sandy Date
General Manager

NOTICE OF SUBSTANTIAL COMPLETION

PROJECT: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure

OWNER: Metropolitan Water District of Salt Lake & Sandy

CONTRACTOR: _____

ENGINEER: Hansen, Allen, & Luce, Inc.

DATE OF SUBSTANTIAL COMPLETION: _____

Authorized representatives of the OWNER, CONTRACTOR AND ENGINEER have inspected the Project and the Project is hereby declared to be substantially complete, as defined in the Contract Documents.

_____
ENGINEER

The CONTRACTOR hereby acknowledges this Notice of Substantial Completion and agrees to complete all remaining items of work within 45 days.

_____
CONTRACTOR

The OWNER hereby accepts the Project as substantially complete and will take possession of the Project at ___ [am/pm] on ___ _____, 20___.

_____
OWNER

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CONTRACTOR'S CERTIFICATE OF FINAL COMPLETION

TO: Metropolitan Water District of Salt Lake & Sandy
3430 East Danish Road
Sandy, Utah 84093

FROM: _____

PROJECT: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure

This is to certify that I, _____, am an authorized official of _____ working in the capacity of _____ and have been properly authorized by said firm or corporation to sign the following statements pertaining to the subject contract:

I know of my own personal knowledge, and do hereby certify, that the WORK of the contract described above has been performed and all materials used and installed to date are in accordance with, and in conformity to, the Contract Documents.

The WORK is now complete in all parts and requirements, excepting the attached list of minor deficiencies and the reasons for each being incomplete to date, for which exemption from final payment requirements is requested in conformance to Article 14.09A of the General Conditions (if no exemptions requested, write "none") _____. The WORK is now ready for your final inspection. The following items required from the CONTRACTOR prior to application for final payment (such as O&M Manuals, guarantees, record drawings, lien waivers, consent of surety, affidavit of payment, etc.,) are submitted herewith, if any: _____
_____
_____. I understand that neither the issuance by the ENGINEER of a Notice of Completion, nor the acceptance thereof by the OWNER, shall operate as a bar of claim against the CONTRACTOR under the terms of the guarantee provisions of the Contract Documents.

SIGNATURE: _____

DATE: _____

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CONSENT OF SURETY FOR FINAL PAYMENT

PROJECT NAME: Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure

LOCATION: Little Cottonwood Water Treatment Plant

TYPE OF CONTRACT: _____

AMOUNT OF CONTRACT: _____

In accordance with the provisions of the above-named contract between the OWNER and the CONTRACTOR, the following named Surety:

_____

_____

_____

on the Payment Bond of the following named CONTRACTOR:

_____

_____

_____

hereby approves of final payment to the CONTRACTOR, and further agrees that said final payment to the CONTRACTOR shall not relieve the Surety of any of its obligations to the following named OWNER (as set forth in said Surety's bond):

Metropolitan Water District of Salt Lake & Sandy

3430 East Danish Road

Cottonwood Heights, UT 84093

IN WITNESS WHEREOF, the Surety has hereunto set its hand and seal this ___ day of _____, 20___.

_____
(Name of Surety)

_____
(Signature of Authorized Representative)

_____
(Name of Authorized Representative)

Title: _____

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AFFIDAVIT OF PAYMENT

To All Whom It May Concern:

WHEREAS, the undersigned has been employed by the Metropolitan Water District of Salt Lake & Sandy to furnish labor and materials under a contract dated _____ 20___ for the project named "Aquifer Storage and Recovery Pilot Testing Phase 1 SIB and Infrastructure", in the County of Salt Lake, State of Utah, of which Metropolitan Water District of Salt Lake & Sandy is the OWNER.

NOW, THEREFORE, this ___ day of _____, 20___, the undersigned, as the CONTRACTOR for the above-named Contract pursuant to the Conditions of the Contract hereby certifies that, except as listed below, he has paid in full or has otherwise satisfied all obligations for all materials and equipment furnished, for all work, labor, and services performed, and for all known indebtedness and claims against the CONTRACTOR for damages arising in any manner in connection with the performance of the Contract referenced above for which the OWNER or his property might in any way be held responsible.

EXCEPTIONS:_____
_____
_____
_____
_____
(If none, write "None". If required by the OWNER, the CONTRACTOR shall furnish bond satisfactory to the OWNER for each exception.)

_____
CONTRACTOR

(Affix corporate seal here)

_____
(Signature of Authorized Representative)

Title: _____

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CONDITIONS OF THE CONTRACT

GENERAL CONDITIONS

ARTICLE 1 – DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents and printed with initial or all capital letters, the following terms have the meanings indicated:

Addenda – Written or graphic instruments issued prior to the opening of Bids which make additions, deletions, or revisions to the Contract Documents.

Agreement – The written contract between the OWNER and the CONTRACTOR for the performance of the WORK pursuant to the Contract Documents. Documents incorporated into the contract by reference become part of the contract and of the Agreement.

Application for Payment – The form furnished by the ENGINEER and completed by the CONTRACTOR to request progress or final payment including supporting documentation to substantiate the amounts for which payment is requested.

Bid – The offer or proposal of a Bidder, submitted on the prescribed form, setting forth the price or prices for the WORK to be performed.

Bidder – Any person, firm or corporation submitting a Bid for the WORK.

Bonds – Performance and Payment Bonds and other instruments which protect the OWNER against loss due to inability or refusal of the CONTRACTOR to perform pursuant to the Contract Documents.

Change Order – A document recommended by the ENGINEER, which is signed by the CONTRACTOR and the OWNER and authorizes an addition, deletion, or revision in the WORK, or an adjustment in the Contract Price or the Contract Time, issued on or after the Effective Date of the Agreement.

Contract Documents – The documents which comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK, consisting of the Drawings, Technical Specifications, General Conditions, Supplementary General Conditions, Notice Inviting Bids, Instructions to Bidders, Addenda, CONTRACTOR's Bid, Information Required of Bidder, Agreement, Performance Bond, Payment Bond, Notice To Proceed and Change Orders. Only printed or hard copies of the documents listed above are Contract Documents.

Contract Price – The total monies payable by the OWNER to the CONTRACTOR for completion of the WORK under the terms and conditions of the Contract Documents.

Contract Time – The number of successive Days or the date stated in the Contract Documents for Substantial Completion of the WORK. The Contract Time begins to run on the date specified in the Notice to Proceed.

CONTRACTOR – The person, firm, or corporation with whom the OWNER has executed the Agreement.

Day – A calendar day of 24 hours measured from midnight to the next midnight.

Defective Work – Work that: is unsatisfactory, faulty, or deficient; does not conform to the Contract Documents; does not meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents; has been damaged prior to the ENGINEER's recommendation of final payment.

Drawings – The drawings, plans, maps, profiles, diagrams, and other graphic representations which show the character, location, nature, extent, and scope of the WORK.

Effective Date of the Agreement – The date indicated in the Agreement on which it was executed.

ENGINEER – The person, firm or corporation named as such in the Contract Documents.

Field Order – A written order issued by the ENGINEER which requires minor changes in the WORK, but which does not involve a change in the Contract Price or Contract Time.

General Requirements – Division 1 of the Technical Specifications.

Laws and Regulations; Laws or Regulations – Includes any and all applicable state, federal and local statutes, common law, rules, regulations, ordinances, codes, and/or orders.

Notice of Award – The OWNER's written notice to the apparent successful Bidder stating that upon compliance with the conditions precedent enumerated therein by the apparent successful Bidder within the time specified, the OWNER will enter into the Agreement.

Notice to Proceed – The OWNER's written notice to the CONTRACTOR authorizing the CONTRACTOR to proceed with the work and establishing the date of commencement of the Contract Time.

OWNER – The Metropolitan Water District of Salt Lake & Sandy.

Partial Utilization – Placing a portion of the WORK in service for the purpose for which it is intended (or a related purpose) before reaching Substantial Completion of the WORK.

Project – A unit of total construction of which the WORK to be provided under the Contract Documents, may be the whole, or a part thereof.

Project Representative – The authorized representative of the ENGINEER who is assigned to the site or any part thereof.

Shop Drawings – All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for the CONTRACTOR to illustrate some portion of WORK and all illustrations, brochures, standard schedules, performance charts, instruction, and diagrams to illustrate material or equipment for some portion of the WORK.

Specifications – (Same definition as for Technical Specifications hereinafter).

Subcontractor – An individual, firm, or corporation having a direct contract with the CONTRACTOR or with any other Subcontractor for the performance of a part of the WORK.

Substantial Completion – That state of construction when the WORK has progressed to the point where, in the opinion of the ENGINEER as evidenced by the Notice of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the WORK can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to any work refer to substantial completion thereof.

Supplementary General Conditions – The part of the Contract Documents which makes additions, deletions, or revisions to these General Conditions.

Supplier – A manufacturer, fabricator, supplier, distributor, materialman, or vendor.

Technical Data – The factual information contained in reports describing physical conditions, including exploration method, plans, logs, laboratory test methods and factual data. Technical Data does not include conclusions, interpretations, interpolations, extrapolations or opinions contained in reports or reached by the CONTRACTOR.

Technical Specifications – Those portions of the Contact Documents consisting of the General Requirements and written technical descriptions of products and execution of the WORK.

Underground Utilities – All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments and any encasements containing such facilities which have been installed under ground to furnish any of the following services or materials: water, sewage and drainage removal, electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, traffic, or other control systems.

WORK – The entire construction required to be furnished under the Contract Documents. WORK is the result of performing services, furnishing labor and supervision, and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 DELIVERY OF BONDS/INSURANCE CERTIFICATES

A. The CONTRACTOR shall deliver to the OWNER the Bonds and insurance certificates required by the Contract Documents within ten days after receiving the Notice of Award from the OWNER.

2.02 COPIES OF DOCUMENTS

A. The OWNER shall furnish the CONTRACTOR five copies of the Contract Documents (Specifications and reduced Drawings), together with five sets of full-scale Drawings. Additional quantities of the Contract Documents will be furnished at reproduction cost.

2.03 STARTING THE PROJECT

A. The CONTRACTOR shall begin construction of the WORK within 10 days after the commencement date stated in the Notice to Proceed, but shall not commence construction prior to the commencement date.

2.04 BEFORE STARTING CONSTRUCTION

A. Before undertaking each part of the WORK, the CONTRACTOR shall carefully study and compare the Contract Documents to check and verify pertinent figures and dimensions shown thereon with all applicable field measurements. The CONTRACTOR shall promptly report in writing to the ENGINEER any conflict, error, or discrepancy which the CONTRACTOR may discover and shall obtain a written interpretation or clarification from the ENGINEER before proceeding with any work affected thereby.

B. The CONTRACTOR shall submit to the ENGINEER for review those documents called for under the Section entitled “Contractor Submittals” in the General Requirements.

2.05 PRECONSTRUCTION CONFERENCE

A. The CONTRACTOR shall attend a preconstruction conference with the OWNER, the ENGINEER and others as appropriate to discuss the construction of the WORK in accordance with the Contract Documents.

2.06 FINALIZING SCHEDULES

A. At least 7 days before the CONTRACTOR's submittal of its first Application for Payment, the CONTRACTOR, the ENGINEER, and others as appropriate will meet to finalize the schedules submitted in accordance with the General Requirements.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 INTENT

A. The Contract Documents comprise the entire agreement between OWNER and CONTRACTOR concerning the WORK. The Contract Documents are complementary, what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the place of the Project.

B. It is the intent of the Contract Documents to describe the WORK, functionally complete, to be constructed in accordance with the Contract Documents. All work, materials, or equipment that may be reasonably inferred from the Contract Documents as being required to produce the completed work shall be supplied whether or not specifically called for. When words which have a well-known technical or trade meaning are used to describe work, materials, or equipment such words shall be interpreted in accordance with that meaning. Reference to standard specifications, manuals, or codes or any technical society, organization, or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual, or code (whether or not specifically incorporated by reference in the Contract Documents) shall be effective to change the duties and responsibilities of the OWNER, the CONTRACTOR, or the ENGINEER or any of their consultants, agents, or employees from those set forth in the Contract Documents.

C. If, during the performance of the WORK, the CONTRACTOR finds a conflict, error or discrepancy in the Contract Documents, the CONTRACTOR shall immediately report it to the ENGINEER in writing and before proceeding with the work affected thereby. The ENGINEER shall then make a written interpretation, clarification, or correction from the ENGINEER.

3.02 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

A. In resolving conflicts resulting from conflicts, errors, or discrepancies in any of the Contract Documents, the order of precedence shall be as follows:

1. Change Orders

2. Agreement

3. Addenda

4. Supplementary General Conditions

5. General Conditions

6. Technical Specifications

7. Referenced Standard Specifications

8. Drawings

9. Contractor's Bid (Bid Form).

B. With reference to the Drawings the order of precedence is as follows:

1. Figures govern over scaled dimensions

2. Detail drawings govern over general drawings

3. Addenda/change order drawings govern over general drawings

4. Contract Drawings govern over standard drawings.

3.03 AMENDING AND SUPPLEMENTING CONTRACT DOCUMENTS

A. The Contract Documents may be amended by a Change Order (pursuant to Article 10) to provide for additions, deletions or revisions in the WORK or to modify terms and conditions.

3.04 REUSE OF DOCUMENTS

A. Neither the CONTRACTOR, Subcontractor, Supplier, nor any other person or organization performing any of the WORK under a contract with the OWNER shall have or acquire any title to or ownership rights in any of the Drawings, Technical Specifications, or other documents used on the WORK, and they shall not reuse or reproduce any of them on the extensions of the Project or any other project without the written consent of the OWNER and the ENGINEER.

B. The Contract Documents are for official use only and are exempt from the Freedom of Information Act (FOIA) (exemption 2). All Contract Documents and any copies made from them shall be returned to the office of the OWNER upon project completion. No refunds will be made for returned documents.

ARTICLE 4 – AVAILABILITY OF LANDS; PHYSICAL CONDITIONS; REFERENCE POINTS

4.01 AVAILABILITY OF LANDS

A. The OWNER shall furnish the lands, rights-of-way and easements upon which the WORK is to be performed and for access thereto, together with

other lands designated for the use of the CONTRACTOR in the Contract Documents. Easements or other adequate property interest for permanent structures or permanent changes in existing major facilities will be obtained and paid for by the OWNER, unless otherwise provided in the Contract Documents. Nothing contained in the Contract Documents shall be interpreted as giving the CONTRACTOR exclusive occupancy of the lands or rights-of-way provided. The CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment. The CONTRACTOR shall not enter upon nor use any property not under the control of the OWNER until a written temporary construction easement agreement or other appropriate agreement has been executed by the CONTRACTOR and the property owner, and a copy of the easement furnished to the ENGINEER prior to its use. Neither the OWNER nor the ENGINEER shall be liable for any claims or damages resulting from the CONTRACTOR's unauthorized trespass or use of any properties.

4.02 PHYSICAL CONDITIONS – SUBSURFACE AND EXISTING STRUCTURES

A. Explorations and Reports: The Supplementary General Conditions identify any exploration reports and subsurface conditions tests at the site that have been utilized by the ENGINEER in the preparation of the Contract Documents. The CONTRACTOR may rely upon the accuracy of the Technical Data contained in these reports. The CONTRACTOR is responsible for the interpretation, extrapolation or interpolation of all technical as well as nontechnical data and its reliance on the completeness, opinions and interpretation of the reports.

B. Existing Structures: The Supplementary General Conditions identify the drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground Utilities referred to in Paragraph 4.04 herein) which are at or contiguous to the site that have been utilized by the ENGINEER in the preparation of the Contract Documents. The CONTRACTOR is responsible for the interpretation, extrapolation or interpolation of all technical as well as nontechnical data and its reliance on the completeness, opinions and interpretation of the reports.

C. In preparation of Drawings and Specifications, ENGINEER or ENGINEER’s Consultants relied upon the reports of explorations and tests of subsurface conditions at the Site as listed in the Supplementary Conditions.

4.03 DIFFERING SITE CONDITIONS

A. The CONTRACTOR shall notify the ENGINEER upon encountering any of the following unforeseen conditions, hereinafter called "differing site conditions," during the prosecution of the WORK. The CONTRACTOR's notice to the ENGINEER shall be in writing and delivered before the differing

site conditions are disturbed, but in no event later than 14 days after their discovery.

1. Subsurface or latent physical conditions at the site of the WORK which could not reasonably have been discovered through diligent inspection by CONTRACTOR before his Bid was submitted which differs materially from those indicated, described, or delineated in the Contract Documents including those reports and documents discussed in Paragraph 4.02; and

2. Physical conditions at the site of the WORK of an unusual nature which could not reasonably have been discovered through diligent inspection by CONTRACTOR before his Bid was submitted and which differ materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents including those reports and documents discussed in Paragraph 4.02.

B. The ENGINEER will review the alleged differing site conditions, determine the necessity of obtaining additional explorations or tests with respect to verifying their existence and extent and advise the OWNER in writing of the ENGINEER's findings and conclusions.

C. If the OWNER concludes that because of newly discovered conditions a change in the Contract Documents is required, a Change Order will be issued as provided in Article 10 to reflect and document the consequences of the differing site conditions.

D. In each such case, an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, or any combination thereof, will be allowable to the extent that they are attributable to the differing site conditions. If the OWNER and the CONTRACTOR are unable to agree as to the amount or length of the Change Order, a claim may be made as provided in Articles 11 and 12.

E. The CONTRACTOR's failure to give written notice of differing site conditions within 14 days of their discovery and before they are disturbed shall constitute a waiver of all claims in connection therewith, whether direct or consequential in nature.

4.04 PHYSICAL CONDITIONS – UNDERGROUND UTILITIES

A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Utilities at or contiguous to the site are based on information and data furnished to the OWNER or the ENGINEER by the owners of Underground Utilities or by others. Unless it is expressly provided in the Supplementary General Conditions, the OWNER and the ENGINEER shall not be responsible for the

accuracy or completeness of any Underground Utilities information or data. The CONTRACTOR's responsibility relating to underground utilities are: review and check all information and data, locate all Underground Utilities shown or indicated in the Contract Documents, coordinate the WORK with the owners of Underground Utilities during construction, safeguard and protect the Underground Utilities, and repair any damage to Underground Utilities resulting from the WORK. The cost of all these activities will be considered as having been included in the Contract Price.

B. Not Shown or Indicated: If an Underground Utility not shown or indicated in the Contract Documents is uncovered or revealed at or contiguous to the site and which the CONTRACTOR could not reasonably have been expected to be aware of, the CONTRACTOR shall identify the owner of the Underground Utility, give written notice of the location to that owner and notify the ENGINEER.

4.05 REFERENCE POINTS

A. The ENGINEER will provide one bench mark, near or on the site of the WORK, and will provide two points near or on the site to establish a base line for use by the CONTRACTOR in laying out the WORK. Unless otherwise specified in the General Requirements, the CONTRACTOR shall furnish all other lines, grades, and bench marks required for proper execution of the WORK.

B. The CONTRACTOR shall preserve all bench marks, stakes, and other survey marks. In case of their removal or destruction by its own employees or by its subcontractor's employees, the CONTRACTOR shall be responsible for the accurate replacement of reference points by professionally qualified personnel at no additional cost to the OWNER.

ARTICLE 5 – BONDS AND INSURANCE

5.01 PERFORMANCE, PAYMENT AND OTHER BONDS

A. The CONTRACTOR shall furnish Performance and Payment Bonds, each in the amount of 100% of the Contract Price as security for the faithful performance and payment of all the CONTRACTOR's obligations under the Contract Documents. The Performance Bond shall remain in effect at least until one year after the date of Notice of Completion, except as otherwise provided by Law or Regulation or by the Contract Documents. After the ENGINEER issues the Notice of Completion, the amount of the Performance Bond may be reduced to 10 percent of the Contract Price, or $1,000, whichever is greater. The CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary General Conditions.

B. If the surety on any Bond furnished by the CONTRACTOR is declared a bankrupt or becomes insolvent or its right to do business is terminated in any

state where any part of the WORK is located, the CONTRACTOR shall within 7 days after written approval by the OWNER of a substitute Bond and Surety substitute the approved Bond and Surety.

5.02 INSURANCE

A. The CONTRACTOR shall purchase and maintain the insurance required under this paragraph. This insurance shall include the specific coverages set out herein and be written for not less than the limits of liability and coverages provided in the Supplementary General Conditions, or required by law, whichever is greater. The CONTRACTOR's liabilities under the Agreement shall not be deemed limited in any way to the insurance coverage required.

B. The CONTRACTOR shall furnish the OWNER with certificates indicating the type, amount, class of operations covered, effective dates and expiration dates of all policies and in a form acceptable to the OWNER. All insurance shall remain in effect until the ENGINEER issues the Notice of Final Completion and at all times thereafter when the CONTRACTOR may be correcting, removing, or replacing defective work in accordance with Paragraph 13.01B or completing punch list items required by the Notice of Substantial Completion. In addition, the insurance required herein (except for Worker's Compensation and Employer's Liability) shall name the OWNER, the ENGINEER, and their officers, agents, and employees as "additional insured" under the policies for claim arising out of the Project. Such coverage to the additional insureds shall be primary to other coverage available to the additional insureds. All liability insurance policies shall be occurrence and not claims made policies.

1. Workers' Compensation and Employer's Liability: This insurance shall protect the CONTRACTOR against all claims under applicable state workers' compensation laws. The CONTRACTOR shall also be protected against claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of a workers' compensation law. This policy shall include an "all states" endorsement. The CONTRACTOR shall require each subcontractor similarly to provide Workers' Compensation Insurance for all of the latter's employees to be engaged in the WORK unless its employees are covered by the protection afforded by the CONTRACTOR's Workers' Compensation Insurance. In the event a class of employees is not protected under the Workers' Compensation Statute, the CONTRACTOR or Subcontractor, as the case may be, shall provide adequate employer's liability insurance for the protection of its employees not protected under the statute.

2. Comprehensive General Liability: This insurance shall be written in comprehensive form and shall protect the CONTRACTOR against all claims arising from injuries to persons, other than its employees, and

damage to property of the OWNER or others arising out of any act or omission of the CONTRACTOR or its agents, employees or subcontractors. The policy shall include the following endorsements: (1) Protective Liability endorsement to insure the contractual liability assumed by the CONTRACTOR under the indemnification provisions in these General Conditions; (2) Broad Form Property Damage endorsement; (3) Personal Injury endorsement to cover personal injury liability for intangible harm. The Comprehensive General Liability coverage shall contain no exclusion relative to blasting, explosion, collapse of building, or damage to underground structures.

3. Comprehensive Automobile Liability: This insurance shall be written in comprehensive form. The policy shall protect the CONTRACTOR against all claims for injuries to employees, members of the public and damage to property of others arising from the use of CONTRACTOR's motor vehicles, whether they are owned, non-owned, or hired, and whether used or operated on or off the site. The motor vehicle insurance required under this paragraph shall include: (a) motor vehicle liability coverage; (b) personal injury protection coverage and benefits; (c) uninsured motor vehicle coverage; and (d) underinsured motor vehicle coverage.

4. Subcontractor's Insurance: The CONTRACTOR shall require each of its subcontractors to procure and to maintain Comprehensive General Liability Insurance and Comprehensive Automobile Liability Insurance of the type and in the amounts specified in the Supplementary General Conditions or insure the activities of its subcontractors in the CONTRACTOR's own policy, in like amount.

5. Builder's Risk: This insurance shall be of the "all risk" type, shall be written in completed value form, and shall protect the CONTRACTOR, the OWNER, and the ENGINEER against damage to buildings, structures, materials and equipment. The amount of this insurance shall not be less than the insurable value of the WORK at completion. Builder's risk insurance shall provide for losses to be payable to the CONTRACTOR, the OWNER, and the ENGINEER as their interests may appear. The policy shall contain a provision that in the event of payment for any loss under the coverage provided, the insurance company shall have no rights of recovery against the CONTRACTOR, the OWNER, or the ENGINEER. The Builder's Risk policy shall insure against all risks of direct physical loss or damage to property from any external cause including flood and earthquake. Allowable exclusions, if any, shall be as specified in the Supplementary General Conditions.

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.01 SUPERVISION AND SUPERINTENDENCE

A. The CONTRACTOR shall supervise and direct the WORK competently and efficiently, devoting the attention and applying the skills and expertise necessary to perform the WORK in accordance with the Contract Documents. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction and safety precautions and programs incidental thereto. The CONTRACTOR shall be responsible to see that the finished WORK complies accurately with the Contract Documents.

B. The CONTRACTOR shall employ the superintendent named in "Information Required of Bidder" on the work site at all times during the progress of the WORK. The superintendent shall not be replaced without the OWNER's written consent. The superintendent will be the CONTRACTOR's representative at the site and shall have authority to act on behalf of the CONTRACTOR. All communications given to the superintendent shall be as binding as if given to the CONTRACTOR. The CONTRACTOR shall issue all its communications to the OWNER through the ENGINEER.

C. The CONTRACTOR's superintendent, or OWNER approved representative shall be present at the site of the WORK at all times while work is in progress. Failure to observe this requirement shall be considered suspension of the WORK by the CONTRACTOR until the superintendent is again present at the site.

6.02 LABOR, MATERIALS, AND EQUIPMENT

A. The CONTRACTOR shall provide skilled, competent and suitably qualified personnel to survey and lay out the WORK and perform construction as required by the Contract Documents. The CONTRACTOR shall at all times maintain good discipline and order at the site.

B. Except in connection with the safety or protection of persons at the WORK, or property at the site or adjacent thereto, all work at the site shall be performed during regular working hours (7:00 a.m. – 6:00 p.m., Monday through Friday), and the CONTRACTOR will not permit overtime work or the performance of work on Saturday, Sunday or any legal holiday observed by the OWNER without the OWNER's written consent given after prior written notice to the ENGINEER. Except as otherwise provided in this Paragraph, the CONTRACTOR shall receive no additional compensation for overtime work, i.e., work in excess of 8 hours in any one calendar day or 40 hours in any one calendar week, even though such overtime work may be required under emergency conditions and may be ordered by the ENGINEER in writing. Additional compensation will be paid the CONTRACTOR for

overtime work in the event extra work is ordered by the ENGINEER and the Change Order specifically authorizes the use of overtime work, but only to the extent that the CONTRACTOR pays overtime wages on a regular basis being paid (>40 hours per week) for overtime work of a similar nature in the same locality.

C. All costs of inspection and testing performed during overtime work approved solely for the convenience of the CONTRACTOR shall be borne by the CONTRACTOR. The OWNER shall have the authority to deduct the costs of all inspection and testing from any partial payments otherwise due to the CONTRACTOR.

D. Unless otherwise specified in the Contract Documents, the CONTRACTOR shall furnish, erect, maintain and remove the construction plant, and temporary works and assume full responsibility for all materials, equipment, labor, transportation, construction equipment, machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities and all other facilities and incidentals necessary for the furnishing, performance testing, start-up and completion of the WORK.

E. All materials and equipment incorporated into the WORK shall be of new and good quality, except as otherwise provided in the Contract Documents. If required by the ENGINEER, the CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. The CONTRACTOR shall apply, install, connect, erect, use, clean, and condition all material and equipment in accordance with the instructions of the manufacturer and Supplier except as otherwise provided in the Contract Documents.

6.03 ADJUSTING PROGRESS SCHEDULE

A. The CONTRACTOR shall submit any adjustments in the progress schedule to the ENGINEER for acceptance in accordance with the provisions for "Contractor Submittals" in the General Requirements.

6.04 SUBSTITUTES AND "OR-EQUAL" ITEMS

A. The CONTRACTOR shall submit proposed substitutes and "or-equal" items in accordance with the provisions for "Contractor Submittals" in the General Requirements.

6.05 SUBCONTRACTORS, SUPPLIERS, AND OTHERS

A. The CONTRACTOR shall be responsible to the OWNER and the ENGINEER for the acts and omissions of its subcontractors and their employees to the same extent as the CONTRACTOR is responsible for the acts and omissions of its own employees. Nothing contained in this paragraph shall create any contractual relationship between any subcontractor and the OWNER or the

ENGINEER nor relieve the CONTRACTOR of any liability or obligation under the Agreement.

6.06 PERMITS

A. Unless otherwise provided in the Supplementary General Conditions, the CONTRACTOR shall obtain and pay for all construction permits and licenses from the agencies having jurisdiction, including furnishing the insurance and bonds required by such agencies. The costs incurred by the CONTRACTOR in compliance with this paragraph shall not be made the basis for claims for additional compensation. The OWNER shall assist the CONTRACTOR, when necessary, in obtaining such permits and licenses. The CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the WORK, which are applicable at the time of opening of Bids, including all utility connection charges for utilities required by the WORK.

B. The CONTRACTOR shall pay all license fees and royalties and assume all costs when any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others when issued in the construction of the WORK or incorporated into the WORK. If a particular invention, design, process, product, or device is specified in the Contract Documents for incorporation into or use in the construction of the WORK and if to the actual knowledge of the OWNER or the ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of these rights shall be disclosed by the OWNER in the Contract Documents. The CONTRACTOR shall indemnify, defend and hold harmless the OWNER and the ENGINEER and anyone directly or indirectly employed by either of them from and against all claims, damages, losses, and expenses (including attorneys' fees and court costs) arising out of any infringement of patent rights or copyrights incident to the use in the performance of the WORK or resulting from the incorporation in the WORK of any invention, design, process, product, or device not specified in the Contract Documents.

6.07 LAWS AND REGULATIONS

A. The CONTRACTOR shall observe and comply with all Laws and Regulations which in any manner affect those engaged or employed on the WORK, the materials used in the WORK, or the conduct of the WORK. If any discrepancy or inconsistency should be discovered in the Contract Documents in relation to any Laws or Regulations, the CONTRACTOR shall report the same in writing to the ENGINEER. Notwithstanding any immunity otherwise provided by applicable workers' compensation statutes, the CONTRACTOR shall indemnify, defend and hold harmless the OWNER, the ENGINEER and their officers, agents, and employees against all claims arising from violation of any Laws or Regulations, by CONTRACTOR or by its

employees or subcontractors. This indemnity provision is intended to provide the greatest protection of the OWNER and ENGINEER allowed by law. Any particular law or regulation specified or referred to elsewhere in the Contract Documents shall not in any way limit the obligation of the CONTRACTOR to comply with all other provisions of federal, state, and local laws and regulations.

6.08 EQUAL OPPORTUNITY

A. The CONTRACTOR agrees not to discriminate against anyone because of race, national origin, ancestry, color, religion, sex, age, or disability. The CONTRACTOR agrees to abide by all applicable civil rights Laws and Regulations.

B. CONTRACTOR shall become familiar with, and strictly comply with, any and all employment verification requirements applicable to the OWNER and applicable to CONTRACTOR or any subcontractor or Supplier. CONTRACTOR shall assure that all subcontracts relating to the WORK contain a similar mandate. CONTRACTOR shall take all reasonable steps to assure compliance by all subcontractors on the WORK. CONTRACTOR shall regularly confirm the compliance of all subcontractors on the WORK. CONTRACTOR and all subcontractors on the WORK shall maintain records that will allow the OWNER to confirm compliance and make them available to the OWNER upon request.

6.09 TAXES

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

6.10 USE OF PREMISES

A. The CONTRACTOR shall confine construction equipment, stored materials and equipment, and other operations of workers to (1) the Project site, (2) the land and areas identified for the CONTRACTOR's use in the Contract Documents, and (3) other lands whose use is acquired by Laws and Regulations, rights-of-way, permits, and easements. The CONTRACTOR shall be fully responsible to the owner and occupant of such lands for any damage to the lands or areas contiguous thereto, resulting from the performance of the WORK or otherwise. Should any claim be made against the OWNER or the ENGINEER by owner or occupant of lands because of the performance of the WORK, the CONTRACTOR shall promptly settle the claim by agreement, or resolve the claim through litigation. The CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify, defend, and hold the OWNER and the ENGINEER

harmless from and against all claims, damages, losses, and expenses (including, but not limited to, fees of engineers, architects, attorneys, and other professionals and court costs) arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any owner or occupant of land against the OWNER or the ENGINEER to the extent the claim is based or arises out of the CONTRACTOR's performance of the WORK.

6.11 SAFETY AND PROTECTION

A. The CONTRACTOR shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the WORK. The CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. All persons on or near the work site and other persons and organizations who may be affected by activities on or near the work site.

2. All the WORK and materials and equipment to be incorporated therein, whether in storage on or off the site; and

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

B. The CONTRACTOR shall comply with all applicable Laws and Regulations (whether referred to herein or not) of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury, or loss and shall erect and maintain all necessary safeguards for such safety and protection. The CONTRACTOR shall notify owners of adjacent property and utilities when prosecution of the WORK may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. Unless the CONTRACTOR otherwise designates in writing a different individual as the responsible individual, the CONTRACTOR's superintendent shall be CONTRACTOR's representative at the site whose duties shall include providing all persons on the work site with a reasonably safe environment and the prevention of accidents.

6.12 SHOP DRAWINGS AND SAMPLES

A. After checking and verifying all field measurements and after complying with the applicable procedures specified in the General Requirements, the CONTRACTOR shall submit all shop drawings to the ENGINEER for

review and approval in accordance with the approved schedule for shop drawings submittals specified in the General Requirements.

B. The CONTRACTOR shall also submit to the ENGINEER for review and approval all samples in accordance with the approved schedule of sample submittals specified in the General Requirements.

C. Before submitting shop drawings or samples, the CONTRACTOR shall determine and verify all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereto and review or coordinate each shop drawing or sample with other shop drawings and samples and with the requirements of the WORK and the Contract Documents. The CONTRACTOR shall stamp each shop drawing, certifying his review. If the same shop drawings require re-submittal more than two times, the CONTRACTOR shall pay for the costs of ENGINEER's and OWNER's subsequent review(s).

6.13 CONTINUING THE WORK

A. The CONTRACTOR shall carry on the WORK and adhere to the progress schedule during all disputes or disagreements with the OWNER. No work shall be delayed or postponed pending resolution of any dispute or disagreement, except as the CONTRACTOR and the OWNER may otherwise mutually agree in writing.

6.14 INDEMNIFICATION

A. To the extent that the OWNER and/or ENGINEER, and their respective trustees, officers and employees are not otherwise defended and fully indemnified under a policy of liability insurance, and to the fullest extent allowed by law, CONTRACTOR shall defend, indemnify and hold OWNER and ENGINEER and its officers, trustees and employees harmless, including costs and attorneys' fees, from any claim, demand, action or cause of action: (i) alleging that OWNER or ENGINEER was at fault in selecting CONTRACTOR for the WORK; or (ii) alleging that OWNER or ENGINEER was at fault in failing to supervise, inspect, direct, instruct, warn or otherwise manage or control CONTRACTOR, or (iii) alleging that OWNER or ENGINEER knew of, should have known of, or had constructive knowledge of a dangerous condition created by CONTRACTOR or any employee, agent or subcontractor of CONTRACTOR; or (iv) alleging OWNER or ENGINEER is vicariously liable for acts or omissions of CONTRACTOR or any employee, agent or subcontractor of CONTRACTOR (under the Peculiar Risk Doctrine or otherwise). This defense and indemnity obligation is not intended to hold OWNER or ENGINEER or their respective officers, trustees, or employees harmless from any claim that is not derivative of CONTRACTOR as described. In no event shall any fault of CONTRACTOR or CONTRACTOR's employees be reapportioned to OWNER or ENGINEER or their respective officers, trustees or employees. CONTRACTOR shall indemnify

and hold OWNER and ENGINEER and their respective officers, trustees and employees harmless from any such reapportionment of fault. The described duty to defend and indemnify is not intended to run to the benefit of any liability insurer to the extent such insurer would be responsible for defense costs or indemnity beyond the deductibles or self insured retentions of OWNER and/or ENGINEER.

B. The CONTRACTOR shall reimburse the OWNER, and the ENGINEER for all costs and expense, (including but not limited to fees and charges of engineers, architects, attorneys, and other professional and court costs) incurred by the OWNER, and the ENGINEER in enforcing the provisions of this Paragraph.

C. The indemnification obligation under this Paragraph shall not be limited in any way by any limitation of the amount or type of damages, compensation, or benefits payable by or for the CONTRACTOR or any such subcontractor or other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts.

6.15 CONTRACTOR'S DAILY REPORTS

A. The CONTRACTOR shall complete a daily report indicating manpower, major equipment, subcontractors, weather conditions, etc., involved in the performance of the WORK. The daily report shall be completed on forms prepared by the CONTRACTOR and acceptable to the ENGINEER, and shall be submitted to the ENGINEER at the conclusion of each workday.

6.16 ASSIGNMENT OF CONTRACT

A. The CONTRACTOR shall not assign, sublet, sell, transfer, or otherwise dispose of the Agreement or any portion thereof, or its right, title, or interested therein, or obligations thereunder, without the written consent of the OWNER except as imposed by law. If the CONTRACTOR violates this provision, the Agreement may be terminated at the option of the OWNER. In such event, the OWNER shall be relieved of all liability and obligations to the CONTRACTOR and to its assignee or transferee, growing out of such termination.

ARTICLE 7 – OTHER WORK

7.01 RELATED WORK

A. The OWNER may perform other work related to the Project at the site by the OWNER's own forces, have other work performed by utility owners, or let other direct contracts for the performance of the other work which may contain General Conditions similar to these. If the fact that such other work is to be performed was not noted in the Contact Documents, written notice thereof will be given to the CONTRACTOR prior to commencing any other work.

B. The CONTRACTOR shall afford each utility owner and other contractor who is a party to a direct contract (or the OWNER, if the OWNER is performing the additional work with the OWNER's employees) proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of the other work. The CONTRACTOR shall properly connect and coordinate the WORK with the other work. The CONTRACTOR shall do all cutting, fitting, and patching of the WORK that may be required to make its several parts come together properly and integrate with the other work. The CONTRACTOR shall not endanger any work of others by cutting, excavating, or otherwise altering their work and shall only cut or alter their work with the written consent of the ENGINEER and the others whose work will be affected.

C. If the proper execution or results of any part of the CONTRACTOR's work depends upon the integration of work with the completion of other work by any other contractor or utility owner (or the OWNER), the CONTRACTOR shall inspect and report to the ENGINEER in writing all delays, defects, or deficiencies in the other work that renders it unavailable or unsuitable for proper integration with the CONTRACTOR's work. Except for the results or effects of material latent defects and deficiencies in the other work which could not reasonably have been discovered by the CONTRACTOR, the CONTRACTOR's failure to report will constitute an acceptance of the other work as fit and proper for integration with the CONTRACTOR's work and as a waiver of any claim for additional time or compensation associated with the integration of the CONTRACTOR's work with the other work.

7.02 COORDINATION

A. If the OWNER contracts with others for the performance of other work on the Project at the site, a coordinator will be identified to the extent that the coordinator can be identified at this time, in the Supplementary General Conditions and delegated the authority and responsibility for coordination of the activities among the various contractors. The specific matters over which the coordinator has authority and the extent of the coordinator's authority and responsibility will be itemized in the Supplementary General Conditions or in a notice to the CONTRACTOR at such time as the identity of the coordinator is determined.

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 COMMUNICATIONS

A. The OWNER shall issue all its communications to the CONTRACTOR through the ENGINEER.

8.02 PAYMENTS

A. The OWNER shall make payments to the CONTRACTOR as provided in Article 14.

8.03 LANDS, EASEMENTS, AND SURVEYS

A. The OWNER's duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. The OWNER shall identify and make available to the CONTRACTOR copies of exploration reports and subsurface conditions tests at the site and in existing structures which have been utilized by the ENGINEER in preparing the Drawings and Technical Specifications as set forth in Paragraph 4.02.

8.04 CHANGE ORDERS

A. The OWNER shall execute approved Change Orders for the conditions described in Paragraph 10.01D.

B. When funds are not budgeted to support continuation of performance in a subsequent fiscal period, the contract shall be canceled and the contractor shall be reimbursed for the reasonable value of any non-recurring costs incurred but not amortized in the price of the supplies or services delivered under the contract.

8.05 INSPECTIONS AND TESTS

A. The OWNER's responsibility with respect to inspection, tests, and approvals is set forth in Paragraph 13.03B.

8.06 SUSPENSION OF WORK

A. In connection with the OWNER's right to stop work or suspend work, see Paragraphs 13.04 and 15.01. Paragraphs 15.02 and 15.03 deal with the OWNER's right to terminate services of the CONTRACTOR under certain circumstances.

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 OWNER'S REPRESENTATIVE

A. The ENGINEER will be the OWNER's representative during the construction period. The duties, responsibilities and the limitations of authority of the ENGINEER as the OWNER's representative during construction are set forth in a separate agreement with the OWNER and are summarized hereafter.

9.02 VISITS TO SITE

A. The ENGINEER will make visits to the site during construction to observe and inspect the progress and quality of the WORK and to determine, in general if the WORK is proceeding in accordance with the Contract Documents.

9.03 PROJECT REPRESENTATIVE

A. The ENGINEER will furnish a Project Representative to observe and inspect the performance of the WORK. The Project Representative and/or other authorized agents of the ENGINEER shall serve as the primary contact(s) with the Contractor during the construction phase. All submittals shall be delivered to, and communications between the ENGINEER and the CONTRACTOR shall be handled by, the Project Representative and/or other authorized agents. The Project Representative shall be the primary authorized representative of the OWNER and the ENGINEER in all on-site relations with the CONTRACTOR.

9.04 CLARIFICATIONS AND INTERPRETATIONS

A. The ENGINEER will issue, with reasonable promptness written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as the ENGINEER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

9.05 AUTHORIZED VARIATIONS IN WORK

A. The ENGINEER may authorize minor variations in the WORK as described in the Contact Documents when such variations do not involve an adjustment in the Contract Price or the Contract Time and are consistent with the overall intent of the Contract Documents. These variations shall be accomplished by issuing a Field Order. The issuance of a Field Order requires the CONTRACTOR to perform the work described in the order promptly. If the CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Time and the parties are unable to agree as to the amount or extent thereof, the CONTRACTOR may make a claim therefor as provided in Article 11 and 12.

9.06 REJECTION OF DEFECTIVE WORK

A. The ENGINEER is authorized to reject work which the ENGINEER believes to be defective and require special inspection or testing of the WORK as provided in Paragraph 13.03G, whether or not the WORK is fabricated, installed, or completed.

9.07 CONTRACTOR SUBMITTALS, CHANGE ORDERS, AND PAYMENTS

A. The ENGINEER will review for approval all CONTRACTOR submittals, including shop drawings, samples, substitutes, and "or equal" items, etc., in accordance with the procedures set forth in the General Requirements.

B. In connection with the ENGINEER's responsibilities as to Change Orders, see Articles 10, 11, and 12.

C. In connection with the ENGINEER's responsibilities as to Applications for Payment, see Article 14.

9.08 DISPUTES, CLAIMS AND OTHER MATTERS

A. All claims, disputes, and other matters concerning the acceptability of the WORK, the interpretation of the requirements of the Contract Documents pertaining to the performance of the WORK, and claims for changes in the Contract Price or Contract Time under Articles 11 and 12 will be referred to the ENGINEER in writing with a request for formal decision in accordance with this paragraph. The ENGINEER will render a decision in writing within 30 days of receipt of the request. Written notice of each claim, dispute, or other matter will be delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 30 days) after the occurrence of the event. Written supporting data will be submitted to the ENGINEER with the written claim unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim.

B. When reviewing the claim or dispute, the ENGINEER will not show partiality to the OWNER or the CONTRACTOR and will incur no liability in connection with any interpretation or decision rendered in good faith. The ENGINEER's rendering of a decision with respect to any claim, dispute, or other matter (except any which have been waived by the making or acceptance of final payment as provided in Paragraph 14.12) shall be a condition precedent to the OWNER's or the CONTRACTOR's exercise of their rights or remedies under the Contract Documents or by Law or Regulations with respect to the claim, dispute, or other matter.

9.09 LIMITATION ON ENGINEER'S RESPONSIBILITIES

A. Neither the ENGINEER's authority to act pursuant to its agreement with the OWNER, nor the description of that authority under this Article 9, nor any other description of the ENGINEER's responsibility in the Contract Documents nor any decision made by the ENGINEER in good faith either to exercise or not exercise its authority shall give rise to any duty or responsibility on the part of the ENGINEER to the CONTRACTOR, any Subcontractor, any Supplier, any surety or any other person or organization performing any part of the WORK.

B. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," as allowed," "as reviewed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," or "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review, or judgement of the ENGINEER as to the WORK, it is intended that such requirement, direction, review, or judgment will be solely to evaluate the WORK for compliance with the Contract Documents, unless there is a specific statement indicating otherwise. The use of any such term or adjective shall not be effective to assign to the ENGINEER any duty or authority to supervise or direct the performance of the WORK or any duty or authority to undertake responsibility contrary to the provisions of its agreement with the OWNER.

C. The ENGINEER will not be responsible for the CONTRACTOR's means, methods, techniques, sequences, or procedures of construction not specified in the Contact Documents. Neither the OWNER nor the ENGINEER shall have any responsibility for safety precautions or programs on site or for the safety of CONTRACTOR's employees, Subcontractors, employees of Subcontractors, Suppliers, employees of Suppliers, or others on site.

D. The ENGINEER will not be responsible for the acts or omissions of the CONTRACTOR nor of any Subcontractor, Supplier, or any other person or organization performing any of the WORK to the extent that such acts or omissions are not reasonably discoverable considering the level of observation and inspection required by the ENGINEER's agreement with the OWNER.

ARTICLE 10 – CHANGES IN THE WORK

10.01 GENERAL

A. Without invalidating the Agreement and without notice to any surety, the OWNER may at any time or from time to time, order additions, deletions, or revisions in the WORK; these will be authorized by a written Field Order issued by the ENGINEER and/or a Change Order. Upon receipt of any of these documents, the CONTRACTOR shall promptly proceed with the work involved pursuant to the applicable conditions of the Contract Documents.

B. If the OWNER and the CONTRACTOR are unable to agree upon the increase or decrease in the Contract Price or an extension or shortening of the Contract Time, if any, that should be allowed as a result of a Field Order, a claim may be made therefor as provided in Articles 11 and 12.

C. The CONTRACTOR shall not be entitled to an increase in the Contract Price nor an extension of the Contract Time with respect to any work performed that is not required by the Contact Documents as amended, modified,

or supplemented by Change Order, except in the case of an emergency and except in the case of uncovering work provided in the Paragraph 13.03G.

D. The OWNER and the CONTRACTOR shall execute appropriate Change Orders covering:

1. Changes in the WORK which are ordered by the OWNER pursuant to Paragraph 10.01A;

2. Changes required because of acceptance of defective work under Paragraph 13.06;

3. Changes in the Contract Price or Contact Time which are agreed to by the parties; or

4. Any other changes agreed to by the parties.

5. Any construction contract change order which increases the contract amount shall have the prior written certification of the District's general manager that the expenditure of the change order amount is properly authorized by the District's board of trustees consistent with the District's budget and financial management policies and the instructions of the board of trustees.

E. If the provisions of any Bond require notice of any change to be given to a surety, the giving of these notices will be the CONTRACTOR's responsibility. The CONTRACTOR shall provide for the amount of each applicable Bond to be adjusted accordingly.

10.02 ALLOWABLE QUANTITY VARIATIONS

A. Whenever a unit price and quantity have been established for a bid item in the Contract Documents, the quantity stated may be increased or decreased to a maximum of 25 percent with no change in the unit price. An adjustment in the quantity in excess of 25 percent will be sufficient to justify a change in the unit price. All changes in the quantities of bid items shall be documented by Change Order.

B. In the event a part of the WORK is to be entirely eliminated and no lump sum or unit price is named in the Contract Documents to cover the eliminated work, the price of the eliminated work shall be agreed upon in writing by the OWNER and the CONTRACTOR. If the OWNER and the CONTRACTOR fail to agree upon the price of the eliminated work, the price shall be determined in accordance with the provisions of Article 11.

ARTICLE 11 – CHANGE OF CONTRACT PRICE

11.01 GENERAL

A. The Contact Price constitutes the total compensation payable to the CONTRACTOR for performing the WORK. Except as directed by Change Orders, all duties, responsibilities, and obligations assigned to or undertaken by the CONTRACTOR shall be at its expense without change in the Contract Price.

B. The Contract Price may only be changed by a Change Order. Any claim for an increase in the Contact Price shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 30 days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered with the claim, unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim, and shall be accompanied by the CONTRACTOR's written statement that the amount claimed covers all known amounts (direct, indirect, and consequential) to which the CONTRACTOR is entitled as a result of the occurrence of the event. If the OWNER and the CONTRACTOR cannot otherwise agree on the amount involved, all claims for adjustment in the Contract Price shall be determined by the ENGINEER in accordance with Paragraph 9.08A. No claim for an adjustment in the Contact Price will be valid if not submitted in accordance with this paragraph.

C. The value of any work covered by a Change Order or of any claim for an increase or decrease in the Contact Price shall be determined in one of the following ways:

1. Where the work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved.

2. By mutual acceptance of a lump sum, which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.

3. On the basis of the cost of work (determined as provided in Paragraphs 11.02 and 11.03) plus a CONTRACTOR's fee for overhead and profit (determined as provided in Paragraph 11.04).

11.02 COST OF WORK (BASED ON TIME AND MATERIALS)

A. General: The term "cost of work" means the sum of all costs necessarily incurred and paid by the CONTRACTOR for labor, materials, and equipment in the proper performance of work. Except as otherwise may be agreed to in writing by the OWNER, such costs shall be in amounts no higher than those prevailing in the locality of the Project.

B. Labor: The cost of labor used in performing work by the CONTRACTOR, a Subcontractor, or other forces will be the sum of the following:

1. The actual wages paid plus any employer payments to, or on behalf of workers for fringe benefits including health and welfare, pension, vacation, and similar purposes. The cost of labor may include the rates paid to foremen when determined by the ENGINEER that the services of foremen do not constitute a part of the overhead allowance.

2. All payments imposed by state and federal laws including, but not limited to, compensation insurance, and social security payments.

3. The amount paid for subsistence and travel required by collective bargaining agreements, or in accordance with the regular practice of the employer.

At the beginning of the extra work and as later requested by the ENGINEER, the CONTRACTOR shall furnish the ENGINEER proof of labor compensation rates being paid.

C. Materials: The cost of materials used in performing work will be the cost to the purchaser, whether CONTRACTOR or Subcontractor, from the Supplier thereof, except as the following are applicable:

1. Trade discounts available to the purchase shall be credited to the OWNER notwithstanding the fact that such discounts may not have been taken by the CONTRACTOR.

2. For materials secured by other than a direct purchase and direct billing to the purchaser, the cost shall be deemed to be the price paid to the actual Supplier as determined by the ENGINEER. Markup except for actual costs incurred in the handling of such materials will not be allowed.

3. Payment for materials from sources owned wholly or in part by the purchaser shall not exceed the price paid by the purchaser for similar materials from these sources on extra work items or current wholesale price for the materials delivered to the work site, whichever is lower.

4. If, in the opinion of the ENGINEER, the cost of material is excessive, or the CONTRACTOR does not furnish satisfactory evidence of the cost of the material, then the cost shall be deemed to be the lowest current wholesale price for the quantity concerned, delivered to the work site less trade discount. The OWNER reserves the right to furnish materials for the extra work and no claim shall be made by the CONTRACTOR for costs and profit on such materials.

D. Equipment: The CONTRACTOR will be paid for the use of equipment at the rental rate listed for the equipment specified in the Rental Rate Blue Book published by Dataquest, Inc. The rental rate will be used to compute

payments for equipment whether the equipment is under the CONTRACTOR's control through direct ownership, leasing, renting, or another method of acquisition. The rental rate to be applied for use of each item of equipment shall be the rate resulting in the least total cost to the OWNER for the total period of use.

1. All equipment shall, in the opinion of the ENGINEER, be in good working condition and suitable for the purpose for which the equipment is to be used.

2. Before construction equipment is used on the extra work, the CONTRACTOR shall plainly stencil or stamp an identifying number thereon at a conspicuous location, and shall furnish to the ENGINEER, in duplicate, a description of the equipment and its identifying number.

3. Unless otherwise specified, manufacturers' ratings and manufacturer-approved modifications shall be used to classify equipment for the determination of applicable rental rates. Equipment which has no direct power unit shall be powered by a unit of at least the minimum rating recommended by the manufacturer.

4. Individual pieces of equipment or tools having a replacement value of $100 or less, whether or not consumed by use, shall be considered to be small tools and no payment will be made therefore.

5. Rental time will not be allowed while equipment is inoperative due to breakdowns.

E. Equipment on the Work: The rental time to be paid for equipment used on the WORK shall be the time the equipment is in productive operation on the extra work being performed and, in addition, shall include the time required to move the equipment to the location of the extra work and return it to the original location or to another location that requires no more moving time than that required to return it to its original location. Moving time will not be paid if the equipment is used on other than the extra work, even though located at the site of the extra work. Loading and transporting costs will be allowed, in lieu of moving time, when the equipment is moved by means other than its own power. However, no payment will be made for loading and transporting costs when the equipment is used on other than the extra work even though located at the site of the extra work. The following shall be used in computing the rental time of equipment on the WORK.

1. When hourly rates are listed, any part of an hour less than 30 minutes of operation shall be considered to be 1/2-hour of operation, and any part of an hour in excess of 30 minutes will be considered one hour of operation.

2. When daily rates are listed, any part of a day less than 4 hours operation shall be considered to be 1/2-day of operation. When owner-operated equipment is used to perform extra work to be paid for on a time and materials basis, the CONTRACTOR will be paid for the equipment and operator, as set forth in Paragraph (3), (4), and (5), following.

3. Payment for the equipment will be made in accordance with the provisions in Paragraph 11.02D, herein.

4. Payment for the cost of labor and subsistence or travel allowance will be made at the rates paid by the CONTRACTOR to other workers operating similar equipment already on the WORK, or in the absence of such labor, established by collective bargaining agreements for the type of workmen and location of the extra work, whether or not the operator is actually covered by such an agreement. A labor surcharge will be added to the cost of labor described herein in accordance with the provisions of Paragraph 11.02B, herein, which surcharge shall constitute full compensation for payments imposed by state and federal laws and all payments made to on behalf of workers other than actual wages.

5. To the direct cost of equipment rental and labor, computed as provided herein, will be added the allowances for equipment rental and labor as provided in Paragraph 11.04, herein.

11.03 SPECIAL SERVICES

A. Special work or services are defined as that work characterized by extraordinary complexity, sophistication, or innovation or a combination of the foregoing attributes which are unique to the construction industry. The following may be considered by the ENGINEER in making estimates for payment for special services:

1. When the ENGINEER and the CONTRACTOR, by agreement, determine that a special service or work is required which cannot be performed by the forces of the CONTRACTOR or those of any of its Subcontractors, the special service or work may be performed by an entity especially skilled in the work to be performed. After validation of invoices and determination of market values by the ENGINEER, invoices for special services or work based upon the current fair market value thereof may be accepted without complete itemization of labor, material, and equipment rental cost.

2. When the CONTRACTOR is required to perform work necessitating special fabrication or machining process in a fabrication or a machine shop facility away from the job site, the charges for that portion of the

work performed at the off-site facility may by agreement, be accepted as a special service and accordingly, the invoices from the work may be accepted without detailed itemization.

3. All invoices for special services will be adjusted by deducting all trade discounts offered or available, whether the discounts were taken or not. In lieu of the allowances for overhead and profit specified in Paragraph 11.04, herein, an allowance of 5 percent will be added to invoices for special services.

B. All work performed hereunder shall be subject to all of the provisions of the Contract Documents and the CONTRACTOR's sureties shall be bound with reference hereto as under the original Agreement. Copies of all amendments to surety bonds or supplemental surety bonds shall be submitted to the OWNER for review prior to the performance of any work hereunder.

11.04 CONTRACTOR'S FEE

A. Work ordered on the basis of time and materials will be paid for at the actual necessary cost as determined by the ENGINEER, plus allowances for overhead and profit. For extra work involving a combination of increases and decreases in the WORK, the actual necessary cost will be the arithmetic sum of the additive and deductive costs. The allowance for overhead and profit shall include full compensation for superintendence, bond and insurance premiums, taxes, office expenses, and all other items of expense or cost not included in the cost of labor, materials, or equipment provided for under Paragraphs 11.02B, C, and D herein, including extended overhead and home office overhead. The allowance for overhead and profit will be made in accordance with the following schedule:

OVERHEAD AND PROFIT ALLOWANCE

Labor .....10 percent

Materials .....10 percent

Equipment .....10 percent

B. It is understood that labor, materials, and equipment may be furnished by the CONTRACTOR or by a Subcontractor, and that the allowance specified herein shall be applied to the labor, materials, and equipment costs of the Subcontractor, to which the CONTRACTOR may add five percent of the Subcontractor's total cost of work. Regardless of the number of hierarchical tiers of Subcontractors, the five- percent markup may be applied one time only for each separate work transaction.

ARTICLE 12 – CHANGE OF CONTRACT TIME

12.01 GENERAL

A. The Contract Time may only be changed by a Change Order. Any claim for an extension of the Contract time shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 30 days) after the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered within 30 days after such occurrence (unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the CONTRACTOR's written statement that the adjustment claimed is the entire adjustment to which the CONTRACTOR has reason to believe it is entitled as a result of the occurrence of said event. Claims for adjustment in the Contract Time shall be determined by the ENGINEER in accordance with Paragraph 9.08 if the OWNER and the CONTRACTOR cannot otherwise agree. No claim for an adjustment in the Contract Time will be valid if not submitted in accordance with the requirements of this paragraph.

B. The Contract Time will be extended in an amount equal to time lost if the CONTRACTOR makes a claim as provided in Paragraph 12.01A and the ENGINEER determines that the delay was caused by events beyond the control of the CONTRACTOR. Examples of events beyond the control of the CONTRACTOR include acts or neglect by the OWNER or others performing additional work as contemplated by Article 7, or by acts of God or of the public enemy, fire, floods, epidemics, quarantine restrictions, strikes, labor disputes, sabotage, or freight embargoes.

C. All time limits stated in the Contract Documents are of the essence.

D. None of the aforesaid time extensions shall entitle the CONTRACTOR to any adjustment in the Contract Price or any damages for delay. Furthermore, the CONTRACTOR hereby indemnifies and holds harmless the OWNER and ENGINEER, their officers, agents and employees from and against all claims, damages, losses and expenses (including lost property and attorney's fees) arising out of or resulting from the temporary suspension of work whether for the OWNER's convenience as defined in Article 15.01A or for whatever other reasons including the stoppage of work by the ENGINEER for the CONTRACTOR's failure to comply with any order issued by the ENGINEER.

12.02 EXTENSIONS OF THE TIME FOR DELAY DUE TO INCLEMENT WEATHER

A. "Inclement weather" is any weather condition or conditions resulting immediately therefrom, causing the CONTRACTOR to suspend construction operations or preventing the CONTRACTOR from proceeding with at least 75 percent of the normal labor and equipment force engaged on the WORK.

B. Should the CONTRACTOR prepare to begin work at the regular starting time at the beginning of any regular work shift on any day on which inclement weather, or its effects on the condition of the WORK prevents work from beginning at the usual starting time and the crew is dismissed as a result thereof, the CONTRACTOR will not be charged for a working day whether or not conditions change thereafter during the day and the major portion of the day could be considered to be suitable for construction operations.

C. The CONTRACTOR shall base its construction schedule upon the inclusion of the number of days of inclement weather specified in the Supplementary General Conditions. No extension of the Contact Time due to inclement weather will be considered until after the stated number of days of inclement weather has been reached. However, no reduction in Contract Time will be made if the number of inclement weather days is not reached.

12.03 EXTENSIONS OF TIME FOR OTHER DELAYS

A. If the CONTRACTOR is delayed in completion of the WORK beyond the Contract Time, by acts of God or of the public enemy, fire, floods, epidemics, quarantine restrictions, strikes, labor disputes, industry-wide shortage of raw materials, sabotage or freight embargoes, the CONTRACTOR shall be entitled to an adjustment in the Contract Time. No such adjustment will be made unless the CONTRACTOR shall notify the ENGINEER in writing of the causes of delay within 15 calendar days from the beginning of any such delay. The ENGINEER shall ascertain the facts and the extent of the delay. No adjustment in time shall be made for delays resulting from noncompliance with the Contract Documents, accidents, failure on the part of the CONTRACTOR to carry out the provisions of the Contract Documents including failure to provide materials, equipment or workmanship meeting the requirements of the Contract Documents; the occurrence of such events shall not relieve the CONTRACTOR from the necessity of maintaining the required progress.

B. If the CONTRACTOR is delayed in completing the WORK beyond the Contract Time by reason of shortages of raw materials required for CONTRACTOR-furnished items, the CONTRACTOR shall be entitled to an adjustment in the Contract Time in like manner as if the WORK had been suspended for the convenience and benefit of the OWNER; provided, however, that the CONTRACTOR shall furnish documentation acceptable to the OWNER and ENGINEER that he placed or attempted to place firm orders with Suppliers at a reasonable time in advance of the required date of delivery of the items in question, that such shortages shall have developed following the date such orders were placed or attempts made to place same, that said shortages are general throughout the affected industry, that said shortages are shortages of raw materials required to manufacture CONTRACTOR-furnished items and not simply failure of CONTRACTOR's Suppliers to manufacture, assemble or ship items on time, and that the

CONTRACTOR shall, to the degree possible, have made revisions in the sequence of his operations, within the terms of the Contract Documents, to offset the expected delay. The CONTRACTOR shall notify the ENGINEER, in writing, concerning the cause of delay, within 15 calendar days of the beginning of such delay. The validity of any claim by the CONTRACTOR to an adjustment in the Contract Time shall be determined by the OWNER acting through the ENGINEER, and his findings thereon shall be based on the ENGINEER's knowledge and observations of the events involved and documentation submitted by the CONTRACTOR, showing all applicable facts relative to the foregoing provisions. Only the physical shortage of raw materials will be considered under these provisions as a cause for adjustment of time and no consideration will be given to any claim that items could not be obtained at a reasonable, practical, or economical cost or price, unless it is shown to the satisfaction of the OWNER that such items could have been obtained only at exorbitant prices entirely out of line with current rates taking into account the quantities involved and the usual practices in obtaining such quantities.

C. If the CONTRACTOR is delayed in completion of the WORK by any act of the ENGINEER or of the OWNER not authorized by the Contract Documents, an adjustment in the Contract Time will be made by the OWNER in like manner as if the WORK had been suspended for the convenience and benefit of the OWNER. In the event of such delay, the CONTRACTOR shall notify the ENGINEER in writing of the causes of delay within 15 calendar days from the beginning of any such delay.

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

13.01 WARRANTY, GUARANTEE AND CORRECTION PERIOD

A. The CONTRACTOR warrants and guarantees to the OWNER and the ENGINEER that all work, equipment, materials and workmanship are in accordance with the Contract Documents and are not defective. Reasonably prompt notice of defects discovered by the OWNER or ENGINEER shall be given to the CONTRACTOR. All defective work, whether or not in place, may be rejected, corrected, or accepted as provided in this Article 13.

B. If within one (1) year after the date of final completion, as set by the Contractor’s Certificate of Final Completion, or a longer period of time prescribed by Laws or Regulations or by the terms of any applicable special guarantee or specific provisions of the Contract Documents, any part of the WORK is found to be defective, the OWNER shall notify the CONTRACTOR in writing and the CONTRACTOR shall promptly, without cost to the OWNER and in accordance with the OWNER's written notification, either correct the defective work, or, if it has been rejected by the OWNER, remove it from the

site and replace it with non-defective work. In the event the CONTRACTOR does not promptly comply with the notification, or in an emergency where delay would cause serious risk of loss or damage, the OWNER may have the defective work corrected or rejected work removed and replaced. All direct, indirect, and consequential costs of the removal and replacement including but not limited to fees and charges of engineers, architects, attorneys and other professionals will be paid by the CONTRACTOR. This paragraph shall not be construed to limit nor diminish the CONTRACTOR's absolute guarantee to complete the WORK in accordance with the Contract Documents.

13.02 ACCESS TO WORK

A. The ENGINEER, other representatives of the OWNER, testing agencies, and governmental agencies with jurisdictional interests shall have access to the work at reasonable times for their observation, inspections, and testing. The CONTRACTOR shall provide proper and safe conditions for their access.

13.03 TESTS AND INSPECTIONS

A. The CONTRACTOR shall give the ENGINEER timely notice of readiness of the WORK for all required inspections, tests, or approvals.

B. If Laws or Regulations of any public body other than the OWNER, with jurisdiction over the WORK require any work to be specifically inspected, tested, or approved, the CONTRACTOR shall pay all costs in connection therewith. The CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with the OWNER's or the ENGINEER's acceptance of a Supplier of materials or equipment proposed as a substitution or "or-equal" to be incorporated in the WORK and of materials or equipment submitted for review prior to the CONTRACTOR's purchase for incorporation in the WORK. The cost of all inspections, tests, and approvals, with the exception of the above which are required by the Contract Documents, shall be paid by the OWNER (unless otherwise specified).

C. The ENGINEER will make, or has made, such inspections and test as the ENGINEER deems necessary to see that the WORK is being accomplished in accordance with the Contract Documents. The CONTRACTOR, without additional cost to the OWNER, shall provide the labor and equipment necessary to make the WORK available for inspections. Unless otherwise specified in the Supplementary General Conditions, all other costs of inspection and testing will be borne by the OWNER. In the event the inspections or tests reveal non-compliance with the requirements of the Contract Documents, the CONTRACTOR shall bear the cost of corrective measures deemed necessary by the ENGINEER, as well as the cost of

subsequent re-inspection and retesting. Neither observations by the ENGINEER nor inspections, tests, or approvals by others shall relieve the CONTRACTOR from the CONTRACTOR's obligation to perform the WORK in accordance with the Contract Documents.

D. All inspections, tests, or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by properly licensed organizations selected by the OWNER.

E. If any work (including the work of others) that is to be inspected, tested, or approved is covered without the ENGINEER's written authorization, it must, if requested by the ENGINEER, be uncovered for testing, inspection, and observation. The uncovering shall be at the CONTRACTOR's expense unless the CONTRACTOR timely notified the ENGINEER of the CONTRACTOR's intention to cover the same and the ENGINEER failed to act with reasonable promptness in response to the notice.

F. If any work is covered contrary to the written request of the ENGINEER, it must, if requested by the ENGINEER, be uncovered for the ENGINEER's observation at the CONTRACTOR's expense.

G. If the ENGINEER considers it necessary or advisable that covered work be observed, inspected or tested by the ENGINEER or others, the ENGINEER shall direct the CONTRACTOR to uncover, expose, or otherwise make available for observation, inspection, or testing that portion of the work in question. The CONTRACTOR shall comply with the ENGINEER's direction and furnish all necessary labor, material, and equipment. If the work is defective, the CONTRACTOR shall bear all direct, indirect and consequential costs of uncovering, exposure, observation, inspection, and testing and of satisfactory reconstruction of the work, including, but not limited to, fees and charges for engineers, architects, attorneys, and other professionals. However, if the work is not defective, the CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Time, or both. The increase in Contract Time and Contract Price shall be the CONTRACTOR's actual time and costs directly attributable to uncovering and exposing the work. If the parties are unable to agree as to the amount or extent of the changes, the CONTRACTOR may make a claim therefor as provided in Articles 11 and 12.

13.04 OWNER MAY STOP THE WORK

A. If the WORK is defective, or the CONTRACTOR fails to perform work in such a way that the completed WORK will conform to the Contract Documents, the OWNER may order the CONTRACTOR to stop the WORK, or any portion thereof, until the cause for the order has been eliminated. This right of the OWNER to stop the WORK shall not give rise to any duty on

the part of the OWNER to exercise this right for the benefit of the CONTRACTOR or any other party.

13.05 CORRECTION OR REMOVAL OF DEFECTIVE WORK

A. When directed by the ENGINEER, the CONTRACTOR shall promptly correct all defective work, whether or not fabricated, installed, or completed, or, if the work has been rejected by the ENGINEER, remove it from the site and replace it with non-defective work. The CONTRACTOR shall bear all direct, indirect and consequential costs of correction or removal, including but not limited to fees and charges of engineers, architects, attorneys, and other professionals made necessary thereby. If the CONTRACTOR does not correct the defective work within 30 days, the OWNER may correct the WORK and charge the CONTRACTOR for the cost of correcting the defective WORK.

13.06 ACCEPTANCE OF DEFECTIVE WORK

A. If, instead of requiring correction or removal and replacement of defective work, the OWNER prefers to accept the work, the OWNER may do so. The CONTRACTOR shall bear all direct, indirect, and consequential costs attributable to the OWNER's evaluation of and determination to accept the defective work. If any acceptance of defective work occurs prior to final payment, a Change Order will be issued incorporating the necessary revisions in the Contact Documents with respect to the WORK, and the OWNER shall be entitled to an appropriate decrease in the Contract Price.

ARTICLE 14 – PAYMENTS TO CONTRACTOR, LIQUIDATED DAMAGES AND COMPLETION

14.01 LUMP SUM BID

A. A schedule of values or lump sum price breakdown will serve as the basis for progress payments for a lump sum Bid and will be incorporated into the form of Application for Payment included in the Contract Documents.

14.02 UNIT PRICE BID

A. Progress payments for a unit price Bid will be based on the number of units completed.

14.03 APPLICATION FOR PROGRESS PAYMENT

A. Unless otherwise prescribed by the OWNER, on the 25th of each month, the CONTRACTOR shall submit to the ENGINEER for review and approval, an Application for Payment completed and signed by the CONTRACTOR covering the WORK completed as of the date of the Application and

accompanied by such supporting documentation as required by the Contract Documents.

B. The Application for Payment shall identify, as a sub-total, the amount of the CONTRACTOR's Total Earnings to Date, plus the Net Value of Materials On-site which have not yet been incorporated in the WORK.

C. The Net Payment Due to the CONTRACTOR shall be the above-mentioned sub-total, from which shall be deducted the retainage amount and the total amount of all previous payments made to the CONTRACTOR.

D. The OWNER may retain five percent of the amount otherwise due to the Contractor as retainage. Monies retained shall be placed in an interest-bearing account for the benefit of the CONTRACTOR.

E. Except as otherwise provided in the Supplementary General Conditions, the value of materials stored at the site shall be valued at 80 percent of the value of the materials. This amount shall be based upon the value of all acceptable materials and equipment stored at the site or at another location agreed to in writing by the OWNER; provided, each individual item has a value of more that $5000 and will become a permanent part of the WORK. The Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that the CONTRACTOR has received the materials and equipment free and clear of all liens, charges, security interests, and encumbrances (which are hereinafter referred to as "Liens") and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect the OWNER's interest therein, all of which will be satisfactory to the OWNER.

14.04 CONTRACTOR'S WARRANTY OF TITLE

A. The CONTRACTOR warrants and guarantees that title to all work, materials, and equipment covered by an Application for Payment, whether incorporated in the WORK or not, will pass to the OWNER no later than the time of final payment, free and clear of all liens.

14.05 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

A. The ENGINEER will, within 7 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to the OWNER, or return the Application to the CONTRACTOR indicating in writing the ENGINEER's reasons for refusing to recommend payment. In the latter case, the CONTRACTOR may make the necessary corrections and resubmit the Application. Thirty days after presentation of the Application for Payment with the ENGINEER's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.05B) become due and when due will be paid by the OWNER to the CONTRACTOR.

B. The OWNER may refuse to make payment of the full amount recommended by the ENGINEER to compensate for claims made by the OWNER on account of the CONTRACTOR's performance of the WORK or other items entitling the OWNER to a credit against the amount recommended, but the OWNER must give the CONTRACTOR written notice within 7 days (with a copy to the ENGINEER) stating the reasons for such action.

14.06 PARTIAL UTILIZATION

A. The OWNER may utilize or place into service any item of equipment or other usable portion of the WORK at any time prior to completion of the WORK. The OWNER shall notify the CONTRACTOR in writing of its intent to exercise this right. The notice will identify the equipment or specific portion or portions of the WORK to be utilized or otherwise placed into service.

B. It shall be understood by the CONTRACTOR that until such written notification is issued, all responsibility for care and maintenance of all items or portions of the WORK to be partially utilized shall be borne by the CONTRACTOR. Upon the issuance of a notice of partial utilization, the ENGINEER will deliver to the OWNER and the CONTRACTOR a written recommendation as to division of responsibilities between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities and insurance. Upon the OWNER's acceptance of these recommendations, the ENGINEER's aforesaid recommendation will be binding on the OWNER and the CONTRACTOR until final payment.

C. The CONTRACTOR shall retain full responsibility for satisfactory completion of the WORK, regardless of whether a portion thereof has been partially utilized by the OWNER, and the CONTRACTOR's one-year correction period shall commence only after the date of Final Completion for the WORK.

14.07 DAMAGES

A. The CONTRACTOR shall pay to the OWNER the amount specified in the Supplementary General Conditions, not as a penalty but as liquidated damages, if he fails to complete the WORK or specified parts of the WORK within the Contract Time. The periods for which these damages shall be paid shall be the number of Days from the Contract Time as contained in the Agreement, or from the date of termination of any extension of time approved by the OWNER, to the date or dates on which the ENGINEER issues the Notice of Substantial Completion as provided in Article 14.08, herein. The OWNER may deduct the amount of said damages from any monies due or to become due the CONTRACTOR. After Substantial Completion, if the CONTRACTOR fails to complete the remaining WORK within 45 days or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER the amount stated in the Supplementary General Conditions as liquidated damages for each day that expires after the 45 days, until readiness for final payment.

B. The said amount is fixed and agreed upon by and between the CONTRACTOR and the OWNER because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the OWNER would sustain; and said amount is agreed to be the amount of damages which the OWNER would sustain.

C. If actual damages are assessed, they will include all costs incurred by the OWNER as a result of a delay in the completion time of the work beyond the contract time.

D. All times specified in the Contract Documents are hereby declared to be of the essence.

14.08 SUBSTANTIAL COMPLETION

A. When the CONTRACTOR considers the WORK ready for its intended use, the CONTRACTOR will notify the OWNER and the ENGINEER in writing that the WORK is Substantially Complete. Within a reasonable time thereafter, the OWNER, the CONTRACTOR, and the ENGINEER shall make an inspection of the WORK to determine the status of completion. If the ENGINEER does not consider the WORK Substantially Complete, the ENGINEER will notify the OWNER and CONTRACTOR in writing giving the reasons therefor. If the ENGINEER considers the WORK Substantially Complete, the ENGINEER will prepare and deliver to the OWNER for its execution the Notice of Substantial Completion signed by the ENGINEER and CONTRACTOR, which shall fix the date of Substantial Completion.

B. The Notice of Substantial Completion shall be a release by the CONTRACTOR of the OWNER and its agents from all claims and liability to the CONTRACTOR for anything done or furnished for, or relating to, the WORK or for any act or neglect of the OWNER or of any person relating to or affecting the WORK, to the date of Substantial Completion, except demands against the OWNER for the remainder of the amounts kept or retained from progress payments and excepting pending, unresolved claims filed in writing prior to the date of Substantial Completion. At the time of delivery of the Notice of Substantial Completion, the ENGINEER will deliver to the OWNER and the CONTRACTOR, if applicable, a written recommendation as to division of responsibilities between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities and insurance. Upon the OWNER's acceptance of these recommendations, the ENGINEER's recommendation will be binding on the OWNER and the CONTRACTOR until final payment.

C. The OWNER, upon written notice to the CONTRACTOR, shall have the right to exclude the CONTRACTOR from the WORK after the date of Substantial Completion, and complete all or portions of the WORK at the CONTRACTOR's expense.

14.09 COMPLETION AND FINAL PAYMENT

A. Upon written certification from the CONTRACTOR that the WORK is complete (if a Notice of Substantial Completion has been issued this certification must occur within 45 days of that date), the ENGINEER will

make a final inspection with the OWNER and the CONTRACTOR. If the OWNER and ENGINEER do not consider the WORK complete, the ENGINEER will notify the OWNER and the CONTRACTOR in writing of all particulars in which this inspection reveals that the WORK is incomplete or defective. The CONTRACTOR shall immediately take the measures necessary to remedy these deficiencies. If the ENGINEER and OWNER consider the WORK complete, the CONTRACTOR may proceed to file its application for final payment pursuant to this Article. At the request of the CONTRACTOR, the ENGINEER may recommend to the OWNER that certain minor deficiencies in the WORK that do not prevent the entire WORK from being used by the OWNER for its intended use, and the completion of which will be unavoidably delayed due to no fault of the CONTRACTOR, be exempted from being completed prerequisite to final payment. These outstanding items of pickup work, or "punch list items", shall be listed on the Notice of Substantial Completion, together with the recommended time limits for their completion, and extended warranty requirements for those items and the value of such items.

B. After the issuance of the Notice of Completion and after the CONTRACTOR has completed corrections that have not been exempted to the satisfaction of the ENGINEER and delivered to the ENGINEER all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, marked-up record documents and other documents, all as required by the Contract Documents; and after the ENGINEER has indicated that the WORK is acceptable, the CONTRACTOR may make application for final payment following the procedure for progress payments. The final application for payment shall be accompanied by all documentation called for in the Contract Documents and other data and schedules as the OWNER or ENGINEER may reasonably require, including an affidavit of the CONTRACTOR that all labor, services, material, equipment and other indebtedness connected with the WORK for which the OWNER or his property might in any way be responsible, have been paid or otherwise satisfied, and a consent of the payment bond surety to final payment, all in forms approved by the OWNER.

14.10 FINAL APPLICATION FOR PAYMENT

A. If, on the basis of the ENGINEER's observation of the WORK during construction and final inspection, and the ENGINEER's review of the final application for payment and accompanying documentation, all as required by the Contract Documents, the ENGINEER is satisfied that the WORK has been completed and the CONTRACTOR has fulfilled all of his obligations under the Contract Documents, the ENGINEER will, within ten days after receipt of the final application for payment, indicate in writing his recommendation of payment and present the application to the OWNER for payment. Thereupon, the ENGINEER will give written notice to the OWNER and the CONTRACTOR that the WORK is acceptable by executing the

Notice of Completion. Otherwise, the ENGINEER will return the application to the CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case the CONTRACTOR shall make the necessary corrections and resubmit the application.

B. Within 45 calendar days after the Notice of Completion, the OWNER will make final payment including all deducted retainage and interest to the CONTRACTOR. The OWNER's remittance of final payment shall be the OWNER's acceptance of the WORK if formal acceptance of the WORK is not indicated otherwise. The final payment shall be that amount remaining after deducting all prior payments and all amounts to be kept or retained under the provisions of the Contract, including the following items:

1. Liquidated or actual damages, as applicable.

2. Two times the value of any outstanding items of pickup work or "punch list items", indicated on the ENGINEER's Notice of Completion as being yet uncompleted.

14.11 CONTRACTOR'S CONTINUING OBLIGATIONS

A. The CONTRACTOR's obligation to perform and complete the WORK in accordance with the Contract Documents shall be absolute. Neither recommendation of any progress or final payment by the ENGINEER, nor the issuance of a Notice of Substantial Completion or Notice of Completion, nor payment by the OWNER to the CONTRACTOR under the Contract Documents, nor any use or occupancy of the WORK or any part thereof by the OWNER, nor any act of acceptance by the OWNER nor any failure to do so, nor any review of a shop drawing or sample submittal, will constitute an acceptance of work or materials not in accordance with the Contract Documents or a release of the CONTRACTOR's obligation to perform the WORK in accordance with the Contract Documents.

14.12 FINAL PAYMENT TERMINATES LIABILITY OF OWNER

A. Final payment is defined as the last progress payment made to the CONTRACTOR for earned funds, less deductions listed in Paragraph 14.10B herein. The acceptance by the CONTRACTOR of the final payment referred to in Paragraph 14.10 herein, shall be a release of the OWNER and its agents from all claims of liability to the CONTRACTOR for anything done or furnished for, or relating to, the work or for any act or neglect of the OWNER or of any person relating to or affecting the work, except demands against the OWNER for the remainder, if any, of the amounts kept or retained under the provisions of Paragraph 14.10 herein; and excepting pending, unresolved claims filed prior to the date of the Notice of Substantial Completion.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 SUSPENSION OF WORK BY OWNER

A. The OWNER acting through the ENGINEER may, by written notice to the Contractor, temporarily suspend the WORK, in whole or in part, for a period or periods of time, but not to exceed 90 days, for the convenience and benefit of the OWNER upon the occurrence of any one or more of the following: (1) unsuitable weather; (2) delay in delivery of OWNER- furnished equipment or materials, or such other conditions as are considered unfavorable for prosecution of the work; (3) shortfall in construction funds; (4) constraints imposed by public entities, public utilities, property owners or legal proceedings; (5) failure or delay in acquisition of easements or right-of-way by the OWNER; or (6) other conditions which, in the opinion of the OWNER, warrant a delay in the WORK. Suspended WORK shall be resumed by the CONTRACTOR within 10 calendar days of receipt from the ENGINEER of written notice to resume work. Whenever the OWNER temporarily suspends work for any conditions enumerated in this Article, the CONTRACTOR shall be entitled to an adjustment in the Contract Time as specified in Article 12.03 C.

B. The suspension of work shall be effective upon receipt by the CONTRACTOR of a written order suspending the work and shall be terminated upon receipt by the Contractor of a written order terminating the suspension.

C. The CONTRACTOR hereby indemnifies and holds harmless the OWNER and ENGINEER, their officers, agents and employees, from and against all claims, damages, losses and expenses, including lost profits and attorney's fees, arising out of or resulting from the temporary suspension of the WORK, whether for the OWNER's convenience described in this Article or for whatever other reasons, including the stoppage of work by the ENGINEER for the CONTRACTOR's failure to comply with any order issued by the ENGINEER.

15.02 TERMINATION OF AGREEMENT BY OWNER (CONTRACTOR DEFAULT)

A. In the event of default by the CONTRACTOR, the OWNER may give written notice to the CONTRACTOR of OWNER's intent to terminate the Agreement. The notice shall state the event of default and the time allowed to remedy the default. It shall be considered a default by the CONTRACTOR whenever the CONTRACTOR shall: (1) declare bankruptcy, become insolvent, or assign its assets for the benefit of its creditors; (2) fail to provide materials or workmanship meeting the requirements of the Contract Documents; (3) disregard or violate provisions of the Contract Documents or ENGINEER's instructions, (4) fail to prosecute the WORK according to the approved progress schedule; or, (5) fail to provide a qualified superintendent,

competent workmen, or materials or equipment meeting the requirements of the Contract Documents. If the CONTRACTOR fails to remedy the conditions constituting default within the time allowed, the OWNER may then issue a Notice of Termination.

B. In the event the Agreement is terminated in accordance with Paragraph 15.02A, the OWNER may take possession of the WORK and may complete the WORK by whatever method or means the OWNER may select. The cost of completing the WORK shall be deducted from the balance which would have been due the CONTRACTOR had the Agreement not been terminated and the WORK completed in accordance with the Contract Documents. If such cost exceeds the balance which would have been due, the CONTRACTOR shall pay the excess amount to the OWNER. If such cost is less than the balance which would have been due, the CONTRACTOR shall have no claim to the difference.

15.03 TERMINATION OF AGREEMENT BY OWNER (FOR CONVENIENCE)

A. The OWNER may terminate the Agreement at any time if it is found that reasons beyond the control of either the OWNER or CONTRACTOR make it impossible or against the OWNER's interests to complete the WORK. In such a case, the CONTRACTOR shall have no claims against the OWNER except: (1) for the value of the work, as determined by the ENGINEER, performed by the CONTRACTOR up to the date the Agreement is terminated; and, (2) for the cost of materials and equipment on hand, in transit, or on definite commitment, as of the date the Agreement is terminated, which would be needed in the WORK and which meet the requirements of the Contract Documents. The value of work performed and the cost of materials and equipment delivered to the site, as mentioned above, shall be determined by the ENGINEER in accordance with the procedure prescribed from making the final application for payment and final payment under Paragraphs 14.09 and 14.10.

15.04 TERMINATION OF AGREEMENT BY CONTRACTOR

A. The CONTRACTOR may terminate the Agreement upon 10 days written notice to the OWNER, whenever: (1) the WORK has been suspended under the provisions of Paragraph 15.01, for more than 90 consecutive days through no fault or negligence of the CONTRACTOR, and notice to resume work or to terminate the agreement has not been received from the OWNER within this time period; or, (2) the OWNER should fail to pay the CONTRACTOR any monies due him in accordance with the terms of the Contract Documents and within 60 days after presentation to the OWNER by the CONTRACTOR of a request therefor, unless within said 10-day period the OWNER shall have remedied the condition upon which the payment delay was based. In the event of such termination, the CONTRACTOR shall have no claims against the OWNER except for those claims specifically

enumerated in Paragraph 15.03, and as determined in accordance with the requirements of that paragraph.

ARTICLE 16 – NOTICE

16.01 GIVING NOTICE

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

16.02 TITLE TO MATERIALS FOUND ON THE WORK

A. The OWNER reserves the right to retain title to all soils, stone, sand, gravel, and other materials developed and obtained from excavations and other operations connected with the WORK. Unless otherwise specified in the Contract Documents, neither the CONTRACTOR nor any Subcontractor shall have any right, title, or interest in or to any such materials. The CONTRACTOR will be permitted to use in the WORK, without charge, any such materials which meet the requirements of the Contract Documents.

16.03 RIGHT TO AUDIT

A. If the CONTRACTOR submits a claim to the OWNER for additional compensation, the OWNER shall have the right, as a condition to considering the claim, and as a basis for evaluation of the claim, and until the claim has been settled, to audit the CONTRACTOR's books. This right shall include the right to examine books, records, documents, and other evidence and accounting procedures and practices, sufficient to discover and verify all direct and indirect costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The right to audit shall include the right to inspect the CONTRACTOR's plants, or such parts thereof, as may be or have been engaged in the performance of the WORK. The CONTRACTOR further agrees that the right to audit encompasses all subcontracts and is binding upon subcontractors. The right to examine and inspect herein provided for shall be exercisable through such representatives as the OWNER deems desirable during the CONTRACTOR's normal business hours at the office of the CONTRACTOR. The CONTRACTOR shall make available to the OWNER for auditing, all relevant accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the OWNER.

16.04 HAZARDOUS MATERIALS

A. If the CONTRACTOR during the course of work observes the existence of hazardous material, the CONTRACTOR shall promptly notify the OWNER and the ENGINEER. The OWNER shall consult with the ENGINEER regarding removal or encapsulation of the hazardous material and the CONTRACTOR shall not perform any work pertinent to the hazardous material prior to receipt or special instruction from the OWNER through the ENGINEER.

ARTICLE 17 – SUBCONTRACT LIMITATIONS

17.01 SUBCONTRACT LIMITATIONS

A. In addition to the provisions of Paragraph 6.05 of the General Conditions, the CONTRACTOR shall perform not less than 20 percent of the WORK with its own forces (i.e., without subcontracting). The 20 percent requirement shall be understood to refer to the WORK, the value of which totals not less than 20 percent of the Contract Price.

ARTICLE 18 – PATENTS AND COPYRIGHTS

18.01 PATENTS AND COPYRIGHTS

A. The CONTRACTOR shall indemnify and save harmless the OWNER, the ENGINEER, and their officers, agents, and employees, against all claims or liability arising from the use of any patented or copyrighted design, device, material, or process by the CONTRACTOR or any of his subcontractors in the performance of the WORK.

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SUPPLEMENTARY GENERAL CONDITIONS

ARTICLE 1

1.01 GENERAL

A. These Supplementary General Conditions amend or supplement the General Conditions of the Contract and any other provisions of the Contract Documents as indicated herein. All provisions which are not so amended or supplemented remain in full force and effect.

B. The terms used in these Supplementary General Conditions which are defined in the General Conditions of the Contract have the meanings assigned to them in the General Conditions of the Contract herein.

1.02 SUPPLEMENTAL DEFINITIONS

A. ENGINEER: The ENGINEER is Hansen, Allen, & Luce, Inc., 859 W. South Jordan Parkway, Suite 200, South Jordan, Utah 84095.

B. OWNER'S REPRESENTATIVE: As designated by the OWNER. OWNER'S REPRESENTATIVE will provide decisions on contractual matters, recommend approval of Change Orders as recommended by the ENGINEER and represent the OWNER in policy matters.

ARTICLE 2

2.02 COPIES OF DOCUMENTS

Delete paragraph A in its entirety and replace with the following:

A. The OWNER shall furnish the CONTRACTOR one electronic copy of the Contract Documents (Specifications and Drawings).

ARTICLE 3

3.04 REUSE OF DOCUMENTS

Add the following new paragraph(s) immediately after Paragraph 3.04.B:

C. The Contract Documents are for official use only and are exempt from the Freedom of Information Act (FOIA) (exemption 2).

ARTICLE 4

4.02 PHYSICAL CONDITIONS – SUBSURFACE AND EXISTING STRUCTURES

Add the following new paragraph(s) immediately after Paragraph 4.02.C:

D. In the preparation of the Drawings and Specifications, ENGINEER relied upon the following drawings of physical conditions in or relating to existing surface and subsurface structures at or contiguous to the Site:

1. As Built drawings for the “Water Treatment Plant” dated 1957.

2. Drawings for the “Office Building” dated December 1999.

3. Drawings for the “Maintenance Building” dated October 10, 2001.

4. Record Drawings for the “Little Cottonwood WTP Expansion” dated November 16, 2003.

5. Record Drawings for the “Little Cottonwood WTP On-Site Improvements” dated September 16, 2004.

E. Copies of full reports itemized in 4.02.D that are not included with Bidding Documents may be examined at the office of OWNER during regular business hours. These reports and drawings are not part of the Contract Documents, but the technical data contained therein upon which the CONTRACTOR may rely as identified and established above are incorporated therein by reference. CONTRACTOR is not entitled to rely upon other information and data utilized by ENGINEER in the preparation of Drawings and Specifications.

ARTICLE 5

5.01 PERFORMANCE, PAYMENT, AND OTHER BONDS

Add the following new paragraph(s) after paragraph 5.01.B:

C. Performance and Payment Bonds. All persons and entities performing any work on OWNER lands or OWNER’s interest in lands will provide performance and payment bonds for the full sum of their contracts, naming the OWNER as obligee.

5.02 INSURANCE

Delete Paragraph 5.02B.1 to 5.02B.5 in their entirety.

Add the following new paragraph(s) immediately after Paragraph 5.02.B:

C. Minimum Limits of Insurance. Except as approved in writing by District in advance of the work to be performed, CONTRACTOR and all of CONTRACTOR's subcontractors shall maintain limits no less than:

1. GENERAL LIABILITY (including claims arising from: premises-operations, independent contractors, products-completed operations, personal and advertising injury, and liability assumed under an insured contract.):

   i. Combined Single Limit (Bodily Injury and Property Damage):

      1. $2,000,000 Per Occurrence

   ii. Personal Injury (including completed operations and products liability):

      1. $2,000,000 Each Occurrence

   iii. General Aggregate:

      1. $3,000,000

   iv. Products - Comp/OP Aggregate:

      1. $3,000,000

   v. Limits to apply to this project individually.

2. AUTOMOBILE LIABILITY:

   i. $2,000,000 Per Occurrence

   ii. "Any Auto" coverage required.

3. WORKERS' COMPENSATION and EMPLOYERS LIABILITY:

   i. Workers' compensation statutory limits.

   ii. Employers Liability statutory limits.

4. CONTRACTORS POLLUTION LIABILITY:

   i. $1,000,000 Per Claim

   ii. $1,000,000 Aggregate

iii. Coverage applies to this project individually.

D. DEDUCTIBLES AND SELF-INSURED RETENTIONS. Any deductibles or self-insured retention (SIRs) must be declared to and approved by the OWNER in writing. At the option of the OWNER, either the insurer may be required to reduce or eliminate such deductibles or SIRs as respects the OWNER, its trustees, officers, and employees as additional insureds; or the CONTRACTOR may be required to procure a bond or other instrument guaranteeing payment of losses and related investigations, claim distribution, and defense expenses of the OWNER, its trustees, officers, and employees as additional insureds.

The OWNER does not ordinarily approve deductibles in an amount exceeding 2.5% of the required minimum limits described above or $50,000, whichever is less. The OWNER does not ordinarily approve SIRs in an amount exceeding 1.0% of the required minimum limits described above or $20,000, whichever is less. With respect to any deductible or SIR, the CONTRACTOR shall pay for costs related to losses, investigations, claim distribution, and defense expenses of the OWNER, its trustees, officers, and employees as additional insureds that would otherwise be covered by an insurer under the coverages described in these insurance requirements if no deductible or SIR existed.

E. OTHER INSURANCE PROVISIONS. The General Liability, Automobile Liability, and Pollution Liability Coverages are to contain, or be endorsed to contain, the following provisions:

1. OWNER, its trustees, officers, and employees are to be covered as additional insureds as respects: claims arising out of the Work, including completed operations. The coverage shall contain no special limitations on the scope of protection afforded to OWNER, its trustees, officers, and employees.

2. Additional insured coverage shall be on a primary basis for ongoing and completed work.

A waiver with respect to OWNER, its trustees, officers, and employees of Worker's Compensation subrogation shall be provided.

F. ACCEPTABILITY OF INSURERS. Insurance and bonds are to be placed with insurers admitted in the State of Utah with a Bests' rating of no less than A-, IX, and in the limits as listed in this document, unless approved in writing by the OWNER.

G. VERIFICATION OF COVERAGE. CONTRACTOR and all of CONTRACTOR's subcontractors shall furnish OWNER with certificates of

insurance and with original endorsements effecting coverage required by this clause. The certificates and endorsements are to be signed by a person authorized by that insurer to bind coverage on its behalf. The certificates and endorsements are to be provided on forms acceptable to the OWNER before WORK commences. OWNER reserves the right to require complete, certified copies of all required insurance policies, with all endorsements, at any time. CONTRACTOR shall provide an insurance certificate and an endorsement evidencing compliance with this provision at least annually. From time to time OWNER may increase the requirement for a liability limit by providing reasonable written notice to CONTRACTOR of such a change.

ARTICLE 6

6.04 SUBSTITUTES AND "OR-EQUAL" ITEMS

Delete paragraph 6.04.A in its entirety and replace with the following:

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

1. "Or-Equal" Items: If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by ENGINEER as an "or-equal" item, in which case review and approval of the proposed item may, in ENGINEER's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this paragraph 6.04.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment ENGINEER determines that: (i) it is at least equal in quality, durability, appearance, strength, and design characteristics; (ii) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole, and;

b. CONTRACTOR certifies that: (i) there is no increase in cost to the OWNER; and (ii) it will conform substantially, even with

deviations, to the detailed requirements of the item named in the Contract Documents.

2. Substitute Items

a. If in ENGINEER's sole discretion an item of material or equipment proposed by CONTRACTOR does not qualify as an "or-equal" item under paragraph 6.04.A.1, it will be considered a proposed substitute item.

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

c. The procedure for review by ENGINEER will be as set forth in paragraph 6.04.A.2.d, as supplemented in the General Requirements and as ENGINEER may decide is appropriate under the circumstances.

d. CONTRACTOR shall first make written application to ENGINEER for review of a proposed substitute item of material or equipment that CONTRACTOR seeks to furnish or use. The application shall certify that the proposed substitute item will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified, and be suited to the same use as that specified. The application will state the extent, if any, to which the use of the proposed substitute item will prejudice CONTRACTOR's achievement of Substantial Completion on time, whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) to adapt the design to the proposed substitute item and whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty. All variations of the proposed substitute item from that specified will be identified in the application, and available engineering, sales, maintenance, repair, and replacement services will be indicated. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other

contractors affected by any resulting change, all of which will be considered by ENGINEER in evaluating the proposed substitute item. ENGINEER may require CONTRACTOR to furnish additional data about the proposed substitute item.

B. Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is shown or indicated in and expressly required by the Contract Documents, CONTRACTOR may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by ENGINEER. CONTRACTOR shall submit sufficient information to allow ENGINEER, in ENGINEER's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The procedure for review by ENGINEER will be similar to that provided in subparagraph 6.04.A.2.

C. ENGINEER's Evaluation: ENGINEER will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to paragraphs 6.04.A and 6.04.B. ENGINEER will be the sole judge of acceptability. No "or-equal" or substitute will be ordered, installed or utilized until ENGINEER's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or-equal". ENGINEER will advise CONTRACTOR in writing of any negative determination.

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

E. ENGINEER's Cost Reimbursement: ENGINEER will record time required by ENGINEER and ENGINEER's Consultants in evaluating substitute proposed or submitted by CONTRACTOR pursuant to paragraphs 6.04.A.2 and 6.04.B and in making changes in the Contract Documents (or in the provisions of any other direct contract with OWNER for work on the Project) occasioned thereby. Whether or not ENGINEER approves a substitute item so proposed or submitted by CONTRACTOR, CONTRACTOR shall reimburse OWNER for the charges of ENGINEER and ENGINEER's Consultants for evaluating each such proposed substitute.

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

6.06 PERMITS

Add the following paragraph(s) immediately after Paragraph 6.06.B:

C. CONTRACTOR shall obtain a SWPPP construction general permit if disturbing more than 1 acre, and a fugitive dust permit if disturbing over 0.25 acres. Both permits are issued by the Utah Department of Environmental Quality. For bid purposes, the Contractor's bid price shall include $500 for the fee. The Contract Price will be adjusted by Change Order once the actual permit fee is determined.

D. CONTRACTOR shall obtain a Building Permit for the of the well house prefabricated building from Cottonwood Heights City. For bid purposes, the Contractor's bid price shall include $500 for the fee. The Contract Price will be adjusted by Change Order once the actual permit fee is determined.

6.14 INDEMNIFICATION

Delete Paragraph 6.14A in its entirety and replace with the following:

A. CONTRACTOR shall defend, indemnify and hold OWNER and its officers, trustees and employees harmless, including costs and attorneys' fees, from any claim, demand, action or cause of action: (i) alleging that OWNER was at fault in failing to supervise, inspect, direct, instruct, warn or otherwise manage or control CONTRACTOR or any employee, agent or Subcontractor of CONTRACTOR, or (ii) alleging that OWNER knew of, should have known of, or had constructive knowledge of a dangerous condition created by CONTRACTOR or any employee, agent or Subcontractor of CONTRACTOR; or (iii) alleging OWNER is vicariously liable for acts of CONTRACTOR or any employee, agent or Subcontractor of CONTRACTOR (under the Peculiar Risk Doctrine or otherwise. This defense and indemnity obligation is not intended to hold OWNER or its officers, trustees, or employees harmless from any claim that is not derivative of CONTRACTOR as described. In no event shall any fault of CONTRACTOR or CONTRACTOR's employees or contractors be reapportioned to OWNER, its officers, trustees or employees. CONTRACTOR shall indemnify and hold OWNER and its officers, trustees and employees harmless from any such reapportionment of fault. The described duty to defend and indemnify is not intended to run to the benefit of any OWNER liability insurer to the extent such insurer would be responsible for defense costs or indemnity beyond OWNER's deductible or self-insured retention.

ARTICLE 12

12.02 EXTENSIONS OF THE TIME FOR DELAY DUE TO INCLEMENT WEATHER

Add a new paragraph immediately after paragraph 12.02.C:

D. The CONTRACTOR's construction schedule shall be based on the inclusion of at least 7 days of unseasonable inclement weather delays.

ARTICLE 14

14.07 DAMAGES

Delete paragraphs 14.07.C in their entirety and replace with the following:

C. Liquidated Damages: The CONTRACTOR shall, as provided in Article 14.07 of the General Conditions, pay to the OWNER as fixed, agreed, and liquidated damages for each calendar day's delay in completion of the work beyond the Contract Time the amount of $ 500.

- END OF SECTION -

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TECHNICAL SPECIFICATIONS

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 GENERAL

A. The Work to be performed under this Project shall consist of furnishing all labor, materials, and equipment necessary or required to complete the work in all respects as shown on the Contract Drawings and as herein specified. All work, materials, and services not expressly shown or called for in the Contract Documents which may be necessary to complete the construction of the Work in good faith shall be performed, furnished, and installed by CONTRACTOR as though originally so specified or shown, at no increase in cost to OWNER.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The work comprise of the construction of two Surface Infiltration Basins (SIBs), equipping of an Aquifer Storage and Recovery (ASR) well, HDPE piping, flow control and valve vaults, electrical and controls equipment, and associated site improvements.

B. The work is located at the Metropolitan Water District of Salt Lake & Sandy Little Cottonwood Water Treatment Plant, 3430 East Danish Road, Cottonwood Heights, Utah 84093.

1.3 CONTRACT METHOD

A. The Work hereunder will be constructed under a single unit price contract.

1.4 CONTRACTOR USE OF PROJECT SITE

A. CONTRACTOR's use of the Project Site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities.

1.5 PROJECT SECURITY

A. CONTRACTOR shall make all necessary provisions to protect the Project and CONTRACTOR's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.

1.6 CHANGES IN THE WORK

A. It is mutually understood that it is inherent in the nature of public works construction that some changes in the plans and specifications may be necessary during the course of construction to adjust them to unforeseen field conditions, and that it is of the essence of the Contract to recognize a normal and expected margin of change. ENGINEER shall have the right to make such changes, from time to time, in the plans, in the character of the Work, and in the scope of the Project as may be necessary or desirable to ensure the completion of the Work in the most satisfactory manner without invalidating the Contract.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 14 00
WORK RESTRICTIONS

PART 1 GENERAL

A. OWNER and/or utility owners may be working within the Project area while this Contract is in progress. If so, CONTRACTOR shall schedule Work in conjunction with these other entities to minimize mutual interference.

B. All compaction and other testing requirements specified shall be provided and paid for by CONTRACTOR.

C. CONTRACTOR shall notify ENGINEER of the schedule for materials testing as required in Section 01 45 00 Quality Control and Materials Testing and Section 01 45 23 Testing and Inspection Services a minimum of 24 hours in advance in order to provide ENGINEER time to be present during desired testing. CONTRACTOR shall be responsible for obtaining copies of testing reports or data and ensuring that the Work is in full compliance with the Contract Documents.

D. CONTRACTOR shall notify owners of Private rights-of-way 72 hours prior to work being performed across owner's right-of-way.

E. If required to work in City Streets or Utah Department of Transportation (UDOT) right-of-way, CONTRACTOR shall notify right-of-way owner 72 hours prior to work being performed therein. Work within the City Streets or UDOT right-of-way shall be in accordance with required permits and any license agreement with OWNER. CONTRACTOR shall obtain and comply with all required permits.

F. CONTRACTOR must work with all adjacent property owners to ensure no harm or damage is caused to homes or property during construction of the project.

1.2 MEASUREMENT AND PAYMENT

A. Work Restrictions shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 22 00
MEASUREMENT AND PAYMENT

PART 1 GENERAL

A. All work completed under this contract shall be in accordance with the Contract Drawings and Specifications and will be measured by ENGINEER/OWNER. The quantities appearing on the Bid Schedule are approximate only, and are prepared for the comparison of bids. Payment to CONTRACTOR on bid items with unit prices other than "Lump Sum" will be made for actual quantities of work performed and accepted, or material furnished in accordance with the Contract. The scheduled quantities of work to be done and materials to be furnished may be increased or decreased in accordance with the General Conditions.

B. The term "Lump Sum" when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure, portion of work, or unit is specified "Lump Sum" as the unit of measurement, the unit will include fittings, accessories, and all work necessary to complete the work as shown on the Contract Drawings and as specified.

C. When the accepted quantities of work vary from the quantities in the Bid Schedule, CONTRACTOR shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the work done. OWNER reserves the right to add to or delete from quantities listed in the bid schedule in order to match the total bid with the budgeted money available.

1.2 BASE BID SCHEDULE

A. BID ITEM NO. A1 & B1- "MOBILIZATION"

1. **GENERAL** This bid item is provided to cover CONTRACTOR's cost for general and miscellaneous responsibilities and operations not normally attributed to any other single bid item within this schedule. This shall include, but is not limited to, work described or enumerated in Section 01 71 13 - Mobilization.

2. **METHOD OF MEASUREMENT** Mobilization shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as required in Section 01 71 13 - Mobilization.

3. **BASIS OF PAYMENT** Payment will be made at the contract lump sum bid price. Payments will be made in accordance with the following schedule:

    a. When 10% of the original contract amount is earned, 25% of the amount bid for mobilization will be paid.
    b. When 25% of the original contract amount is earned, an additional 25% for a total of 50% of the amount bid for mobilization will be paid.
    c. When 50% of the original contract amount is earned, an additional 25% for a total of 75% of the amount bid for mobilization will be paid.
    d. When 75% of the original contract amount is earned, an additional 25% for a total of 100% of the amount bid for mobilization will be paid.

B. **BID ITEM NO. A2 & B2 - "SITE PREPARATION AND SWPPP"**

1. **METHOD OF MEASUREMENT** Site Preparation and SWPPP shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as required in Sections 01 50 00 - Temporary Construction Utilities and Environmental Controls, 01 50 30 - Protection of Existing Facilities, and 01 56 00 - Dust Control.

2. **BASIS OF PAYMENT** Payment will be made at the contract lump sum bid price. Payments will be made in accordance with the following schedule:

   a. When 10% of the original contract amount is earned, 25% of the amount bid for site preparation and SWPPP will be paid.
   b. When 25% of the original contract amount is earned, an additional 25% for a total of 50% of the amount bid for site preparation and SWPPP will be paid.
   c. When 50% of the original contract amount is earned, an additional 25% for a total of 75% of the amount bid for site preparation and SWPPP will be paid.
   d. When 75% of the original contract amount is earned, an additional 25% for a total of 100% of the amount bid for site preparation and SWPPP will be paid.

C. **BID ITEM NO. A3 & B3 - "CONSTRUCTION SURVEYING AND STAKING"**

1. **GENERAL** This item is provided to cover the Contractor's cost for general and miscellaneous responsibilities and operations associated with Construction Surveying. Construction Surveying shall be performed by a registered professional land surveyor.

2. **METHOD OF MEASUREMENT** Construction Surveying shall be measured based on the percentage of work completed for the project according to the amount defined in the Bid Schedule.

3. **BASIS OF PAYMENT** Payment for Construction Surveying will be made at the contract lump sum bid price as shown and accepted by OWNER and ENGINEER in the Bid Schedule. Payments will be made in accordance with the following schedule:

   a. When 10% of the original contract amount is earned, 25% of the amount bid for construction surveying will be paid.
   b. When 25% of the original contract amount is earned, an additional 25% for a total of 50% of the amount bid for construction surveying will be paid.
   c. When 50% of the original contract amount is earned, an additional 25% for a total of 75% of the amount bid for construction surveying will be paid.
   d. When 75% of the original contract amount is earned, an additional 25% for a total of 100% of the amount bid for construction surveying will be paid.

D. **BID ITEM NO. A4 & B4 – "MATERIALS QUALITY CONTROL AND TESTING"**

1. **GENERAL** This item is provided to cover the Contractor's cost for general and miscellaneous responsibilities and operations associated with Materials Testing. This item shall include, but is not limited to, work described or enumerated in Section 01 45 00 - Quality Control and Materials Testing and Section 01 45 23 - Testing Agency Services.

2. **METHOD OF MEASUREMENT** The Materials Testing shall be measured based on the percentage of work completed for the project according to the amount defined in the Bid Schedule.

3. **BASIS OF PAYMENT** Payment for Material Testing will be made at the contract lump sum bid price as shown and accepted by Owner and Engineer in the Bid Schedule. Payments will be made in accordance with the following schedule:

   a. When 10% of the original contract amount is earned, 25% of the amount bid for material testing will be paid.
   b. When 25% of the original contract amount is earned, an additional 25% for a total of 50% of the amount bid for material testing will be paid.
   c. When 50% of the original contract amount is earned, an additional 25% for a total of 75% of the amount bid for material testing will be paid.
   d. When 75% of the original contract amount is earned, an additional 25% for a total of 100% of the amount bid for material testing will be paid.

E. **BID ITEM NO. A5 & A6 – "FURNISH AND INSTALL 16-INCH HDPE DR 32.5 WATERLINE" and "FURNISH AND INSTALL 24-INCH HDPE DR 32.5 WATERLINE"**

1. **METHOD OF MEASUREMENT** Measurement for 16- and 24-inch HDPE DR 32.5 waterlines shall be according to the lineal foot of pipe acceptably installed as shown on the Contract Drawings and specified herein. Measurement shall be along the horizontal centerline of the acceptably installed pipe. Measurement shall not include pipe which are paid elsewhere.

2. **BASIS OF PAYMENT** Payment for 16-inch and 24-inch HDPE DR 32.5 waterlines shall be paid for at the contract unit bid price per lineal foot listed in the bidder's proposal and shall be considered complete compensation for all labor, equipment, and materials necessary, including but not limited to furnishing the 16- and 24-inch HDPE DR 32.5 pipe to make a functional system, excavation, dewatering, fusion welding, select pipe zone material, backfilling with select trench backfill material, compaction, removal and disposal of excess excavated material, commissioning of pipeline (including pressure testing and disinfection where required); temporary bulkheads, temporary sample taps; valves, fittings and appurtenances where not paid for elsewhere; protection of buried utilities, potholing as needed; looping and re-routing of any affected utilities; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

F. **BID ITEM NO. A7, A8, AND A9 – "SURFACE INFILTRATION BASIN (SIB) #1 EXCAVATION & MATERIAL DISPOSAL", "SURFACE INFILTRATION BASIN (SIB) #2 EXCAVATION & MATERIAL DISPOSAL", and "EXISTING CONSTRUCTION DEBRIS EXCAVATION & MATERIAL DISPOSAL"**

1. **METHOD OF MEASUREMENT** Measurement for SIB #1 Excavation & Material Disposal, SIB #2 Excavation & Material Disposal, and Existing Construction Debris Excavation & Material Disposal bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for SIB #1 Excavation & Material Disposal, SIB #2 Excavation & Material Disposal, and Existing Construction Debris Excavation & Material Disposal shall be made at the contract lump sum bid price listed in the bidder's proposal and shall be considered complete compensation for all labor, equipment, materials, including but not limited to: excavation to depths identified on the Contract Drawings, finished grading, disposal of excavated materials at designated location on site or to an offsite location, transportation, spreading and compaction of excavated materials at the designated location on site; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

G. **BID ITEM NO. A10 – "DRAIN HOLES"**

1. **METHOD OF MEASUREMENT** Drain Holes shall be measured per each complete drain hole constructed as shown in the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Drain Holes shall be made at the Contract unit bid price for each acceptable complete drain hole constructed. Payment shall be considered complete compensation for all labor, equipment, and materials, including but not limited to excavation (borehole); gravel, manhole section; removal and disposal of excess excavation materials; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

H. **BID ITEM NO. A11 – "SIB OVERFLOW PIPING"**

1. **METHOD OF MEASUREMENT** SIB Overflow Piping bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for SIB Overflow Piping shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: excavation, removal and disposal of excavated materials; site grading, furnishing the 16-inch HDPE DR 32.5 pipe to make a functional system, dewatering, select pipe zone material, backfilling with select trench backfill material, compaction, commissioning of pipeline; and appurtenances where not paid for elsewhere; protection of buried utilities, potholing as needed; looping and re-routing of any affected utilities; geotextile fabric, loading, hauling, placing; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

I. **BID ITEM NO. A12 – "DRAINAGE BERM (3'-0" HIGH)"**

1. **METHOD OF MEASUREMENT** Measurement of Drainage Berm bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Drainage Berm shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all

labor, equipment, materials, including but not limited to: installation of berm to depths identified on the Contract Drawings, finished grading, disposal of excess materials at designated location on site or to an offsite location, transportation, spreading and compaction of excavated materials at the designated location on site; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

J. **BID ITEM NO. A13 – "SIB RIP RAP APRON"**

1. **METHOD OF MEASUREMENT** Measurement for SIB Rip Rap Apron bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for SIB Rip Rap Apron shall be made at the lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, and materials necessary, including but not limited to excavation, removal and disposal of excavated materials, site grading, geotextile fabric, furnishing, loading, hauling, placing; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

K. **BID ITEM NO. A14 – "UBC ACCESS ROAD (12'-0" WIDE X 6" THICK)"**

1. **METHOD OF MEASUREMENT** Measurement for UBC Access Road bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for UBC Access Road shall be made at the contract lump sum bid price for completion of the work as shown on the drawings and specified herein. Payment shall be considered complete compensation for all labor, equipment, materials, appurtenances, including but not limited to: 6-inches of compacted road base approximately 12-feet in width; including excavation, preparation of subgrade, import materials, compaction, testing, protection of existing facilities, removal and disposal of excess material, and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

L. **BID ITEM NO. A15 – "FURNISH AND INSTALL ASR VALVE VAULT STRUCTURE"**

1. **METHOD OF MEASUREMENT** ASR Valve Vault Structure bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for ASR Valve Vault Structure shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: cast in place concrete vault, concrete forming, concrete curing, reinforcement, grouting, manhole frame and cover, ladder, ladder extension; excavation regardless of depth of structure, dewatering, shoring, removal and disposal of excavated materials, foundation gravel, geotextile fabric, bedding, backfill, compaction; ductile iron pipe, tee, reducing tee, gate valve, fittings, thrust collar, pipe support(s), appurtenances, floor stand with 18"

handwheel, grating, rebate, connection to HDPE pipe, cleaning, testing, disinfection; any incidental work which are not paid elsewhere with individual items; and all other incidentals and materials as herein described and as shown on the Contract Drawings, required to complete this item.

M. **BID ITEM NO. A16 – "FURNISH AND INSTALL SIB VALVE VAULT STRUCTURES"**

1. **METHOD OF MEASUREMENT** SIB Valve Vault Structures bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for SIB Valve Vault Structures shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: cast in place concrete vault, concrete forming, concrete curing, reinforcement, grouting, access hatch, ladder, ladder extension; excavation regardless of depth of structure, dewatering, shoring, removal and disposal of excavated materials, foundation gravel, geotextile fabric, bedding, backfill, compaction; ductile iron pipe, flow meter, ball valve, fittings, thrust collar, pipe support(s), appurtenances, grating, rebate, connection to HDPE pipe, cleaning, testing; any incidental work which are not paid elsewhere with individual items; and all other incidentals and materials as herein described and as shown on the Contract Drawings, required to complete this item.

N. **BID ITEM NO. A17 – "FURNISH AND INSTALL SIB VALVE VAULTS ELECTRICAL AND CONTROLS"**

1. **METHOD OF MEASUREMENT** SIB Valve Vaults Electrical and Controls bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for SIB Valve Vaults Electrical and Controls shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: valve actuator, flood alarm, furnish and install conduit and wiring with all preparations required for trenching, coring, drilling, excavating, supporting conduit, pulling wire, and completing wiring terminations; all coordination and protection with existing utilities, excavation, dewatering, shoring, applying sand backfill, laying out conduits, completing sand pipe zone material, backfilling with approved backfill material, compaction, installation of detectable marker, backfilling and compaction as required to achieve level finish grade, removal and disposal of excess excavated material, furnish and install all handholes and pull-boxes as required in the Contract Drawings and Specifications and as needed to provide wire pulls that prevent wire damage, provide support for conduits as outlined in the Contract Drawings, Specifications and by code, debur conduit and apply protection as required to prevent wire damage, and usage of conduit materials consistent with the environments in which it is installed and as outlined in the Contract Drawings and Specifications and by code; install electrical wiring of the correct size per the amperage of load by code and as outlined in the Contract Drawings and Specifications, ensure wiring if of the correct insulation rating and material consistent with the environments and voltage and as outlined in

the Contract Drawings and Specifications, and terminate all wiring per required procedures, torques, terminations, finishes, environments and as outlined in the Contract Drawings and Specifications, and assisting OWNER personnel in SCADA programming and integration, and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

O. **BID ITEM NO. A18 – "FURNISH AND INSTALL CONTROL PANEL, SCADA PROGRAMMING, AND INTEGRATION"**

1. **METHOD OF MEASUREMENT** Furnish and Install Control Panel, SCADA Programming, and Integration bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Furnish and Install Control Panel, SCADA Programming, and Integration shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and specified herein. Payment shall be considered complete compensation for all labor, equipment, materials, appurtenances, including but not limited to: wire and assembly, instrumentation, cabinet(s), supports, components, electrician support during loop checks, assisting OWNER personnel in SCADA programing and integration, and all other related items as shown on the Contract Drawings not paid elsewhere.

P. **BID ITEM NO. A19 – "FURNISH AND INSTALL SIB AND MONITORING WELL LEVEL SENSORS"**

1. **METHOD OF MEASUREMENT** Furnish and Install SIB and Monitoring Well Level Sensors bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Furnish and Install SIB and Monitoring Well Level Sensors shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and specified herein. Payment shall be considered complete compensation for all labor, equipment, materials, appurtenances, including but not limited to: instrumentation (level sensors), perforated PVC pipe, furnish and install conduit and wiring with all preparations required for trenching, coring, drilling, excavating, supporting conduit, pulling wire, and completing wiring terminations; all coordination and protection with existing utilities, excavation, dewatering, shoring, applying sand backfill, laying out conduits, completing sand pipe zone material, backfilling with approved backfill material, compaction, installation of detectable marker, backfilling and compaction as required to achieve level finish grade, removal and disposal of excess excavated material, furnish and install all handholes and pull-boxes as required in the Contract Drawings and Specifications and as needed to provide wire pulls that prevent wire damage, provide support for conduits as outlined in the Contract Drawings, Specifications and by code, debur conduit and apply protection as required to prevent wire damage, and usage of conduit materials consistent with the environments in which it is installed and as outlined in the Contract Drawings and Specifications and by code; install electrical wiring of the correct size per the amperage of load by code and as outlined

in the Contract Drawings and Specifications, ensure wiring if of the correct insulation rating and material consistent with the environments and voltage and as outlined in the Contract Drawings and Specifications, and terminate all wiring per required procedures, torques, terminations, finishes, environments, and assisting OWNER personnel in SCADA programing and integration, and all other related items as shown on the Contract Drawings not paid elsewhere.

Q. **BID ITEM NO. A20 – "FURNISH AND INSTALL 16-INCH HDPE DR 32.5 ASR WASTE LINE"**

1. **METHOD OF MEASUREMENT** Measurement for 16-inch HDPE DR 32.5 ASR Waste Line shall be according to the lineal foot of pipe acceptably installed as shown on the Contract Drawings and specified herein. Measurement shall be along the horizontal centerline of the acceptably installed pipe. Measurement shall not include pipe which are paid elsewhere.

2. **BASIS OF PAYMENT** Payment for 16-inch HDPE DR 32.5 pipeline shall be paid for at the contract unit bid price per lineal foot listed and shall be considered complete compensation for all labor, equipment, and materials necessary, including but not limited to furnishing the 16-inch HDPE DR 32.5 pipe to make a functional system, excavation, dewatering, shoring, geotextile, select pipe zone material, backfilling with select trench backfill material, compaction, removal and disposal of excess excavated material, commissioning of pipeline (including testing and video inspection); protection of buried utilities, potholing as needed; looping and re-routing of any affected utilities; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

R. **BID ITEM NO. A21 – "3X3 PRECAST ASR WASTE LINE CATCH BASIN"**

1. **METHOD OF MEASUREMENT** 3x3 Precast ASR Waste Line Catch Basin bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for 3x3 Precast ASR Waste Line Catch Basin shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and specified herein. Payment shall be considered complete compensation for all labor, equipment, materials, appurtenances necessary, including but not limited to: precast concrete catch basin including trough formation, excavation regardless of depth of catch basin, dewatering, shoring, removal and disposal of excavated materials, foundation gravel, geotextile fabric, bedding backfill, compaction, pip jointing, cleaning, grouting, testing and all other operations and materials required to complete this portion of work as herein described and as shown on the Contract Drawings.

S. **BID ITEM NO. A22 – "SITE RESTORATION"**

1. **METHOD OF MEASUREMENT** Site Restoration bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Surface Restoration shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and specified herein. Payment shall be considered complete compensation for all labor, equipment, materials, appurtenances, including but not limited to: existing access road(s), landscaping, irrigation systems, fences, signs, bollards, concrete pads, slab on grades, and all other surface improvements damaged or removed during construction of the project; including excavation, preparation of subgrade, import materials, compaction, protection of existing facilities, restoration of underground irrigation systems, removal and disposal of excess material, all other site restoration or improvements not included in other items, and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

T. **BID ITEM NO. A23 – "SWPPP CONSTRUCTION GENERAL PERMIT AND FUGITIVE DUST PERMIT FEE ALLOWANCE"**

1. **METHOD OF MEASUREMENT** SWPPP Construction General Permit and Fugitive Dust Permit Fee Allowance bid item shall not be measured, but shall be paid for on a lump sum basis for the actual cost of the SWPPP Construction General Permit and Fugitive Dust Permit obtained from Utah Department of Environmental Quality. Refer to Supplementary General Conditions, Part 6.06.

2. **BASIS OF PAYMENT** SWPPP Construction General Permit and Fugitive Dust Permit Fee Allowance shall be made at the contract lump sum bid price and any adjustment, if required, for the actual fee for the SWPPP Construction General Permit and Fugitive Dust Permit obtained from Utah Department of Environmental Quality. Payment shall only be for SWPPP Construction General Permit and Fugitive Dust Permit and shall not include preparation of permit application package or other incidental costs, those costs shall be included in Item A1 Mobilization.

U. **BID ITEM NO. B5 – "WELL HOUSE PAD"**

1. **METHOD OF MEASUREMENT** Well House Pad bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Well House Pad shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: excavation, removal and disposal of excavated materials; site grading, concrete flat work, steel reinforcement, forming, concrete curing, subgrade preparation, untreated base course; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

V. **BID ITEM NO. B6 – "FURNISH WELL HOUSE PREFABRICATED BUILDING"**

1. **METHOD OF MEASUREMENT** Furnish Well House Prefabricated Building bid item shall not be measured, but shall be paid for on a lump sum basis for furnishing complete Well House Prefabricated Building as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Furnish Well House Prefabricated Building shall be made at the contract lump sum bid price for furnishing complete Well House Prefabricated Building as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation to supply all components of the prefabricated building including shipping as herein described and as shown on the Contract Drawings.

W. **BID ITEM NO. B7 – "INSTALL WELL HOUSE PREFABRICATED BUILDING"**

1. **METHOD OF MEASUREMENT** Install Well House Prefabricated Building bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Install Well House Prefabricated Building shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: erection of prefabricated building, miscellaneous hardware, temporary bracing, doors, window, skylights, insulation; and all other operations and materials required to complete this portion of the work as herein described and as shown on the Contract Drawings.

X. **BID ITEM NO. B8 – "BUILDING PERMIT FEE ALLOWANCE"**

1. **METHOD OF MEASUREMENT** Building Permit Fee Allowance bid item shall not be measured, but shall be paid for on a lump sum basis for the actual cost of the Building Permit obtained from Cottonwood Heights City.

2. **BASIS OF PAYMENT** Payment for Building Permit Fee Allowance shall be made at the contract lump sum bid price and any adjustment, if required, for the actual fee for the Building Permit obtained from Cottonwood Heights City. Payment shall only be for Building Permit and shall not include preparation of permit application package or other incidental costs, those costs shall be included in Item B1 Mobilization.

Y. **BID ITEM NO. B9 – "FURNISH WELL HOUSE PUMPING EQUIPMENT"**

1. **METHOD OF MEASUREMENT** Furnish Well House Pumping Equipment bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Furnish Well House Pumping Equipment shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation to supply pump discharge head, isolation sleeves and washers; pump bowl assembly, shafting, columns, motor, and all other pump related items not paid elsewhere for a complete and operable well pump and motor.

Z. **BID ITEM NO. B10 – "INSTALL WELL HOUSE PUMPING EQUIPMENT"**

1. **METHOD OF MEASUREMENT** Install Well House Pumping Equipment bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Install Well House Pumping Equipment shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: installing pump discharge head, extending existing well casing, installing isolation sleeves and washers; installing pump bowl assembly, installing shafting, installing columns, installing motor, PVC sounder tubes, Baski Flow Control Valve, startup and testing, and all other pump related items not paid elsewhere for a complete and operable well pump and motor.

AA. **BID ITEM NO. B11 – "FURNISH AND INSTALL WELL HOUSE ELECTRICAL AND HVAC EQUIPMENT"**

1. **METHOD OF MEASUREMENT** Well House Electrical and HVAC Equipment bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Well House Electrical and HVAC Equipment shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: all electrical equipment at the well pump house, one (1) variable frequency drive with control wiring, panelboards, transformer, grounding system, lighting, service outlets, pressure switches, pressure transducers, intrusion switches, buried conduits including spares, electrical service connection, heat trace, wiring for equipment controls, instruments and signals including the control panel, pump motor terminations, lightning protection system, HVAC, and all other items as shown on the Contract Drawings required for a complete and operable electrical and control system.

BB. **BID ITEM NO. B12 – "FURNISH AND INSTALL WELL HOUSE PIPING"**

1. **METHOD OF MEASUREMENT** Well House Piping bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Well House Piping shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: piping, valves, flow meter, pressure relief valve, pump control valve, fittings and appurtenances, pipe supports, excavation, polyethylene wrap, concrete encasement, air valves, pressure gauge and pressure switch piping and fittings, pipe coating, flange isolation kits, joint restraints, disinfection and testing, ASR waste line and catch basin, and all other appurtenances and related items not paid elsewhere for a complete and operable piping system.

CC. **BID ITEM NO. B13 – "FURNISH AND INSTALL WELL HOUSE CONTROLS"**

1. **METHOD OF MEASUREMENT** Well House Controls bid item shall not be measured, but shall be paid for on a lump sum basis for the completion of the work as shown on the Contract Drawings and Specifications.

2. **BASIS OF PAYMENT** Payment for Well House Controls shall be made at the contract lump sum bid price for completion of the work as shown on the Contract Drawings and Specifications. Payment shall be considered complete compensation for all labor, equipment, materials, including but not limited to: furnishing and installing the station control panel (listed on the Contract Drawings as the PLC), including wire and assembly per Division 26, instrumentation, cabinet(s), supports, and all other and all other items as shown on the Contract Drawings required for a complete and operable electrical and control system.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, Submittals, and Work of various sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.

C. After OWNER occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of OWNER's activities.

D. OWNER and/or utility owners may be working within the project area while this contract is in progress. If so, CONTRACTOR shall schedule Work in conjunction with these other organizations to minimize mutual interference.

E. All existing utilities and pipelines shall remain active during the construction of this project.

1.2 ACCESS TO THE SITE

A. Access to the sites shall be from public right of ways and access as granted by OWNER

B. The CONTRACTOR shall take necessary steps to protect the rights and property of private property owners.

1.3 FIELD ENGINEERING

A. CONTRACTOR shall provide all survey construction staking as necessary to complete the required work according to the Contract Documents.

B. Construction staking and surveying shall be performed by a registered Land Surveyor in the State of Utah.

C. CONTRACTOR shall locate and protect survey control and reference points. Promptly notify ENGINEER of discrepancies discovered.

D. Control datum for survey is that shown on Contract Drawings.

E. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

F. Promptly report to ENGINEER loss or destruction of reference point or relocation required because of changes in grades or other reasons.

G. CONTRACTOR shall be responsible to coordinate with all property owners to determine the location of existing sewer and water service laterals. CONTRACTOR shall be

responsible to coordinate with all property owners during installation or relocation of existing service laterals.

1.4 PRECONSTRUCTION MEETING

A. Prior to the commencement of work at the site, a preconstruction conference will be held at a mutually agreed time and place which shall be attended by CONTRACTOR's Project Manager, its superintendent, and its subcontractors as appropriate. Other attendees will be:

1. ENGINEER and the Resident Project Representative (RPR)
2. Representatives of OWNER
3. Governmental representatives as appropriate
4. Others as requested by CONTRACTOR, OWNER, or ENGINEER.

B. Unless previously submitted to ENGINEER, CONTRACTOR shall bring to the conference one copy of each of the following:

1. Progress schedule
2. Procurement schedule of major equipment and materials and items requiring long lead time
3. Shop Drawings/Sample/Substitute or "Or Equal" submittal schedule.

C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda may include the following:

1. CONTRACTOR's tentative schedules
2. Transmittal, review, and distribution of CONTRACTOR's submittals
3. Processing applications for payment
4. Maintaining record documents
5. Critical work sequencing
6. Field decisions and Change Orders
7. Use of project site, office and storage areas, security, housekeeping, and OWNER's needs
8. Major equipment deliveries and priorities
9. CONTRACTOR's assignments for safety and first aid

D. ENGINEER will preside at the preconstruction conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

E. CONTRACTOR should plan on the preconstruction conference taking no less than 2 hours.

1.5 PROGRESS MEETINGS

A. CONTRACTOR shall schedule and hold regular on-site progress meetings at least weekly and at other times as required by ENGINEER or as required by progress of the work. CONTRACTOR, ENGINEER, and all subcontractors active on the site shall be represented at each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers', and other subcontractors.

B. ENGINEER shall preside at the meetings and provide for keeping and distribution of the minutes. The purpose of the meetings will be to review the progress of the work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.

C. At each construction progress meeting a progress report shall be presented by CONTRACTOR containing an updated Progress Schedule. Where the delayed completion date of a project phase is noted, CONTRACTOR shall describe the anticipated delays or problems and outline the action plan being taken to resolve the issues.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall prepare a schedule of the WORK in accordance with the Contract Documents that will allow ENGINEER and/or OWNER to determine if the WORK can be substantially complete within the Contract Time.

B. CONTRACTOR shall develop the project construction schedule using a computer software program using the Critical Path Method (CPM) for scheduling. The program shall be **Primavera Project Planner (P6),** or approved equal.

1.2 RELATED WORK

A. Related work in other sections includes but is not limited to:

1. 01 30 00 Administrative Requirements
2. 01 33 00 Submittal Procedures

1.3 DEFINITIONS

A. **Activity.** A discrete, identifiable task or event that takes time, uses resources, has a definable start and stop date, furthers the work's progress, and can be used to plan, schedule, and monitor a project.

B. **Activity ID.** A unique, alphanumeric, identification code assigned to an activity.

C. **Bar Chart.** Also called a Gantt chart, a graphic representation of a schedule without relationships. A timescale appears along the horizontal axis.

D. **Completion Date, Contract.** The original date specified in the contract for completion of the project or a revised date resulting from authorized time extensions. The contract may also specify completion dates for interim milestones, phases, or other portions of the project.

E. **Completion Date, Scheduled.** The completion date projected or forecasted by the schedule. The schedule may also project or forecast interim completion dates for milestones, phases, or other portions of the project.

F. **Constraints.** A restriction imposed on the start or finish dates of an activity that modifies or overrides the activity's logic relationships.

G. **Critical Path**. The **Longest Path.**

H. **Data Date.** The first day in the Initial or Baseline Schedule and the first day for performance of the work remaining in the Monthly Schedule Update. (May also be defined as the date from which a schedule is calculated.)

I. **Float, Total.** The amount of time an activity can be delayed and not delay the project completion date.

J. Holidays. Holidays observed are:

1. 1st day in January (New Year's Day)
2. 3rd Monday in January (Martin Luther King, Jr. Day)
3. 3rd Monday in February (Presidents' Day)
4. Last Monday in May (Memorial Day)
5. 4th day in July (Independence Day)
6. 24th day in July (Pioneer Day)
7. 19th day in June (Juneteenth)
8. 1st Monday in September (Labor Day)
9. 11th day in November (Veterans Day)
10. 4th Thursday and the following Friday in November (Thanksgiving Day and the following Friday)
11. 24th and 25th days in December (Christmas Eve and Christmas Day)
12. For holidays that fall on a Saturday, both the Saturday and the preceding Friday are considered to be holidays. For holidays that fall on a Sunday, both the Sunday and the following Monday are considered to be holidays.

K. **Longest Path.** The sequence of activities that establishes the scheduled completion date.

L. **Open End.** The condition that exists when an activity has either no predecessor or no successor, or when an activity's only predecessor relationship is a finish-to-finish relationship or only successor relationship is a start-to-start relationship.

1.4 ADMINISTRATIVE REQUIREMENTS

A. General Requirements - Plan and schedule the project and report progress to the owner. Provide a schedule using the critical path method (CPM). The owner's acceptance of any schedule, whether initial, baseline, or update, does not modify the contract or constitute endorsement or validation by OWNER of the contractor's logic, activity durations, or assumptions in creating the schedule. By accepting the schedule, OWNER does not guaranty that the project can be performed or completed as scheduled. If CONTRACTOR or OWNER discovers errors after the schedule has been accepted, correct the error in the next schedule submission.

B. Title Block: Show on each page the following items:

1. Project Title, Contract Number, and CONTRACTOR's name
2. Date of Submittal, revision number, page number, and Project status cutoff date
3. Approval signatures for each subcontractor
4. Legend of Symbols, codes, and abbreviations
5. Network nomenclature, e.g., "Detailed" or "Summary" or "Building Area" identification

C. Required Schedules

1. **Initial Schedule -** OWNER will use the initial schedule to monitor progress until the baseline schedule is accepted. Prepare and submit a schedule for the first 60 calendar days of work plus a summary bar chart schedule for the balance of the project. Activity durations on the summary chart may exceed 15 working days.

a. At least 10 calendar days before the preconstruction meeting, submit the initial schedule to the owner. Ensure that the schedule shows milestone and completion dates no later than the specified contract milestone and completion dates.
b. OWNER will review the initial schedule at the preconstruction meeting. At this meeting, be prepared to generally discuss the proposed schedule for the entire project, not just the 60-day period covered by the initial schedule. If deviations to the staging, phasing, or sequencing required by the contract documents are proposed, be prepared to discuss these deviations.

c. Within 5 calendar days of the preconstruction meeting, OWNER will respond by accepting the initial schedule, rejecting the schedule and identifying the reason for rejection, or by asking for more information. Address the reasons for rejection or provide the information requested and resubmit the revised initial schedule no more than 5 calendar days after OWNER's response. OWNER may withhold progress payments until CONTRACTOR submits the initial schedule.

2. **Baseline Schedule -** No more than 30 calendar days after approval of the initial schedule, prepare and submit a baseline schedule to OWNER for review. Within 10 calendar days of receipt of the baseline schedule, OWNER will respond by accepting the baseline schedule, rejecting the schedule and identifying the reason for rejection, or by asking for more information. Address the reasons for rejection or provide the information requested and resubmit the revised baseline schedule no more than 10 calendar days after OWNER's response. OWNER may withhold progress payments until the contractor submits and OWNER accepts the baseline schedule.

3. **Monthly Schedule Update** - Prepare and submit a monthly schedule update to OWNER that depicts the status of the project as of the end of the month. The update will reflect a new data date, work performed up to, but not including, the new data date, and the plan for completing the project. Submit the schedule update by the first Monday of the following month. OWNER may withhold progress payments until the contractor submits and the owner accepts the schedule update.

4. **Final Schedule** - Within 30 calendar days of final acceptance of the project, submit a final schedule with actual start and finish dates for each activity. Include with the submission a certification signed by the principal of the firm stating:

a. “To the best of my knowledge, the enclosed final schedule reflects the actual start and finish dates of the activities contained herein.”

1.5 SCHEDULE REQUIREMENTS

A. Provide a schedule that meets the following requirements:

1. Calculate the schedule using the Retained Logic scheduling option unless written authorization is obtained from OWNER to use the Progress Override scheduling option.
2. Do not use the following types of logic relationships:
   a. Negative lags
   b. Lags in excess of 10 workdays
   c. Start-to-Finish relationships

d. Open Ends (Only the first activity will have no predecessor and only the last activity will have no successor)
e. Constraints (CONTRACTOR may use a limited number of constraints only with OWNER's written authorization)
f. Manually modified dates (CONTRACTOR may manually modify dates only with OWNER's written authorization)
g. Obtain OWNER's authorization prior to using lags with finish-to-start relationships

3. Includes the following work activities, as applicable:
   a. Work to be performed by CONTRACTOR, subcontractors, and suppliers.
   b. Work to be performed by OWNER, other contractors, and third parties such as government agencies and authorities, permitting authorities, or other entities required for completion of the project.
   c. The project start date, scheduled completion date, and other contractually mandated milestones, start or finish dates for phases, or site access or availability dates.
   d. Submittal, review, and approval activities when applicable, including time periods for OWNER's approval as specified in the contract documents.
   e. Fabrication, delivery, installation, testing, and similar activities for materials, plants, and equipment
   f. Sampling and testing periods
   g. Settlement and surcharge periods
   h. Cure periods
   i. Utility notification and relocation
   j. Installation, erection and removal, and similar activities related to temporary systems or structures such as temporary electrical systems or shoring.
   k. Punch list, substantial completion, final cleanup, and similar activities.
   l. Required acceptance testing, inspections, or similar activities.
   m. Duration for receipt of permits or acquisition of rights-of-way.
4. Define the following attributes for each activity in the schedule:
   a. A unique alphanumeric Activity ID.
   b. A unique descriptive name, using such attributes as work type and location to distinguish activities.
   c. A duration stated in workdays of no more than 15 workdays, unless a longer duration is requested by CONTRACTOR and approved by OWNER.

1.6 SCHEDULE SUBMISSION REQUIREMENTS

A. For each schedule submission, submit the following items:

1. A Transmittal Letter
2. A narrative report
3. A Primavera Version 6.0 compatible electronic file of the schedule on a CD, DVD, or thumb-drive
4. The critical path in bar chart format (Longest Path sort)
5. Work paths with total float values within 20 workdays of the critical path's total float value in bar chart format. For example, if the critical path has a total float value of zero, then show all of the work paths with total float values of 20 or less.
6. An activity network diagram plotted in color, on E-size paper, with each sheet of the plot including a title, match data for diagram correlation, a page number, and a legend. The activity network diagram should only be submitted with schedules with revised relationships or activity durations.

7. A Predecessor/Successor report with the following items for each activity:
    a. Activity ID and description
    b. Original duration
    c. Remaining duration
    d. Calendar ID
    e. Predecessors and Successors
    f. Early state date
    g. Early finish date
    h. Late start date
    i. Late finish date
    j. Total float
    k. Relationship type
    l. Lags
    m. Constraints

B. Narrative Reports for the Initial and Baseline Schedule – For each submission of the initial and baseline schedule provide a narrative report that includes the following information:

1. Explanation of the overall plan to complete the project, including where the work will begin and the how the work and crews will flow through the project.
2. Use and application of the workdays per week, number of shifts per day, number of hours per shift, holidays observed, and how the schedule accommodates adverse weather days for each month or activity.
3. If the project is a multi-year project, then identify the work to be completed in each construction season
4. A statement explaining why the schedule completion date is forecast to occur before or after the contract completion date
5. An explanation stating why any of the contract milestone dates are forecast to occur late
6. A description of problems or issues anticipated.
7. A description of anticipated delays, including:
    a. Identification of the delayed activity by activity ID and description
    b. Type of delay
    c. Cause of the delay
    d. Effect of the delay on other activities, milestones, and completion dates
    e. Identification of the actions needed to avoid or mitigate the delay
8. A description of the critical path
9. A description of work paths with total float values within 20 workdays of the critical path's total float value. For example, if the critical path has a total float value of zero, then describe all of the work paths with total float values of 20 or less.
10. A statement identifying constraints and an explanation of the reason for and purpose of each constraint
11. A statement describing the status of required permits
12. The statement describing the reason for the use of each lag

C. Narrative Reports for the Monthly Schedule Update and Revised Schedule – For each submission of the monthly schedule update and revised schedule provide a narrative report that includes the following information:

1. A description of the status of the scheduled completion date (and any contract milestone date(s)) since the last schedule submitted
2. A statement explaining why the scheduled completion date is forecast to occur before or after the contract completion date. An explanation stating why any of the contract milestone dates are forecasted to occur late
3. A description of the work performed since the last schedule update.
4. A description of unusual labor, shift, equipment, or material conditions or restrictions encountered or anticipated.
5. A description of the problems encountered or anticipated since the last schedule submission.
6. A statement that identifies and describes any current and anticipated delays. A discussion of delays in the narrative report does not constitute notice and does not replace the need for CONTRACTOR to provide notice as required by the contract. Include the following:
    a. Identification of the delayed activity by activity ID and description
    b. Type of delay
    c. Cause of the delay
    d. Effect of the delay on other activities, milestones, and completion dates
    e. Identification of the actions needed to avoid or mitigate the delay.
7. A description of the critical path
8. A description of changes in the critical path and schedule completion date (for the project or its milestones) from the last schedule submission
9. Descriptions of the status of work paths that have total float values within 20 workdays of the critical path identified in the previous schedule submission.
10. Descriptions of work paths with total float values within 20 workdays of the critical path's total float value. For example, if the critical path has a total float value of negative 25, then show all of the near critical paths with total float values of negative 5 or less.
11. A statement or Claim Digger report that identifies the changes made between the previous schedule submission and the current proposed schedule, including, but not limited to:
    a. Data date
    b. Completion date
    c. Activity code assignments
    d. Scheduling options
    e. Activity descriptions
    f. Added activities
    g. Deleted activities
    h. Added activity relationships
    i. Deleted activity relationships
    j. Activity original durations
    k. Activity remaining durations
    l. Activity actual start and finishes
    m. Percent complete
    n. Constraints
    o. Activity resources
    p. Activity costs
    q. Activity coding
12. A statement providing status of pending items, including, but not limited to:
    a. Permits
    b. Change orders

c. Time extension requests
d. Noncompliance or similar notices indicating deficiencies in CONTRACTOR's performance

1.7 FLOAT TIME

A. Neither OWNER nor CONTRACTOR owns the float time. The Project owns the float time. Liability for the delay to the project complete date rests with the party causing the delay.

1.8 CHANGE ORDERS

A. Upon approval of a Change Order or upon receipt by CONTRACTOR of authorization to proceed with additional work, the change shall be reflected in the next Monthly Schedule update. Contractor shall utilize a sub-network in the schedule depicting the changed work and its effect on other activities. This sub-network shall be tied to the main network with appropriate logic so that a true analysis of the critical path can be made. In order to receive an extension in Contract Times and change in price for time extension, CONTRACTOR must submit the sub-network analysis.

1.9 INCLEMENT WEATHER PROVISIONS

A. CONTRACTOR's schedule shall include at least the number of days of delay due to unusually severe weather as required by the Supplementary General Conditions.

1.10 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for construction progress scheduling. Full compensation for construction progress scheduling shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUBMITTAL PROCEDURES

A. General

1. This Section outlines the general terms that CONTRACTOR must follow for preparing and providing Submittals to ENGINEER for review.
2. CONTRACTOR shall anticipate resubmitting Submittals for major equipment or complex systems.
3. If CONTRACTOR has questions about submittal requirements, CONTRACTOR is encouraged to communicate with ENGINEER to discuss requirements prior to submitting the Submittal.
4. Substitutions shall be clearly identified on the Submittal transmittal form and shall include all the information required per Section 01 60 00 – Product Requirements.

B. Wherever Submittals are required by the Contract Documents, transmit a single electronic PDF file of each Submittal to ENGINEER with a Submittal transmittal form which is acceptable to ENGINEER.

C. Sequentially number transmittal forms. Mark revised Submittals with original number and sequential alphabetic or numeric suffix, i.e., Submittal 1, Submittal 1.A, Submittal 1.1, etc.

D. Identify Project, Contractor, subcontractor and/or supplier, pertinent drawing and detail number, and Specification section number, appropriate to Submittal.

E. Each Submittal shall contain material pertaining to no more than one equipment or material item.

F. Each Submittal shall have the Specification section and applicable paragraph number clearly identified on the front of the Submittal transmittal form. A copy of the Specification section and applicable paragraph shall be included with the Submittal and items included shall be clearly mark as either in compliance or not in compliance. For items not in compliance a description shall be provided explaining the reason for non-compliance.

G. CONTRACTOR shall review Submittals prior to submission to ENGINEER. Apply Contractor's stamp, signed and dated, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents. Identify any deviations from the Contract Documents on the Submittal transmittal form.

H. Schedule Submittals to expedite Project and deliver to ENGINEER at their business address. Coordinate submission of related items.

I. Submittals shall be submitted sufficiently in advance to allow ENGINEER not less than ten regular working days for examining the drawings. These drawings shall be accurate, distinct, and complete and shall contain all required information, including satisfactory

identification of items and unit assemblies in relation to the Contract Drawings and/or specifications.

J. Identify variations from Contract Documents and product or system limitations which may adversely affect successful performance of completed Work.

K. If a Submittal is returned to CONTRACTOR marked “APPROVED”, or similar notification, formal revision and resubmission will not be required.

L. If a Submittal is returned marked “APPROVED – MAKE CORRECTIONS NOTED”, or similar notification, CONTRACTOR shall make the corrections on the Submittal, however, formal revision and resubmission will not be required.

M. Resubmittals

1. If a Submittal is returned marked “AMEND AND RESUBMIT”, or similar notification, CONTRACTOR shall revise the Submittal and resubmit the required number of copies.
2. Identify changes made since the previous submission.

N. Rejected Submittals

1. If a Submittal is returned marked “REJECTED – RESUBMIT”, or similar notification, it shall mean either that the proposed material or product does not satisfy the specification, the Submittal is so incomplete that is cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 – Product Requirements.
2. CONTRACTOR shall prepare a new Submittal or submit a substitution request according to Section 01 60 00 – Product Requirements and shall submit the required number of copies.

O. Distribute copies of reviewed Submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

P. Submittals not requested will not be recognized or processed.

Q. Unless noted otherwise, corrections indicated on Submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the Contract requirements.

R. Fabrication or purchase of an item may only commence after ENGINEER has reviewed the pertinent Submittals and returned copies to CONTRACTOR marked either “APPROVED” or “APPROVED – MAKE CORRECTIONS NOTED”.

S. ENGINEER's review of CONTRACTOR Submittals shall not relieve CONTRACTOR of the entire responsibility for the corrections of details and dimensions. CONTRACTOR shall assume all responsibility and risk for any misfits due to any errors in CONTRACTOR Submittals. CONTRACTOR shall be responsible for dimensions and quantities, coordinating with all trades, the design of adequate connections and details, and satisfactory and safe performance of the work.

1.2 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial schedules within 15 days after date of Owner-Contractor Agreement. After review comments on the initial schedule are received from ENGINEER and OWNER, CONTRACTOR shall resubmit required revised data within ten days.

B. Submit revised Progress Schedules with each Application for Payment.

C. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

D. Submit computer generated horizontal bar chart with separate line for each major portion of Work or operation, identifying first work day of each week.

E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration.

F. Indicate estimated percentage of completion for each item of Work at each submission.

G. Submit separate schedule of submittal dates for shop drawings, product data, and samples.

1.3 PRODUCT DATA

A. Product Data: Submit to ENGINEER for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 78 50 - Project Closeout.

1.4 SHOP DRAWINGS

A. Shop Drawings: Submit to ENGINEER for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Fabrication of an item may be commenced only after ENGINEER has reviewed the pertinent submittals and returned copies to CONTRACTOR marked either "APPROVED", or "APPROVED - MAKE CORRECTIONS NOTED". Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

C. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.

1. Include signed and sealed calculations to support design.
2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 78 50 - Project Closeout.

1.5 SAMPLES

A. Whenever indicated in the Specifications or requested by ENGINEER, CONTRACTOR shall submit at least 1 sample of each item or material to ENGINEER for acceptance at no additional cost to OWNER.

B. Samples, as required herein, shall be submitted for acceptance prior to ordering such material for delivery to the jobsite, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delay in the Work.

C. Unless otherwise specified, all colors and textures of specified items will be selected by ENGINEER from the manufacturer's standard colors and standard materials, products, or equipment lines.

1.6 CERTIFICATES

A. When specified in individual Specification sections, submit certification by manufacturer, installation/application subcontractor, or CONTRACTOR to ENGINEER, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to ENGINEER.

1.7 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual Specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to ENGINEER for delivery to Owner in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.8 MANUFACTURER'S FIELD REPORTS

A. When required in individual sections, have Manufacturer or Supplier provide qualified representative to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable and to make written report of observations and recommendations to ENGINEER.

1.9 OPERATIONS AND MAINTENANCE MANUAL SUBMITTAL

A. CONTRACTOR shall furnish to ENGINEER five (5) identical sets of Operations and Maintenance Manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl, hard-cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A Table of Contents shall be provided which indicates all equipment and suppliers in the Operations and Maintenance Manuals.

B. CONTRACTOR shall also furnish ENGINEER one copy of the Operations and Maintenance Manuals in PDF electronic format.

C. CONTRACTOR shall include in the Operations and Maintenance manuals full details for care and maintenance for all visible surfaces as well as the following for each item of mechanical, electrical, and instrumentation equipment (except for equipment furnished by the Owner):

1. Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.
2. Preventative maintenance procedures and schedules
3. A description of proper maintenance activities
4. Complete parts lists, by generic title, identification number, and catalog number, complete with exploded views of each assembly.
5. Disassembly and reassembly instruction
6. Name and location of nearest supplier and spare parts warehouse
7. Name and location of manufacturer
8. Recommended troubleshooting and start-up procedures
9. Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

D. All Operations and Maintenance manuals shall be submitted in final form to ENGINEER not later than the 75 percent of construction completion date. All discrepancies found by ENGINEER in the Operations and Maintenance manuals shall be corrected by CONTRACTOR prior to final acceptance of the project.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 42 13
ABBREVIATIONS

PART 1 GENERAL

1.1 DESCRIPTION

A. Wherever in these Specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of these Specifications, the following acronyms or abbreviations which may appear in these Specifications shall have the meanings indicated herein.

1.2 ABBREVIATIONS AND ACRONYMS

AASHTO	American Association of the State Highway and Transportation Officials
ABMA	American Bearing Manufacturers Association (formerly AFBMA)
ACI	American Concrete Institute
AGA	American Gas Association
AGC	American General Contractors
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American Nation Standards Institute, Inc.
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASOC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BBC	Basic Building Code, Building Officials and Code Administrators International
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CRSI	Concrete Reinforcing Steel Institute
DIPRA	Ductile Iron Pipe Research Association
DWQ	Department of Water Quality
DWR	Drinking Water Regulations
ECTC	Erosion Control Technology Council
EIA	Electronic Industries Association
EPA	Environmental Protection Agency
ETC	Electrical Test Laboratories

FEMA	Federal Emergency Management Agency
FM	Factory Mutual System
HI	Hydraulic Institute
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
ICC-ES	International Code Council Evaluation Service
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IFC	International Fire Code
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code
ISA	Instrument Society of America
ISO	International Organization of Standardization
LPI	Lightning Protection Institute
LRQA	Lloyd’s Register Quality Assurance
MBMA	Metal Building Manufacturer's Association
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NISO	National Information Standards Organization
NSF	NSF International (formerly National Sanitation Foundation)
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
RMA	Rubber Manufacturers Association
RWMA	Resistance Welder Manufacturer's Association
SSPC	Society for Protective Coating (formerly Steel Structure Painting Council)
TPI	Truss Plate Institute
UDOT	Utah Department of Transportation
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UPRR	Union Pacific Railroad
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcements Institute, Inc.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 42 19
REFERENCE STANDARDS

PART 1 GENERAL

1.1 QUALITY ASSURANCE

A. TITLES OF SECTIONS AND PARAGRAPHS. Captions accompanying Specifications sections and paragraphs are for convenience of reference only, and do not form a part of the Specification.

B. APPLICABLE PUBLICATIONS. Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards or requirements of the respective issuing agencies which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the drawings shall be waived because of any provision of, or omission from, said standards or requirements.

C. SPECIALISTS, ASSIGNMENTS. In certain instances, specifications test requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such assignments shall be recognized as special requirements and shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of contract requirements remains with CONTRACTOR.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all Work specified herein shall conform to or exceed the requirements of all applicable codes and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of these Specifications nor the applicable codes.

B. Reference herein to "Building Code" or “Uniform Building Code” shall mean the International Building Code of the International Code Council. The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, drawings and the other Contract Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of ENGINEER for clarification and directions prior to ordering or providing any materials or labor. CONTRACTOR shall bid the most stringent requirements.

D. APPLICABLE STANDARD SPECIFICATIONS. CONTRACTOR shall construct the Work specified herein in accordance with the requirements of the Contract Documents

and the referenced portions of those referenced codes, standards, and Specifications listed herein; except, that wherever references to "Standard Specifications" are made, the provisions therein for measurement and payment shall not apply.

E. References in the Contract Documents to "Standard Specifications" shall mean the Contract Documents including all current supplements, addenda, and revisions thereof.

F. References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including changes and amendments thereto.

H. UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY. Wells, tanks, pumping stations and culinary water pipelines shall conform to the requirements of Utah Administrative Code Rule R 309. Water and sewer pipeline installation shall conform to the requirements of Utah Administrative Code Rule R 317-3-2.9 “Protection of Water Supplies” for horizontal and vertical separation.

I. UTAH DEPARTMENT OF TRANSPORTATION (UDOT) REQUIREMENTS. CONTRACTOR's work on UDOT property or right-of-way shall conform to UDOT’s latest edition of Standard Specifications For Road and Bridge Construction.

J. U.S. ARMY CORPS OF ENGINEERS (COE) REQUIREMENTS. CONTRACTOR's work shall conform to COE Specifications in accordance with Section 404 of the Clean Water Act for excavation in wetlands.

K. Reference herein to APWA shall mean the latest edition of the “Manual of Standard Specifications” and “Manual of Standard Plans” as prepared by the American Public Works Association and the Associated General Contractors of America.

L. All provisions of the Manual of Standard Specifications, Latest Edition and Manual of Standard Plans, Latest Edition both published by the Utah Chapter of the American Public Works Association are hereby made a part of the Contract Documents by reference. The publications may be purchased separately from the Utah Technology Transfer Center, Utah State University, 4111 Old Main Hill, Logan, UT 84322-4111. Any conflicts, between the technical specifications, drawings, and other provisions or documents contained in the Contract Form or Contract Documents versus provisions contained in the Manual of Standard Specifications, Latest Edition and Manual of Standard Plans, Latest Edition published by the Utah Chapter of the American Public Works Association, shall be resolved in favor of the technical specifications, drawing, and provisions contained in the Contract form or Contract Documents.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 45 00
QUALITY CONTROL AND MATERIALS TESTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section outlines responsibilities for controlling quality of materials, products and workmanship.

1.2 MATERIALS

A. All materials incorporated in the project shall be new and shall fully comply with the Specifications. Unless otherwise clearly provided in the Specifications, all workmanship, equipment, materials, and articles incorporated in the Work covered by the Contract are to be of the best available grade of their respective kinds. Whenever, in the specifications, any material, article, device, product, fixture, form, type of construction, or process indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired and shall be deemed to be followed by the words "or approved equal" and CONTRACTOR may in such case, upon receiving ENGINEER's approval, purchase and use any item, type, or process which shall be substantially equal in every respect to that indicated or specified.

B. Materials and equipment may be used in the Work based upon receipt of a Supplier's certificate of compliance. Certificate must be in possession of CONTRACTOR and reviewed by ENGINEER prior to use.

C. Quality Assurance Testing by OWNER and/or ENGINEER shall not relieve CONTRACTOR of responsibility to furnish materials and work in full compliance with Contract Documents.

1.3 MANUFACTURER'S INSTRUCTIONS

A. Should instructions conflict with Contract Documents, request clarification before proceeding.

B. When required in individual sections, submit manufacturer's instructions in the quantity required for product data, delivery, handling, storage, assembly, installation, start-up, adjusting, balancing, and finishing, as appropriate.

1.4 WORKMANSHIP

A. Maintain performance control and supervision over Subcontractors, Suppliers, manufacturers, products, services, workmanship, and site conditions, to produce work in accordance with Contract Documents.

B. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

C. Provide suitable qualified personnel to produce specified quality.

D. Ensure finishes match approved samples.

1.5 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from ENGINEER before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.6 TESTING AND INSPECTION SERVICES

A. Testing agency and testing for quality control and material testing shall be furnished by CONTRACTOR as part of the project. Results of testing shall be reported to CONTRACTOR and ENGINEER on site. Reports of the testing shall be transmitted directly to ENGINEER.

B. Materials to be supplied under this contract will be tested and/or inspected either at their place of origin or at the site of the work by the testing agency. CONTRACTOR shall give ENGINEER written notification well in advance of actual readiness of materials to be tested and/or inspected at point of origin so ENGINEER may witness testing by the testing agency. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude retesting or reinspection at the site of the work.

C. CONTRACTOR shall furnish such samples of materials as are requested by the ENGINEER, without charge. No material shall be used until reports from the testing agency have been reviewed and accepted by ENGINEER. See Section 01 33 00 - Submittal Procedures.

1.7 UNSATISFACTORY CONDITIONS

A. Examine areas and conditions under which materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

1.8 QUALITY CONTROL TESTING

A. ENGINEER’s failure to detect any defective Work or materials does not prevent later rejection when such defect is discovered nor does it obligate ENGINEER for acceptance.

B. CONTRACTOR shall provide 24-hours minimum notice to ENGINEER for all testing required by these specifications so ENGINEER may coordinate or be present during testing.

1.9 TESTING ACCEPTANCE AND FREQUENCY

A. Minimum Quality Control Testing Frequency: As defined in Table 01 45 00-1, CONTRACTOR shall be responsible to ensure that all testing is performed at the frequencies shown. CONTRACTOR shall uncover any work at no cost to OWNER to allow the testing agency to perform required testing at the frequency shown.

B. Acceptance of Defective Work: As defined in Article 14.04 of the General Conditions.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

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.

TABLE 01 45 00-1: QUALITY CONTROL TESTING FREQUENCY

SYSTEM or MATERIAL	TESTS	MINIMUM REQUIRED FREQUENCY
SUBGRADE AND BACKFILL MATERIALS		
Section 31 23 15 Excavation and Backfill for Buried Pipelines	Field Density	1 test per 200 linear feet per 1.5 feet of backfill thickness placed.
	Laboratory	1 test for each material type which includes proctor, classification, and gradation.
Section 31 23 23 Excavation and Backfill for Structures	Field Density	1 test per 200 linear feet per 1.5 feet of backfill thickness placed.
	Laboratory	1 test for each material type which includes proctor, classification, and gradation.
Section 32 11 23 Road Base - Untreated Base Course	Field Density	Base course subgrade: 1 test per 2,000 square feet of area. Base course: 1 test per 2,000 square feet of area.
	Laboratory	Base course: 1 test for each material type which includes proctor, classification, and gradation.
PORTLAND CEMENT CONCRETE		
Section 3 30 00 Cast-in-Place Concrete	Slump	1 test every day of placement (if less than 100 cubic yards in a day), 1 test for every 100 cubic yards, or 1 test for each 3,000 square feet of surface area for slabs and more frequently if batching appears inconsistent.
	Entrained air	1 test with slump test.
	Ambient and concrete temperatures	1 test with slump test.
	Water cement ratio.	to be verified and provided with batch tickets.
	Compressive strength	1 set of 5 cylinders. 1 test every day of placement (if less than 100 cubic yards in a day), 1 test for every 100 cubic yards, or 1 test for each 3,000 square feet of surface area for slabs, and more frequently if batching appears inconsistent.

NOTES:

1 Additional tests shall be conducted when variations occur due to CONTRACTOR's operations, weather conditions, site conditions, etc.
2 Classification, moisture content, Atterberg limits and specific gravity tests shall be conducted for each compaction test, if applicable.
3 Tests can substitute for same tests required under "Aggregates" (from bins or source), although gradations will be required when blending aggregates.
4 Aggregate moisture tests are to be conducted in conjunction with concrete strength tests for water/cement calculations.

- END OF SECTION -

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SECTION 01 45 23
TESTING AGENCY SERVICES

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall be responsible for providing Construction Quality Control Testing of all soils, concrete, etc. as required by the various sections of these Specifications. This section includes the following:

1. Use of independent testing agency
2. Control testing report submittal requirements
3. Responsibilities of testing agency

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 22 00 Measurement and Payment

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 3740 Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
2. ASTM D 4561 Standard Practice for Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials
3. ASTM E 329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.4 DEFINITIONS

A. Independent Testing Agency: A testing agency NOT owned by CONTRACTOR, and an agency that does not have any preferential affiliation or association with CONTRACTOR, or any of CONTRACTOR's Subcontractors and Suppliers other than entering into a contract with CONTRACTOR to perform the duties defined in these Specifications.

B. Professional Engineer: An engineer who complies with Utah licensing law and is acceptable to the authority having jurisdiction.

1.5 QUALITY ASSURANCE

A. CONTRACTOR shall employ and pay for services of an independent testing agency which complies with ASTM D 3740, ASTM D 4561, and ASTM E 329 to test materials for contract compliance.

1.6 CONTRACTOR SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures

B. If CONTRACTOR is employing and paying for an independent testing agency, prior to start of Work, submit testing agency's name, address, telephone number and the following:

1. Concrete Technician: Approved by ENGINEER or ACI certified.
2. Person charged with engineering managerial responsibility
3. Professional engineer on staff to review services
4. Level of certification of technicians

1.7 TESTING AGENCY SUBMITTALS

A. Field Test Report: Submit report no later than the end of the current day.

B. Laboratory Test Report: Submit original report within 48 hours after test results are determined.

C. Final Summary Report: Submit prior to final payment

D. On all reports include:

1. Project title, number and date of the report
2. Date, time and location of test
3. Name and address of material Supplier
4. Identification of product being tested and type of test performed
5. Identify whether test is initial test or retest
6. Results of testing and interpretation of results
7. Name of technician who performed the testing

1.8 RESPONSIBILITIES OF TESTING AGENCY

A. Calibrate testing equipment at least annually with devices with an accuracy traceable to either National Bureau of Standards or acceptable values of natural physical constraints.

B. Provide sufficient personnel at site and cooperate with CONTRACTOR, ENGINEER and OWNER's Representative in performance of testing service.

C. Secure samples using procedures specified in the applicable testing code.

D. Perform testing of products in accordance with applicable sections of the Contract Documents.

E. Immediately report any compliance or noncompliance of materials and mixes to CONTRACTOR, ENGINEER, and OWNER's Representative.

F. When an out-of-tolerance condition exists, perform additional inspections and testing until the specified tolerance is attained, and identify retesting on test reports.

1.9 LIMITS ON TESTING AGENCY AUTHORITY

A. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Agency may not suspend Work.

C. Agency has no authority to accept Work for OWNER.

1.10 MEASUREMENT AND PAYMENT

A. Testing agency services shall be measured or paid as provided in Section 01 22 00-Measurement and Payment.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 50 00
TEMPORARY CONSTRUCTION UTILITIES AND ENVIRONMENTAL CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers temporary utilities, including electricity, lighting, telephone service, water, and sanitary facilities; temporary controls, including barriers, protection of work, and water control; and construction facilities, including parking, progress cleaning, and temporary buildings.

1.2 TEMPORARY UTILITIES

A. Temporary Electricity: CONTRACTOR shall provide, maintain, and pay for all power required by CONTRACTOR, including electrical service to CONTRACTORS field office.

B. Temporary Lighting: CONTRACTOR shall provide all temporary lighting required for execution of his work and for employee and public safety. As a minimum, lighting levels during working hours shall meet the requirements of OSHA Subsection 1926.56 illumination.

C. Temporary Heating and Cooling

1. Provide heating and cooling devices as needed to maintain specified conditions for construction operations.

D. Temporary Ventilation

1. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

E. Telephone Service: CONTRACTOR shall provide, maintain and pay for telephone service to the field office at time of project mobilization.

F. Temporary Water Service

1. CONTRACTOR shall provide for all his workers on the project, adequate and reasonably convenient uncontaminated drinking water supply. All facilities shall comply with the regulations of the local and State Departments of Health.
2. CONTRACTOR shall be responsible to arrange for water, both potable and non-potable water.
3. When water is taken from a city water system or any other potable water supply source for construction purposes, suitable precautions shall be taken to prevent cross connections and contamination of water supply.

G. Temporary Sanitary Facilities: CONTRACTOR shall provide and maintain sanitary facilities for his employees and his subcontractors' employees that will comply with the regulations of the local and State Departments of Health.

1.3 TEMPORARY CONTROLS

A. Barriers: Provide barriers as necessary to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

B. Project Security

1. CONTRACTOR shall make all necessary provisions to protect the project and CONTRACTOR's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.
2. Entry Control:
   a. Restrict entrance of persons and vehicles into Project site.
   b. Allow entrance only to authorized persons.

C. Dust Control: Execute Work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into the atmosphere. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced.

D. Pest Control: Provide methods, means, and facilities to prevent rodents, pests and insects from damaging the Work.

E. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. All chemicals used during construction or furnished for project operation whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval of the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instruction of the manufacturer.

F. Protection of Work: CONTRACTOR shall protect installed work and provide special protection where specified in individual specifications sections. CONTRACTOR shall provide temporary and removable protection for installed products, and shall control activity in immediate work area to minimize damage.

G. Open Burning: No open burning of waste materials will be allowed.

H. Explosives and Blasting: The use of explosives on the work will not be permitted.

I. Noise Abatement: In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation.

J. STORM AND GROUND WATER

1. CONTRACTOR shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water entering the excavation or other parts of the work, whether the water be from surface or underground water sources.

2. In excavation, fill, and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water into private property or into streets or drainage ways inadequate for the increased flow.
3. CONTRACTOR shall maintain effective means to minimize the quantity of sediments leaving the work area either by storm water or CONTRACTOR's own dewatering operations. CONTRACTOR shall be responsible for obtaining required permits and complying with all City, State, and Federal storm water management regulations and requirements, including preparing and implementing a Storm Water Pollution Prevention Plan (SWPPP) for Construction Activities. If required, CONTRACTOR shall submit a copy of the Notice of Intent and the SWPPP to the OWNER for review and approval.

1.4 CONSTRUCTION FACILITIES

A. VEHICULAR ACCESS

1. Construct temporary access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes.
2. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.
3. Location of temporary access roads and detours shall be approved by ENGINEER.
4. Provide unimpeded access for emergency vehicles.
5. Provide and maintain access to fire hydrants and control valves free of obstructions.
6. Provide means of removing mud from vehicle wheels before entering streets.
7. When possible, use existing on-site roads for construction traffic.

B. Parking: CONTRACTOR shall provide temporary parking areas to accommodate use of construction personnel. Parking shall be located in an area approved by ENGINEER.

C. Progress Cleaning

1. CONTRACTOR shall maintain areas free of waste materials, debris, and rubbish. Maintain the site in a clean and orderly condition. Upon completion of work, repair all damage caused by equipment and leave the project site free of rubbish or excess materials of any kind.
2. Thoroughly clean all spilled dirt, gravel, or other foreign materials caused by the construction operations from all streets and roads at the conclusion of each day's operation.
3. It shall be the responsibility of CONTRACTOR to promptly clean up and remove any oil and/or fuel spills caused by CONTRACTOR or his Sub-contractors during the course of the project. Contaminated soil shall be properly disposed of by CONTRACTOR in accordance with all applicable laws. CONTRACTOR shall be responsible for any damages to OWNER resulting from CONTRACTOR's negligence in promptly cleaning up said spills.

1.5 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Prior to Final Application for Payment, CONTRACTOR shall remove temporary above grade or buried utilities, equipment, facilities, and materials; clean and repair damage

caused by installation or use of temporary work; and restore existing facilities used during construction to original condition.

1.6 CULTURAL RESOURCES

A. CONTRACTOR's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archeological, or cultural resources (hereinafter called "cultural resources").

B. CONTRACTOR shall conform to the applicable requirements of the National Historic Preservation Act of 1966 as it relates to the preservation of cultural resources.

C. If a suspected or unsuspected historical, archaeological, or paleontological item, feature, or site or other cultural resource is encountered during subsurface excavations at the site of construction, the following procedures shall be instituted:

1. Construction operations shall be immediately stopped in the vicinity of the discovery and ENGINEER and OWNER shall be notified of the nature and exact location of the finding. CONTRACTOR shall not damage the discovered objects and shall provide written confirmation of the discovery to ENGINEER within two (2) calendar days.
2. OWNER and ENGINEER will then immediately notify the State Historical Preservation Office (SHPO) and the Utah Geological Survey (UGS).
3. SHPO and UGS will investigate the finding and determine if the resource requires protection and the disposition of the said resource.

D. If SHPO and UGS determine that the potential find is a bona fide cultural resource, CONTRACTOR shall suspend work at the location of the find under the provisions for changes contained in Articles 11, 12, and 13 of the General Conditions, Section 00 70 00 – General Conditions.

PART 2 PRODUCTS

2.1 TEMPORARY EROSION CONTROL MATERIALS

A. EROSION CONTROL BLANKETS

1. Erosion control blankets shall meet the requirements of the Erosion Control Technology Council (ECTC) and the FHWA Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-03 Section 713.17 as a Type 3.B Extended Term Double Net Erosion Control Blanket. The erosion control blanket shall be fabricated from UV-stabilized polypropylene and a straw/coconut blend. The blanket shall be **Model SC150 by Tensar North American Green, Excel CS-3 by Western Excelsior**, or approved equal. The functional longevity shall be 24 months minimum.

B. SILT FENCE

1. Use woven fabric meeting the following properties.

Table 1 - Silt Fence Geotextile			
Property	**ASTM**	**MARV's**	
		Standard	**High Performance**
Grab Tensile Strength, lbs.	D 4632	90[(a)]	120[(a)]
Grab Elongation, %	D 4632	< 40	< 40
Flux, gal/min/ft^2	D 4491	15	90
Apparent Opening Size, (AOS-US sieve)	D 4751	> 20	> 30
Ultraviolet Degradation, %	D 4355	70	90
NOTES (a) Percent of tensile strength retained determined after weathering per ASTM D 4355 for 500-hours			

2. High performance fence to have tape yarns in one principle direction only.
3. Add stabilizers or inhibitors to make the filaments resistant to sunlight or heat deterioration.
4. Finish edges to prevent outer yarn from pulling away from the fabric.
5. Sheets of fabric may be sewn or bonded together. Provide minimum width recommended by manufacturer.
6. No deviation from any requirement in Table 2 due to the presence of seams.
7. Manufactured with pockets for posts, hems with cord, or with posts pre-attached using staples or button head nails.

C. POSTS

1. Minimum length: 4-feet.
2. Steel: Round, U shaped, T shaped, or C shaped with a minimum weight of 1.3-pounds per foot, and have projections for fastening wire.
3. Wood as follows:
   a. Soft wood posts at least 3-inches in diameter, or nominal 2 x 4-inches and straight to provide a fence without noticeable misalignment.
   b. Hard wood post providing a minimum cross-sectional area of 2.25 square-inches.
4. Fasteners for Wooden Posts:
   a. Wire staples No. 17 gage minimum with a crown at least 3/4-inches wide and legs at least 1/2-inch long.
   b. Nails 14 gage minimum, 1-inch long with 3/4-inch button.

PART 3 EXECUTION

3.1 SILT FENCE

A. Beginning work means acceptance of existing conditions.

B. Maintain the silt fence until revegetation is complete (defined as when cover reaches a density of at least 70% of pre-disturbance levels.

C. Clear area of any debris and obstructions that may damage geotextile.

D. Place post in all low points.

E. Install posts a maximum of 8-feet apart with at least 18-inches in the ground. If not possible to achieve depth, secure posts to prevent overturning.

F. Attach filter fabric by wire, cord, pockets, staples, nails, or other effective means.

1. When using a wire support fence, provide at least 6 horizontal wires with a minimum of 12 gage wire. Space vertical wires 6-inches maximum. Secure geotextile to the up slope side of the post. Extend wire into the trench a minimum of 2-inches and extend a maximum or 36-inches above the ground surface.

G. Install fabric so 6 to 8-inches of fabric remain at the bottom to be buried. Splice together only at support posts with at least a minimum overlap of 18-inches. Extend buried portion 6-inches deep and the rest upstream of the fabric fence.

H. Sediment Removal: Remove sediment before deposit reaches 1/2 of the height of the silt fence or raise the height of silt fence. After removal of sediment, dress landscape.

I. Schedule of Locations: Typical locations include the toe of fill slopes, the downhill side of fill slopes, the downhill side of large cut areas, and at natural drainage areas. Limit geotextile materials to handle an area equivalent to 1,000 square feet per 10-feet of fence. Use caution should site slope be steeper than 1:1 (horizontal:vertical), and water flow rates exceed 1 cubic foot per second per 10-feet of fence face.

- END OF SECTION -

SECTION 01 50 30
PROTECTION OF EXISTING FACILITIES

PART 1 GENERAL

1.1 DESCRIPTION

A. Any existing facilities, disturbed which are located in or adjacent to the line of work such as curbs, gutters, drive approaches, sidewalks, driveways, fences, underground pipes, conduits, or utilities, shall be cleaned up and restored in kind by CONTRACTOR and in accordance with the Specifications contained herein governing the various types of services involved.

B. CONTRACTOR shall not perform work that would affect any oil, gas, sewer, or water pipeline; any telephone, fiber optic, television cable, or electric transmission line; any fence; or any structure, until authorization has been obtained from owner of the improvement. Provide owner of the improvement due notice of the beginning of the work, and remove, shore, support, or otherwise protect such improvement or replace the same.

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

Section 01 78 50 Project Closeout

1.3 RESTORATION OF FENCES

A. Where it is necessary to remove any fence to facilitate CONTRACTOR's operation, CONTRACTOR shall obtain prior agreement with owner of the fence for removal of the fence and shall be responsible for any damage due to negligence of CONTRACTOR. As soon as practical, the fence shall be restored substantially to the same or improved condition as it was prior to the commencement of the work. Where livestock is present CONTRACTOR shall provide temporary fencing to keep livestock away from the construction area.

1.4 UNDERGROUND SERVICE ALERT

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, CONTRACTOR shall notify the regional notification center (Blue Stakes of Utah) at 1-800-662-4111 or 811 or submit an on-line request at www.bluestakes.org at least 2 days, but no more than 7 days, prior to such excavation.

1.5 INTERFERING STRUCTURES AND UTILITIES

A. CONTRACTOR shall exercise all possible caution to prevent damage to existing structures and utilities, whether above ground or underground. Prior to submittal of Shop Drawings, and prior to commencing any excavations for new pipelines or structures, conduct investigations, including exploratory excavations and borings, to

determine the location and type of underground utilities and services connections that could result in damage to such utilities. It shall be the responsibility of CONTRACTOR to locate and expose all existing underground and overhead structures and utilities in such a manner as to prevent damage to same. CONTRACTOR shall notify all utility offices concerned at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, television cables, fiber optic communication, gas, and electric. CONTRACTOR shall be responsible for any and all changes to, reconnections to public utility facilities encountered or interrupted during prosecution of the work, and all costs relating hereto shall be at CONTRACTOR's expense. CONTRACTOR shall contract with and pay Public Utility Agencies for work required in connection with all utility interferences and handle all necessary notifications, scheduling, coordination, and details. The cost of public utility interferences shall be included in CONTRACTOR's lump sum or unit price bid covering the major contract facility to which interference or changes are attributable.

B. All exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of the construction to avoid possible delays to CONTRACTOR's progress. Prepare a report identifying each utility by its size, elevation, station and material of construction. Immediately notify ENGINEER and the utility in writing as to any utility discovered in a different position than as marked in the field or shown on the Drawings, or any utility which is not marked in the field or not shown on the Drawings.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility. Conform to local agency requirements for backfill and pavement repair subsequent to performing exploratory excavations.

D. Any damages to private property, either inside or outside the limits of the easements provided by OWNER, shall be the responsibility of CONTRACTOR. Any roads, structures, or utilities damaged by the work shall be repaired or replaced in a condition equal to or better than the condition prior to the damage. Such repair or replacement shall be accomplished at CONTRACTOR's expense without additional compensation from OWNER.

E. CONTRACTOR shall remove and replace small miscellaneous structures such as fences and culverts which are damaged by the construction activity at his own expense without additional compensation from OWNER. CONTRACTOR shall replace these structures in a condition as good as or better than their original condition.

F. At points where CONTRACTOR's operations are adjacent to or across properties of railway, telegraph, telephone, irrigation canal, power, gas, water, or adjacent to other property (damage to which might result in considerable expense, loss, and inconvenience), no work shall be started until all arrangements necessary for the protection thereof have been made.

G. The locations of the major existing culinary water lines, gas pipes, underground electric, cable television, and telephone lines that are shown on the plans were taken from city maps, and maps supplied by the utility owner. No excavations were made to verify the locations shown for underground utilities, unless specifically stated on the Drawings. It should be expected that some location discrepancies will occur. Neither OWNER nor its

officers or agents shall be responsible for damages to CONTRACTOR as a result of the locations of the utilities being other than those shown on the plans or for the existence of utilities not shown on the plans.

H. CONTRACTOR shall be solely and directly responsible to owners and operators of such properties for any damage, injury, expense, loss or inconvenience, delay, suits, actions, or claims of any character brought because of an injury or damage which may result from the carrying out of the work to be done under the contract.

I. All utilities including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities encountered along the line of the work shall remain continuously in service during all operations under the Contract, unless other arrangements satisfactory to ENGINEER are made with owner of said utility.

J. In the event of interruption to either domestic or irrigation water, or to other utility services as a result of accidental breakage, or as a result of being exposed or unsupported, CONTRACTOR shall promptly notify the proper authority. CONTRACTOR shall cooperate with the authority in restoration of service as soon as possible, and shall not allow interruption of any water or utility service outside working hours unless prior approval is received.

K. In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of CONTRACTOR, be notified by OWNER to move such property within a specified reasonable time. When utility lines that are to be moved are encountered within the area of operations, CONTRACTOR shall notify ENGINEER a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

L. Where the proper completion of the WORK requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, CONTRACTOR shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to ENGINEER and OWNER of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished by CONTRACTOR in a manner that will restore or replace the Utility or improvement as nearly as possible to its former locations and to as good or better condition than found prior to removal.

1.6 RIGHTS-OF-WAY

A. CONTRACTOR shall be required to confine construction operations within the dedicated rights-of-way for public thorough fares, or within areas for which construction easements have been obtained, unless they have made special arrangements with the affected property owners in advance. CONTRACTOR shall be required to protect stored materials, cultivated trees and crops, and other items adjacent to the proposed construction site.

B. CONTRACTOR shall submit for approval by ENGINEER the type and size of equipment used, and the methods for work performed on the rights-of-way across private properties, to avoid or minimize injury to trees, shrubs, gardens, lawns, fences, driveways, retaining walls, or other improvements within the rights-of-way.

C. The construction easement widths and access to private properties are as shown on the Drawings and as described in the easement documents; however CONTRACTOR is to minimize impacts to surface improvements within the right-of-way. CONTRACTOR shall obtain a signed release from the property owner, approving restoration of work in the construction easements across or bordering private properties. See Project Closeout Section 01 78 50, 1.4.D.

D. Property owners affected by the construction shall be notified by CONTRACTOR at least 48 hours in advance of the time the construction begins. During all construction operations, CONTRACTOR shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to his property for a period exceeding 8 hours unless CONTRACTOR has made special arrangements with the affected persons. CONTRACTOR shall, daily or more frequently if necessary, grade all disturbed areas to be smooth for motor vehicle traffic.

1.7 PROTECTION OF SURVEY, STREET OR ROADWAY MARKERS

A. CONTRACTOR shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by CONTRACTOR shall be accurately restored after street or roadway resurfacing has been completed.

1.8 TREES OR SHRUBS WITHIN PROJECT LIMITS

A. Except where trees or shrubs are indicated to be removed, CONTRACTOR shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or OWNER. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by CONTRACTOR or a certified tree company under permit from the jurisdictional agency and/or OWNER. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.

1. Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1-1/2 inches in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.
2. CONTRACTOR shall immediately notify the jurisdictional agency and/or OWNER if any tree or shrub is damaged by CONTRACTOR's operations. If, in the opinion of said agency or OWNER, the damage is such that replacement is necessary, CONTRACTOR shall replace the tree or shrub at its own expense. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a smaller size, CONTRACTOR shall pay to OWNER of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or OWNER. The size of the tree or shrub shall be not less than 1-inch diameter nor less than 6 feet in height.

1.9 LAWNS

A. Lawns that are damaged or destroyed during performance of the work shall be repaired or replaced with turf sod according to APWA Section 32 92 00 - Turf and Grass.

1.10 FENCES

A. Fences that are damaged or destroyed during performance of the work shall be repaired or replaced back to the original condition or better to the satisfaction of the land owner and OWNER.

1.11 LANDSCAPING

A. All landscaping on private property that is damaged or destroyed during performance of the work shall be repaired or replaced back to the original condition or better to the satisfaction of the land owner and OWNER.

1.12 OTHER SURFACE IMPROVEMENTS

A. All other surface improvements not explicitly mentioned herein that are damaged or destroyed during performance of the work shall be repaired or replaced back to original condition or better.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 56 00
DUST CONTROL

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials and equipment as required to provide dust control for the project.

B. All materials and services shall comply with the requirements of the State of Utah, Department of Environmental Quality, Division of Air Quality and the City's Municipal Code.

PART 2 PRODUCTS

2.1 MATERIALS

A. Water. CONTRACTOR shall be responsible to arrange and pay for water for dust control.

B. Calcium chloride shall be added to the water used to provide dust control, if required by the City.

PART 3 EXECUTION

3.1 DUST CONTROL

A. CONTRACTOR shall comply with the requirements of the State of Utah Department of Environmental Quality, Air Quality Regulations (including R301-205 Emission Standards: Fugitive Emissions and Fugitive Dust, and R307-309 Fugitive Emissions and Fugitive Dust, of the Utah Air Conservation Rules (UACR). CONTRACTOR shall submit a Fugitive Dust Control Plan to the Utah Division of Air Quality, which meets the requirements of R307-309-4. CONTRACTOR shall obtain a permit from the Division of Air Quality.

B. CONTRACTOR shall execute Work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into the atmosphere. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced.

3.2 WATER PLACEMENT FOR DUST CONTROL

A. CONTRACTOR is responsible for placement of sufficient water to control dust on the project. Dust control is defined by the permit requirements of the State of Utah, Division of Environmental Quality, Division of Air Quality. Permit shall be obtained by CONTRACTOR.

3.3 WATER AND CALCIUM CHLORIDE MIXTURE FOR DUST CONTROL

A. CONTRACTOR may also use a water and calcium chloride solution to abate the dust for the project. The mixture of calcium chloride per 10,000-gallon truck shall be 10 pounds. The calcium chloride shall be added to the water truck container as the water is being put into the water truck in order to provide sufficient mixing.

B. In the absence of providing the water and calcium chloride mixture, CONTRACTOR shall meet the requirements of Subsection 3.2 of this document, or shall use other approved methods by OWNER that will allow CONTRACTOR to meet permit requirements.

- END OF SECTION -

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 PRODUCTS

A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

C. Furnish interchangeable components from same manufacturer for components being replaced.

1.2 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.3 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

D. For exterior storage of fabricated products, place on sloped supports above ground.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.4 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

1.5 PRODUCT SUBSTITUTION PROCEDURES

A. ENGINEER will consider requests for Substitutions only after Notice of Award.

B. Substitutions may be considered when a product becomes unavailable through no fault of CONTRACTOR.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that CONTRACTOR:

1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
2. Will provide same warranty for Substitution as for specified product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to OWNER.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse OWNER for review or redesign services associated with re-approval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:

1. Submit four copies of request for Substitution for consideration to ENGINEER.
2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. ENGINEER may require CONTRACTOR to provide additional data about the proposed substitution.
4. ENGINEER will be the sole judge as to the type, function, and quality of any such substitution and ENGINEER’s decision shall be final.
5. ENGINEER will notify CONTRACTOR in writing of decision to accept or reject request.
6. Acceptance by ENGINEER of a substitution proposed by CONTRACTOR shall not relieve CONTRACTOR of the responsibility for full compliance with the Contract Documents and for the adequacy of the substitution.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 71 13
MOBILIZATION

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section is provided to cover CONTRACTOR's cost of general and miscellaneous responsibilities and operations not normally attributed to, or included in, any other single bid item. This shall include, but not necessarily be limited to, work described or enumerated in this section under the following subsections.

1.2 MOVING TO AND FROM THE JOB SITE

A. This shall include CONTRACTOR's preliminary arrangement for starting and stopping construction operations, work schedules, and transportation of equipment and personnel to and from the project.

1.3 CLEAN-UP

A. The cost of all clean-up work as specified and not covered under other items shall be included in the Bid. Values shall be included in the Bid Schedule, lump-sum price, for “Mobilization”.

1.4 TEMPORARY UTILITIES

A. The cost of water, power, etc. required by CONTRACTOR in performing the Work specified in the Contract shall be included in the Bid. Values shall be included in the Bid Schedule, lump-sum price, for “Mobilization”.

1.5 PERFORMANCE BOND, PAYMENT BOND, AND INSURANCE

A. The cost of the Performance Bond, Payment Bond, and any required insurance and/or other miscellaneous cost associated with this Project shall be included with the Bid. Values shall be included in the Bid Schedule, lump-sum price, for “Mobilization”.

1.6 PERMITS

A. CONTRACTOR shall provide all necessary permits for completion of the Work. Values shall be included in the Bid Schedule, lump-sum price, for “Mobilization”.

1.7 PRE-CONSTRUCTION VIDEO RECORDS

A. CONTRACTOR is required to produce a preconstruction video recording of areas where Work is to be performed. The video record shall be of professional quality and the coverage shall be such, as to allow accurate determination of location, size, and conditions, etc. of existing features and improvements within the rights-of-way. CONTRACTOR shall provide OWNER with a copy of the rights-of-way video in electronic format on a digital video disc (DVD) or solid-state drive (USB or Thumb Drive) before construction begins.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 78 50
PROJECT CLOSEOUT

PART 1 GENERAL

1.1 FINAL CLEANUP

A. CONTRACTOR shall promptly remove from the vicinity of the completed Work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the Work by OWNER will be withheld until CONTRACTOR has satisfactorily complied with the foregoing requirements for final cleanup of the Project Site.

1.2 TOUCH-UP AND REPAIR

A. CONTRACTOR shall touch up or repair all finished surfaces on structures, equipment, fixtures, etc., that have been damaged prior to final acceptance. Surface on which such touch-up or repair cannot be successfully accomplished shall be completely refinished or in the case of hardware and similar small items, the item shall be replaced.

1.3 CLOSEOUT TIMETABLE

A. CONTRACTOR shall establish dates for equipment testing, acceptance periods and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow OWNER, ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

1.4 MAINTENANCE AND GUARANTEE

A. CONTRACTOR shall comply with the maintenance and guarantee requirements contained in Article 7 of the General Conditions, Section 00 70 00.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such required repair work shall be completed by CONTRACTOR at no cost to OWNER.

C. CONTRACTOR shall make all repairs and replacements promptly upon receipt of written order from OWNER. If CONTRACTOR fails to make such repairs or replacement promptly, OWNER reserves the right to do the work and CONTRACTOR and his surety shall be liable to OWNER for the cost thereof.

D. CONTRACTOR shall obtain a signed release from the property owner approving restoration of work in the construction easements across or bordering private property.

1.5 BOND

A. CONTRACTOR shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above, and Article 13 of the General Conditions, Section 00700.

1.6 FINAL ACCEPTANCE

A. Final acceptance and final payment shall not be made until all provisions of the General Conditions Section 00700 Article 14 have been satisfied.

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 utilized.
3. Changes made by Addenda and modifications.

F. Record Drawings: Legibly mark each item to record actual construction including:

1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements
2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work
3. Field changes of dimension and detail
4. Details not on original Contract drawings

G. Submit documents to ENGINEER with claim for final Application for Payment.

1.8 CONTRACT CLOSEOUT

A. As a condition precedent to final acceptance of the project, CONTRACTOR shall complete the following forms and submit the original and two copies of each form to the Project Representative.

1. Contractor's Notice of Substantial Completion
2. Contractor's Certificate of Final Completion
3. Affidavit of Payment

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work necessary to furnish, install, and complete, the concrete formwork.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 30 00 Cast-in-Place Concrete

1.3 MEASUREMENT AND PAYMENT

A. Concrete formwork shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.4 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Concrete Institute (ACI) -ACI 347R- Guide to Formwork for Concrete
2. American Hardboard Association (AHA) -AHA A135.4- Basic Hardboard
3. Department of Commerce (DOC) -DOC PS 1- Structural Plywood
4. ACI 350R-01 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
5. NSF International (NSF) 61 - Drinking Water System Components - Health Effects

1.5 DESIGN

A. Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the finish specified in Section 03 30 00 Cast-in-Place Concrete. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

1.6 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. The following shall be submitted:

1. Drawings showing details of forming, shoring and bracing for footings, walls, and floors shall be submitted to ENGINEER at least 3 weeks prior to their use. Drawings showing details of formwork shall include joints, supports, studding and shoring, and sequence of form and shoring removal.

2. If requested by ENGINEER, design analysis and calculations shall be submitted for form design and methodology used in the design. The analysis and calculations shall verify the selection of form ties, horizontal and vertical stiff-backs or braces for wall panels, forming and form openings, or any other part of forming, shoring or bracing which may be considered critical by ENGINEER.
3. Manufacturer's data including literature describing form materials, accessories, and form releasing agents.
4. Manufacturer's recommendation on method and rate of application of form releasing agent.

C. ENGINEER's review will not relieve CONTRACTOR from any responsibility as to the adequacy of the forming, shoring and bracing design. Any formwork installed by CONTRACTOR shall be solely at CONTRACTOR's risk. ENGINEER's review will not lessen or diminish CONTRACTOR's liability.

PART 2 PRODUCTS

2.1 FORM MATERIALS

A. Form surfaces shall be in "new and undamaged" condition and may be plywood, hard plastic finished plywood, overlaid waterproof particle board, and steel of sufficient strength and surface smoothness to produce the specified finish. CONTRACTOR shall verify that his types of form surfaces and panel sizes satisfy all requirements of these specifications.

B. The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.

2.2 FORM TIES

A. Form ties on exposed surfaces shall be located in a uniform pattern. Snap ties shall not be broken until the concrete has reached the design concrete strength. The use of tie wires as form ties will not be permitted. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used. Form ties shall be **Plastic Cone Snap Tie by Dayton-Superior, Wrench Head Snap Tie by MASCO Mason Supply,** or approved equal.

B. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess. Taper ties shall be **Taper Tie by Dayton-Superior, Taper-Tie by MASCO Mason Supply**, or approved equal.

2.3 FORM RELEASING AGENTS

A. Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 EXECUTION

3.1 INSTALLATION

A. Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03 30 00 Cast-in-Place Concrete. Forms shall be used, whenever necessary, to confine the concrete, to shape the concrete to the required lines and grades, and to obtain a thoroughly compacted dense concrete through proper vibrating. The forms shall have sufficient strength and rigidity to hold the concrete and to withstand the necessary pressure, tamping and vibration, without deflection from the prescribed lines. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar.

B. The surfaces of all forms in contact with the concrete shall be clean, rigid, tight and smooth. All dirt, chips, sawdust, mud, water and other foreign matter shall be removed from within the forms or within the excavated areas, before any concrete is deposited therein.

C. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be thoroughly cleaned of mortar from previous concreting and of all other dirt and foreign matter before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

D. Bulkheads to form vertical wall joints shall be strong enough to withstand concrete pressures during pouring and vibrating, and shall be properly placed between the forms to avoid mortar seepage. Holes shall be provided in the bulkheads to permit passage of horizontal mild steel reinforcing where required by the Contract Drawings. Unless these are specifically called for on the Contract Drawings, no chamfer strips shall be placed in the corners of vertical construction joints.

3.2 COATING

A. Form inside surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.3 ALIGNMENT AND TOLERANCES

Forms shall be properly aligned and adequately supported to produce concrete surfaces conforming to construction tolerance given in Table 03 10 00-1, Tolerances for Formed Surfaces.

TABLE 03 10 00-1
TOLERANCES FOR FORMED SURFACES

Condition	Measurement	Tolerance
1. Variations from the plumb:	In any 10 feet of length	1/4-inch
a. In the lines and surfaces of columns, piers, walls and in arises	Maximum for entire length	1 inch
b. For exposed corner columns, control-joint grooves, and other conspicuous lines	In any 20 feet of length Maximum for entire length	1/4-inch 1/2-inch
2. Variation from the level or from the grades indicated on the drawings	In any 10 feet of length In any bay or in any 20 feet of length	1/4-inch 3/8-inch
3. Variation of the linear building lines from established position in plan	In any 20 feet Maximum	1/2-inch 1-inch
4. Variation of distance between walls, columns, partitions	1/4-inch per 10 feet of distance, but not more than 1/2-inch in any one bay, and not more than 1-inch total variation	
5. Variation in the thickness of slabs and walls	Minus Plus	1/4-inch 1/2-inch

3.4 FORM REMOVAL

A. Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Forms shall not be removed until approval is given by ENGINEER. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement.

B. CONTRACTOR shall remove all wood splinters on concrete surfaces after stripping of wood forms.

- END OF SECTION -

SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the reinforcing steel bars, wire fabric or rod mats for cast-in-place concrete.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 301 Specifications for Structural Concrete
2. ACI 315 Details and Detailing of Concrete Reinforcement
3. ACI 318 Building Code Requirements for Structural Concrete and Commentary
4. ACI 350R Code Requirements for Environmental Engineering Concrete Structures and Commentary

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
2. ASTM A 615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
3. ASTM A 767 Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
4. ASTM A 775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars
5. ASTM A 1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

D. CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

1. CRSI (DA4) Manual of Standard Practice (MSP-1)

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 - Submittal Procedures:

1. Drawings of Concrete Reinforcement System with details showing reinforcing steel schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.
2. Reinforcing Steel with certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

1.5 DELIVERY AND STORAGE

A. Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

1.6 MEASUREMENT AND PAYMENT

A. Concrete reinforcement shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 DOWELS

A. Dowels shall conform to ASTM A 615, Grade 60.

2.2 FABRICATED BAR MATS

A. Fabricated bar mats shall conform to ASTM A 184.

2.3 REINFORCING STEEL

A. Reinforcing steel shall be deformed bars conforming to ASTM A 615 grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 1064. When no grade is indicated use 60 ksi grade steel. Special coated bars (epoxy and zinc) may be specified for use in a highly corrosive atmosphere where concrete cover is not considered sufficient. In which case reference to ASTM A 767 and A 775 will be included.

2.4 WELDED WIRE FABRIC

A. Welded wire fabric shall conform to ASTM A 1064.

2.5 WIRE TIES

A. Wire ties shall be 16-gauge or heavier black annealed steel wire.

2.6 SUPPORTS

A. Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI (DA4) MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete.

B. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within ½ inch of concrete surface shall be plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

PART 3 EXECUTION

3.1 REINFORCEMENT

A. Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete.

B. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety.

C. Placement:

1. Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete.
2. Reinforcement shall be placed in accordance with ACI 318 at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

D. Splicing:

1. Splices of reinforcement shall conform to ACI 318 and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6-inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 WELDED-WIRE FABRIC

A. Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Lap

splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWELS

A. Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately aligned parallel to the finished concrete surface and rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

- END OF SECTION -

SECTION 03 25 00
EXPANSION JOINTS, CONSTRUCTION JOINTS AND WATERSTOPS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers the work necessary to furnish, install and complete expansion and construction joints, including waterstops.

B. All waterstops and sealants in contact with potable water including waterstops embedded in concrete floors and walls of potable water tanks shall be NSF 61 certified.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 33 00 Cast-in-Place Concrete

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 318 Building Code Requirements for Reinforced Concrete

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
3. ASTM C 920 Standard Specification for Elastomeric Joint Sealants
4. ASTM D 570 Standard Test Method for Water Absorption of Plastics
5. ASTM D 624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
6. ASTM D 638 Standard Test Method for Tensile Properties of Plastics
7. ASTM D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
8. ASTM D 747 Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
9. ASTM D 792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
10. ASTM D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
11. ASTM D 1752 Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

12. ASTM D 2240 Standard Test Method for Rubber Property-Durometer Hardness

D. FEDERAL SPECIFICATIONS (FS)

1. FS-TT-S-00227E Sealing Compound: Elastomeric Type, Multi-Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 – Submittal Procedures:

1. Submit certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements specified. ENGINEER, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by OWNER. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by CONTRACTOR.
2. Samples of factory fabricated waterstop joints representing in all respects the material and workmanship of the material that will be furnished under this contract. Samples will be submitted and approved by ENGINEER prior to use of the factory joints in the field.
3. Manufacturer's catalog data and manufacturer's recommended instructions for splicing of waterstops.

1.5 OBSTRUCTIONS

A. CONTRACTOR shall pay particular attention to removing all obstructions such as concrete, nails, etc., from joints when movements of floor or wall sections can be expected under temperature and other conditions.

1.6 QUALITY ASSURANCE

A. Waterstop manufacturer shall demonstrate five years (minimum) continuous, successful experience in production of waterstops.

1.7 DELIVERY AND STORAGE

A. Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

1.8 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for expansion joints, construction joints, and waterstops. Full compensation for expansion joints, construction joints, and waterstops shall be considered as included in the Contract unit or lump sum prices for the various items of the Contract to which it relates.

PART 2 PRODUCTS

2.1 HORIZONTAL JOINT SEALANT

A. Horizontal joints not requiring waterstops or when so indicated on the Contract Drawings, shall be sealed using **Sikaflex-2c NS**, or approved equal, and shall meet the requirements of ASTM C-920, Type M, Grade NS, Class 25 and FS-TT-S-00227E, Type II, Class A, and shall be NSF 61 certified (Sikaflex 2c NS EZ) if in contact with potable water. Color shall match color of concrete.

2.2 VERTICAL JOINT SEALANT

A. Vertical joints not requiring waterstops or when so indicated on the Contract Drawings, shall be sealed using **Sikaflex-2c NS,** or approved equal, and shall meet the requirements of ASTM C-920, Type M, Grade NS, Class 25 and FS-TT-S-00227E, Type II, Class A, and shall be NSF 61 (Sikaflex 2c NS EZ) certified if in contact with potable water. Color shall match color of concrete.

2.3 JOINT PRIMER

A. All joints receiving a joint sealant shall be primed using **Sikaflex Primers 429/202**, or approved equal.

2.4 EXPANSION JOINTS

A. Expansion joints shall be composed of cellular fibers securely bonded together and uniformly saturated with asphalt. Joint shall be resilient, flexible, and non-extruding. Expansion joints shall meet the requirements of ASTM D 1751. Manufacturer shall be **Fibre Expansion Joint by W.R. Meadows, Fiberflex by JD Russel Company**, or approved equal.

2.5 PVC WATERSTOPS

A. Waterstops shall be of an approved type, supplied by an approved manufacturer and shall be plastic made of virgin polyvinylchloride (PVC) compound, shall be ribbed, uniform in dimensions, dense, homogeneous, free from porosity, and as detailed on the Contract Drawings. No reclaimed PVC shall be used in the compound.

B. The finished waterstop material shall meet the following minimum requirements:

Tensile strength	2,000 psi min.	(ASTM D 638)
Ultimate elongation	300% min.	(ASTM D 638)
Shore A hardness	75 ± 5	(ASTM D 2240)
Specific gravity	1.38 max	(ASTM D 792)
Stiffness in flexure	600 psi min.	(ASTM D 747)
Cold brittleness	No Failure at -35°F	(ASTM D 746)
Water absorption: 48 hours	0.15% max	(ASTM D 570)
Tear Resistance	290 lb./in. min.	(ASTM D 624)

C. Manufacturer, or approved equal:

1. Vinylex Waterstop & Accessories
2. Greenstreak, Inc. (Sika Corporation)
3. Durajoint Concrete Accessories

D. Factory made waterstop joints shall have a tensile strength across the joint equal to at least 600 psi. Field splices and joints shall be made in accordance with the waterstop manufacturer's instructions using a thermostatically-controlled heating iron.

2.6 HYDROPHILIC WATERSTOP

A. Non-bentonite rubber hydrophilic waterstop shall only be used where shown on the Contract Drawings or when approved by ENGINEER. Size shall be as indicated on the Contract Drawings.

B. The hydrophilic waterstop shall meet the following physical properties:

Physical Property	Test Method	Result
Tensile Strength (Minimum)	ASTM D412	350 psi
Elongation (minimum)	ASTM D412	600 %
Hardness	ASTM D2240	52 +/-5 Shore A
Tear Resistance	ASTM D624	50 lb/in
Specific Gravity	ASTM D792	1.35 +/-5

C. Manufacturer, or approved equal:

1. Conseal CS-231
2. Sika Hydrotite CJ-1020-2K

PART 3 EXECUTION

3.1 WATERSTOPS

A. Waterstops shall be of the type indicated and shall be installed at the locations shown to form a continuous water-tight diaphragm. The waterstop shall be correctly positioned in the forms so that the center of the waterstop is centered on the joint. Waterstop shall be held in place in the forms by use of a split form or other approved method that will positively hold the waterstop in the correct position and to the correct alignment. Vibrate concrete to obtain impervious concrete in the vicinity of all joints. In horizontal joints, ensure that the areas below the water stop are completely filled with concrete.

B. Horizontal plastic waterstops shall be bent up during placing of concrete until the concrete has been brought to the level of the waterstop; additional concrete shall then be placed over the waterstop, after which the concrete shall be thoroughly vibrated. All horizontal and vertical waterstops, which are not accessible during pouring, shall be tied off in two directions every 12 inches in such a manner that bending over one way or another is prevented. A hog-ring or nail may be driven through both ends of the waterstop to facilitate placing and tying of waterstops to reinforcing steel forms or form-ties.

C. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. All waterstops shall be properly spliced and joints shall be checked for strength and pinholes after splicing. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the waterstop, and shall be watertight. Splices in waterstop shall be made in conformance with the recommendations of the waterstop manufacturer. Continuity of cross sectional features shall be maintained across the splice. Splices showing evidence of separation after bending shall be remade.

D. Install hydrophilic waterstop in accordance with the manufacturer's written instructions. Adhesives shall meet the requirements of ASTM C 920 and shall be **Manus Bond 75-AM Lot NSF61**, **DAP Premium Polyurethane Construction Adhesive**, or approved equal.

3.2 JOINTS

A. Joints shall be installed at locations indicated and as authorized. Joints shall be constructed so as to produce straight joints, and shall be vertical or horizontal, except where walls intersect sloping floors.

B. Construction Joints

1. Prior to placing the abutting concrete for all construction joints, the contact surface shall be cleaned by approved means to remove all laitance and expose the aggregate. The exposed portion of the reinforcing steel shall be cleaned of all concrete. The cleaning method shall be conducted so as to not damage waterstop, if waterstop is present. Where the joint is to receive a sealant, a recess 3/4-inch deep shall be formed along the joint using a dressed-and-oiled wood strip or other method approved by ENGINEER. The wood strip shall be removed after the concrete has set.

C. Expansion Joints

1. Expansion joint filler shall be used where required on the Contract Drawings. The edges of the joint shall be neatly finished with an edging tool of 1/8-inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a recess 3/4-inch deep to be filled with sealant. The wood strip shall be removed after the concrete has set. In lieu of the wood strip a removable expansion filler cap designed and fabricated for this purpose may be used.

D. Joint Sealant

1. The joint cavity shall be cleaned by sandblasting or power wire brushing and shall be blown clean of dust and sand with compressed air before the joint sealant may be applied. Joints must be frost-free, free of oils, grease, curing compound residues, and any other foreign matter that might prevent bond. A bond breaker tape shall be installed over the joint per manufacturer's instructions. After the joints have been prepared as described above, the joints shall be primed and the sealant shall be applied in accordance with the manufacturer's recommendations.

- END OF SECTION -

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers cast-in-place concrete mix design and placement.

B. CONTRACTOR shall provide cast-in-place concrete as indicated in the Specifications and the Contract Drawings.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control and Material Testing
3. Section 03 10 00 Concrete Forming and Accessories
4. Section 03 20 00 Concrete Reinforcement
5. Section 03 25 00 Expansion Joints, Construction Joints, and Waterstops
6. Section 09 90 00 Painting and Finishes
7. Section 31 23 23 Excavation and Backfill for Structures

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 117 Specifications for Tolerances for Concrete Construction and Materials and Commentary
2. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
3. ACI 301 Structural Concrete for Buildings
4. ACI 304 Guide for Measuring, Mixing, Transporting, and Placing Concrete
5. ACI 305R Hot Weather Concreting
6. ACI 306R Cold Weather Concreting
7. ACI 318 Building Code Requirements for Structural Concrete and Commentary
8. ACI 350R Code Requirements for Environmental Engineering Concrete Structures and Commentary

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. ASTM C 33 Standard Specification for Concrete Aggregates
3. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C 42 Standard Test Method for Obtaining and Testing Drilled Cores and

Sawed Beams of Concrete

5. ASTM C 78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
6. ASTM C 94 Standard Specification for Ready-Mixed Concrete
7. ASTM C 109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
8. ASTM C 143 Standard Test Method for Slump of Hydraulic-Cement Concrete
9. ASTM C 150 Standard Specification for Portland Cement
10. ASTM C 171 Standard Specification for Sheet Materials for Curing Concrete
11. ASTM C 172 Standard Specification for Sampling Freshly Mixed Concrete
12. ASTM C 173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
13. ASTM C 192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
14. ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
15. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete
16. ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
17. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
18. ASTM C 618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

1.4 DEFINITIONS

A. Average Strength (f_{cr}): The required average strength for 30 consecutive strength tests which statistically assures not more than the permissible proportions of tests will fall below Specified Strength.

B. Specified Strength (f_c'): The indicated strength.

1.5 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

B. Provide catalog information for all products to be used as part of the submitted mix design.

C. The results of trial mix designs along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory. Indicate whether mixes have been designed for pumping. Include in the report the following information:

1. Water-cement ratio.
2. Proportion of materials in the mix.

3. Source and type of cement.
4. Analysis of water to be used unless potable.
5. Type and name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used and the resulting change in placement times.
6. Slump, air content and temperature of samples.
7. Unit weight of fresh and dry light weight concrete.

D. Preapproved Mix Design Data: If supplier has on record, an OWNER approved mix design, submit name and address of supplier for each mix design 1 day prior to using concrete mix.

E. Certified copies of laboratory test reports, including all test data, for aggregate, admixtures, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials. Test reports shall meet the following requirements:

1. Date of mix design: No older than 365 days from the date of submission.
2. Physical properties of the aggregate: Test results shall not be older than 455 days from the date of submission. A new report will be required if aggregate source is changed.

F. Cementitious Materials showing Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement and pozzolan.

G. Submit catalog information on the curing compound and the proposed location to be used.

1.6 QUALITY ASSURANCE

A. Do not change material sources, type of cement, air-entraining agent, water reducing agent, other admixtures, or aggregate without ENGINEER'S approval.

B. In proportioning materials for mixing, use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.

C. Do not change the quantity of cement per cubic yard for approved mix design without written approval of ENGINEER.

D. Use of admixtures will not relax hot or cold weather placement requirements.

E. Ready-mixed concrete to be in accordance with Alternate No. 3 of ASTM C-94 and the requirements in this Section.

F. Tolerances for concrete construction and materials shall be in accordance with ACI 117.

1.7 PRODUCT STORAGE AND HANDLING

A. Store bagged and bulk cement in weatherproof enclosures to exclude moisture and contaminants.

B. Stockpile aggregate to avoid segregation and prevent contamination.

C. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing.

1.8 MEASUREMENT AND PAYMENT

A. Cast-in-place concrete shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 ADMIXTURES

A. Admixtures shall be approved by ENGINEER prior to use. Any admixtures to be used shall be included in proposed concrete mix designs.

B. Air Entrainment: ASTM C 260.

C. Later Reducing and Set Retarding Agents: ASTM C494.

1. Type A: Set water reducing.
2. Type B: Set retarding.
3. Type C: Set accelerating.
4. Type D: Water reducing and set retarding.
5. Type E: Water reducing and set accelerating.
6. Type F: High range water reducing (super plasticizer).*
7. Type G: High range water reducing and set retarding.*

* The relative durability factor of water reducing admixtures shall not be less than 80 and the chlorides content (as Cl^-) expressed as a percent of the cement shall not exceed 0.1 percent by weight.

D. Calcium Chloride: None allowed.

E. Pozzolan: Pozzolan conforming to the requirements of ASTM C 618, Class F, is allowed as a Portland cement replacing agent under the following conditions:

1. The maximum percentage of Portland cement replacement is:
   a. 15 percent, for concrete exposed to weather.
   b. 20 percent, for interior concrete.
2. Pozzolan should not exceed 25% by weight of the cement plus pozzolans.
3. The minimum cement content shall be used in the design formulas before replacement is made.
4. Loss of ignition of pozzolan is less than 3 percent and the water requirement does not exceed 100 percent.
5. All other requirements of this section still apply.
6. Mix designs including trial batches are required for each aggregate source and for each concrete class.

F. Cementitious Materials showing Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement and pozzolan.

2.2 CEMENTITIOUS MATERIALS

A. Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

1. Cement: Use Portland cement, ASTM C 150, Type II, Type IIA, or Type V, low alkali, unless noted otherwise.
2. Portland - Pozzolan Cement: ASTM C-595, Type IP-A(MS). Do not use Pozzolan cement unless approved by ENGINEER

B. Only one brand of cement from one manufacturing plant may be used.

2.3 AGGREGATES

A. Aggregates shall be natural aggregates, free from deleterious coatings, and shall conform to the requirements of ASTM C 33, except as modified herein. Aggregates shall not be potentially reactive as defined in Appendix XI of ASTM C 33. CONTRACTOR shall import nonreactive aggregates if local aggregates are reactive.

B. Fine Aggregates

1. Fine aggregate shall consist of clean, sharp, natural sand and shall conform to the requirements of ASTM C 33. Fine aggregate shall be graded as follows:

FINE AGGREGATES	
Sieve Size	Percent Passing by Weight
3/8 inch	100
#4	95-100
#8	80-100
#16	50-85
#30	25-60
#50	10-30
#100	2-10

2. Fine aggregates shall have no more than two percent by weight passing #200 sieve.

C. Coarse Aggregate

1. Coarse aggregate shall be washed gravel or crushed stone, or a combination of these materials, consisting of hard, tough, durable particles free from adherent coatings. It shall contain no more than 15 percent flat or elongated particles. A thin, flat or elongated particle is defined as a particle having a maximum dimension in excess of five times its minimum dimension. Aggregate which has disintegrated or weathered badly under exposure conditions similar to those which will be encountered in the work under consideration shall not be used. Coarse aggregate shall be graded as follows (ASTM C 33):

COARSE AGGREGATES	
Sieve Size	Percent Passing by Weight
1-1/2 inch	100
1 inch	95-100
½ inch	25-60
#4	0-10
#8	0-5

2. Coarse aggregates shall have no more than 1.75 percent by weight passing #200 sieve. Proof of gradation will be provided to ENGINEER by CONTRACTOR.

2.4 ACI MIX DESIGN

A. The amount by which the average strength (f_{cr}) of a concrete mix exceeds the specified compressive strength (f'_c) shall be based upon no more than 1 in 100 random individual strength tests falling more than 500 psi below the specific strength.

B. Proportion the materials in accordance with ACI 211.1, 211.2 or 211.3 as applicable to produce concrete having the properties or limitations of Table No. 03 30 00-A.

2.5 HAND MIXING

A. Do not hand mix batches exceeding 0.5 cubic yards.

B. Hand mix only on watertight platform. Mix cement and aggregate prior to adding water.

C. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency.

2.6 HEATING, WATER AND AGGREGATE

A. Do not allow products of fuel combustion to contact the aggregate.

B. Heat mixing water to maximum temperature of 150 degrees F. Heat aggregates uniformly.

C. Do not mix cement with water and aggregate at a mix temperature greater than 100 degrees F.

2.7 WATER

A. Water shall be potable, except that non-potable water may be used if it produces mortar cubes having 7- and 28-day strengths at least 90 percent of the strength of similar specimens made with water from a municipal supply. The strength comparison shall be made on mortars, identical except for mixing water, prepared and tested in accordance with ASTM C 109. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

2.8 PROPORTIONS OF MIX

A. Mixture Proportioning, Normal Weight Concrete: All concrete that must be watertight

and resistant to freeze-thaw cycles and to naturally occurring or commonly used chemicals should be air entrained. All materials should be proportioned to produce a well-graded mixture of high density and maximum workability with a minimum specified 28 day compressive strength of concrete classification. Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios. Trial mixes shall be proportioned to produce concrete strengths specified. In the case where ground iron blast-furnace slag is used, the weight of the slag will be substituted in the equations for the term P which is used to denote the weight of pozzolan. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength. Maximum water-cement or water-cement plus pozzolan Ratio: 0.45.

B. Average Strength: In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 1,000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

TABLE NO. 03 30 00-A

CONCRETE MIX PROPERTIES (e)

CONCRETE PROPERTIES	CONCRETE CLASSIFICATION(S)		
	Class 4000	Class 3500	Class 3000
Specified Compressive Strength $f_{c'}$ at 28 days, min., psi	4,000	3,500 (d)	3,000 (d)
Compressive Strength at 7 days, min., psi (a)	2,680	2,345	2,010
Cement content (94 lb. sacks of cement per cubic yard of concrete), min. (b)	6.0	5.75	5.5
Entrained air content, (% by volume).	6±1	6±1	6±1
Slump Range, in. (c)	1 - 4 (f)	2 - 4	2 - 4
Maximum Water Cement Ratio	0.45	0.45	0.45

(a) Used for monitoring purposes only.

(b) May include pozzolan replacements if approved by ENGINEER.
(c) Not more than 8 inches after adding high range water reducing admixture (super-plasticizer) at site.
(d) Not allowed if concrete is exposed to freezing and thawing temperatures. Use Class 4000 or higher compressive strength and 6±1.0 percent air entrainment.
(e) All mix designs must be approved by ENGINEER.
(f) 1-3" for footings, sub-structural walls and 1-4" for slabs, beams, reinforced walls and columns.

2.9 CURING MATERIALS

A. Normal Curing Compound

1. Curing compound shall be white pigmented and shall conform to ASTM C 309, Type 2 Class B.
2. Sodium silicate compounds cannot be used.
3. Manufacturer, or approved equal:
   a. 1200-White by W.R. Meadows
   b. White Resin Cure J10W by Dayton Superior
   c. Safe-Cure 2000 by ChemMasters
   d. Aqua Kure White by Lambert Corporation

B. Dissipating Curing Compound

1. When the curing compound must be removed for finishes or grouting, compounds shall be of a dissipating type, conforming to the requirements of ASTM C 309, Type 1 or Type 2, Class B
2. Manufacturer, or approved equal:
   a. 1100-Clear by W.R. Meadows
   b. Kurez DR VOX by Euclid Chemical Company
   c. Clear Cure VOC J7WB by Dayton Superior
   d. Safe-Cure Clear DR by ChemMasters

PART 3 EXECUTION

3.1 GENERAL

A. CONTRACTOR shall inform ENGINEER at least 72 hours in advance of time and places at which CONTRACTOR intends to place concrete. All preparation work for concrete placements shall be substantially completed at least 2 workdays prior to the scheduled start of concrete placement to allow for ENGINEER's review and any necessary corrections.

3.2 PREPARATION OF SURFACES

A. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance.

B. Foundations: Earthwork shall be as specified. Flowing water shall be diverted without washing over freshly deposited concrete. Rock foundations shall be cleaned by high velocity air-water jets, sandblasting, or other approved methods. Debris and loose, semi-detached or unsound fragments shall be removed. Rock surfaces shall be moist but

without free water when concrete is placed. Semi porous subgrades for foundations and footings shall be damp when concrete is placed. Pervious subgrades shall be sealed by blending impervious material with the top 6 inches of the in-place pervious material or by covering with an impervious membrane.

C. Preparation of Previously Placed Concrete: Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be moist but without free water when concrete is placed.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

B. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations as indicated or shown on the Contract Drawings. Proper placement and locations shall be the responsibility of CONTRACTOR.

3.4 BATCHING, MIXING AND TRANSPORTING CONCRETE

A. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and non-agitating units shall comply with NRMCA TMMB-1. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA-QC 3.

B. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quantity and quality of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by ENGINEER.

C. Truck mixers and their operation must be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than 1 inch when the specified slump is 3 inches or less, or more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

D. Admixtures: Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible. Retarding admixture shall be added within one minute after addition of water is complete or in the first quarter of the required mixing time, whichever is first. Superplasticizing admixtures shall be added at the project site, and the concrete with the admixture shall be mixed 4 to 5 minutes before placing as recommended by

manufacturer. Concrete that shows evidence of total collapse or segregation caused by the use of admixture shall be removed from the site.

E. Control of Mixing Water: No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch. No water shall be added at the jobsite without the approval of ENGINEER.

3.5 SAMPLING AND TESTING

A. Sampling and Testing of the concrete will be as defined in Section 01 45 00 – Quality Control and Material Testing. If there are discrepancies between this Section and Section 01 45 00, the more stringent requirement shall apply.

1. Aggregates: Aggregates for normal weight concrete shall be sampled and tested in accordance with ASTM C 33.
2. Sampling of Concrete: Samples of concrete for air, slump, unit weight, and strength tests shall be taken in accordance with ASTM C 172.
    a. Air Content: Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231. A minimum of 1 test shall be conducted each time a slump test is made.
    b. Slump: At least 1 slump test shall be made on randomly selected batches of each mixture of concrete for every 100 cubic yards of ready-mixed concrete delivered to the job site. Also note the time batched at the plant and the starting time when unloading began at the site. Tests shall be performed in accordance with ASTM C 143.
    c. Temperature: Concrete and air temperatures shall be measured and recorded with each slump test or with each set of cylinders and the air temperature shall also be recorded when the air temperature at the site is 40 degrees F or below and/or 90 degrees F or above.
3. Evaluation and Acceptance of Concrete
    a. Frequency of Testing: Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 100 cubic yards of concrete, nor less than once for each 3,000 square feet of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or from each truck if fewer than 5 truck loads are used. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.
    b. Testing Procedures: Cylinders for acceptance tests shall be molded and cured in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another specified test age.

c. Evaluation of Results: Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength by more than 500 pounds per square inch.
d. Unless noted otherwise, make a minimum of five (5) concrete cylinders each time a test is required. When concrete is being placed in suspended slabs, beams and retaining walls make two (2) extra cylinders which must be cured on site. The extra cylinders will be used to determine when to remove forms and/or when to backfill.

B. Investigation of Low-Strength Test Results: When any strength test of standard-cured test cylinder falls below the specified strength requirement by more than 500 pounds per square inch, or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by ENGINEER to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by ENGINEER to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by ENGINEER in accordance with the requirements of ACI 318. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to ENGINEER. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by ENGINEER, at the expense of CONTRACTOR.

3.6 CONVEYING CONCRETE

A. Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph 3.6 CONCRETE PLACEMENT by methods which will prevent segregation or loss of ingredients. Conveying concrete shall be in accordance with the requirements of ACI 304.

1. Chutes: When concrete can be placed directly from a truck mixer or other transporting equipment, chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.
   a. Use metal or metal lined chutes with a maximum length of 20-feet.

b. The minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them.

2. Buckets: Bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.

3. Pumps: Concrete may be conveyed by positive displacement pumps when approved. Pump shall be the piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.7 CONCRETE PLACEMENT

A. Mixed concrete which is transported in truck mixers or agitators or concrete which is truck mixed, shall be discharged within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations may be waived by ENGINEER if the concrete is of such slump after the 1-1/2 hour time or 300 revolution limit has been reached that it can be placed, without the addition of water to the batch. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the truck.

1. Placing Operation: Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by CONTRACTOR prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 4 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Concrete should not be allowed to drop through a cage of reinforcing steel. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screened to the proper level to avoid excessive shimming or grouting.
   a. Additional requirements for depositing concrete in walls include, but are not limited to:

1) Deposit concrete in a continuous operation until section is completed.
2) Place concrete in approximately horizontal layers 2 ft maximum thickness.
3) Each layer of concrete shall be plastic when covered with following layer.
4) Rate of vertical rise not more than 4 ft per hour.
5) Pump concrete or use a tremie having varying lengths for placing concrete in columns and walls to prevent free fall of more than 4 ft.
6) Allow concrete to thoroughly settle before top is finished. Remove all laitance, debris, and surplus water from surfaces at tops of forms by screeding, scraping, or other effective means.

b. Additional requirements for depositing concrete in slabs include, but are not limited to:
1) Deposit concrete in a continuous operation until section is completed.
2) Concrete shall be deposited as nearly as practicable to its final position to avoid segregation due to rehandling or flowing.
3) In sloping slabs, proceed uniformly from the bottom of the slab to the top for the full width of the placement.

2. Consolidation: Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 8,000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique.

B. Cold Weather Requirements: Cold weather requirements shall conform to ACI 306 and this Specification. Special protection measures, approved by ENGINEER, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. Provisions should be made to keep the concrete at a minimum temperature of 50 degrees F for 7 days. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 32 degrees F. No concrete shall be placed on frozen ground. The temperature of the concrete when placed shall be not less than 55 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Calcium chloride shall not be used.

C. Hot Weather Requirements: Hot weather requirements shall conform to ACI 305 and this Specification. The temperature of the concrete placed during hot weather shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing

temperature. In no case shall the placing temperature exceed 95 degrees F.

3.8 CONSTRUCTION JOINTS

A. Construction joints shall be located as indicated on the Contract Drawings. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of ENGINEER. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete is no longer plastic, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints are required, a strip of 1-inch square-edge lumber, beveled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph 3.1, PREPARATION OF SURFACES.

3.9 FINISHING CONCRETE

A. Formed Surfaces

1. Repair of Surface Defects: Surface defects shall be repaired within 24 hours after the removal of forms. Honeycombed and other defective areas shall be cut back to solid concrete or to a depth of not less than 1 inch, whichever is greater. Edges shall be cut perpendicular to the surface of the concrete. The prepared areas shall be dampened and brush-coated with neat cement grout. The repair shall be made using mortar consisting of not more than 1 part cement to 2-1/2 parts sand. The mixed mortar shall be allowed to stand to stiffen (approximately 45 minutes), during which time the mortar shall be intermittently remixed without the addition of water. After the mortar has attained the stiffest consistency that will permit placing, the patching mix shall be thoroughly tamped into place by means approved by ENGINEER and finished slightly higher than the surrounding surface. For Class A and Class B finished surfaces the cement used in the patching mortar shall be a blend of job cement and white cement proportioned to produce a finished repair surface matching, after curing, the color of adjacent surfaces. Holes left after the removal of form ties shall be cleaned and filled with patching mortar. Holes left by the removal of tie rods shall be reamed and filled by dry-packing. Repaired surfaces shall be cured as required for adjacent surfaces. The temperature of concrete, mortar patching material, and ambient air shall be above 50 degrees F while making repairs and during the curing period. Concrete with defects which affect the strength of the member or with excessive honeycombs will be rejected, or the defects shall be corrected as directed by ENGINEER.
2. Class A Finish: Where a Class A finish is indicated, fins shall be removed. A mortar mix consisting of one-part Portland cement and two parts well-graded sand passing a No. 30 sieve, with water added to give the consistency of thick paint, shall be prepared. White cement shall be used to replace part of the job cement. After the

surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously applied to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads until all visible grout film is removed. The rubbing pads shall have on their surfaces the same sand-cement mix specified above but without any mixing water. The finish of any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours. The temperature of the air adjacent to the surface shall be not less than 50 degrees F for 24 hours prior to, and 48 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas.

3. Class B Finish: Where a Class B finish is indicated, fins shall be removed. Concrete surface shall be smooth with a texture at least equal to that obtained through the use of Grade B-B plywood forms.
4. Class C Finish: Where a Class C finish is indicated, fins shall be removed. Concrete surfaces shall be relatively smooth with a texture imparted by the forms used.
5. Class D Finish: Where a Class D finish is indicated, fins exceeding 1/4 inch in height shall be chipped or rubbed off. Concrete surfaces shall be left with the texture imparted by the forms used.
6. See Specification Section 09 90 00 Painting and Finishes for required finishes.

B. Unformed Surfaces: In cold weather, the air temperature in areas where concrete is being finished shall not be less than 50 degrees F in accordance with ACI 306R. In hot windy weather when the rate of evaporation of surface moisture, as determined by methodology presented in ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour; coverings, windbreaks, or fog sprays shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than 5/16-inch when tested with a 10-foot straightedge. Surfaces shall be pitched to drains.

1. Rough-Slab Finish: Slabs to receive fill or mortar setting beds shall be screened with straightedges immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible.
2. Float Finish: Slabs to receive a steel trowel finish and slabs where indicated shall be given a float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections. Float finish is normally specified for surfaces that will receive other treatment such as built-up roofing, nonslip surfacing material. Float Finish shall not be used on wearing surfaces.
3. Trowel Finish: Slabs where indicated, shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand. Trowel finish shall be used on wearing surfaces and where a smooth finish is required.
4. Broom Finish: After floating, slabs where indicated, shall be lightly troweled, and

then broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

5. See Specification Section 09 90 00 Painting and Finishes for required finishes.

3.10 CURING AND PROTECTION

A. General: All concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days
Concrete with Type II or IIA, or V, low alkali cement	7 days
Concrete with Type IP-A(MS) cement blended with pozzolan	10 days

B. Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. All materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

C. Moist Curing: Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2-inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap. Once the moist curing has started the concrete surface must not be allowed to become surface dry for the entire curing period.

D. Membrane Curing:

1. Normal membrane curing compound shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete. Use a Dissipating curing compound for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring.
2. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam.
3. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface.

4. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period.
5. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions.
6. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified.
7. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period.
8. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.11 QUALITY CONTROL TESTING

A. Quality Control Testing shall be in accordance with Section 01 45 00 – Quality Control and Material Testing.

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SECTION 03 60 00
GROUT

PART 1 GENERAL

1.1 REQUIREMENTS

A. CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents.

B. Unless indicated otherwise, grouts shall be provided as listed in this Section whether indicated on the Contract Drawings or not.

C. The following types of grouts are covered in this Section:

1. Cement Grout
2. Non-Shrink Grout – Class I (cement based)
3. Non-Shrink Grout – Class II (cement based)
4. Non-Shrink Epoxy Grout
5. Epoxy Anchor Grout for Adhesive Anchors
6. Topping Grout and Concrete/Grout Fill

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 60 00 Product Requirements
3. Section 03 30 00 Cast-in-Place Concrete

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. American Society for Testing Materials (ASTM)

1. ASTM C 33 Standard Specification for Concrete Aggregates
2. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
3. ASTM C 150 Standard Specification for Portland Cement
4. ASTM C 307 Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
5. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
6. ASTM C 496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
7. ASTM C 531 Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
8. ASTM C 579 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

9. ASTM C 580 Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
10. ASTM C 827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
11. ASTM C 881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
12. ASTM C 882 Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
13. ASTM C 939 Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
14. ASTM C 942 Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
15. ASTM C 1090 Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
16. ASTM C 1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
17. ASTM C 1339 Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
18. ASTM D 648 Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
19. ASTM D 695 Standard Test Method for Compressive Properties of Rigid Plastics

1.4 CONTRACTOR SUBMITTALS

A. Submittals shall be furnished in accordance with Section 01 33 00 – Submittal Procedures.

B. Provide the following submittals for each type of grout used on the project:

1. Test reports accompanied by a manufacturer’s statement that previously tested material is of similar type, quality, and manufacture as that which is proposed for use on this project shall be submitted for:
   a. Cement
   b. Aggregates
   c. Retardants
   d. Bonding compounds
   e. Epoxy Resin
2. Certifications that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
3. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor grout for adhesive anchors.
4. Manufacturer’s certification that non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.
5. Submit manufacturer's written warranty as indicated herein.
6. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Grout and grout materials shall be stored in a dry shelter, protected from moisture, and for prepackaged grout, maintained in accordance with the manufacturer's recommendations.

1.6 QUALITY ASSURANCE

A. The work shall be subject to inspection at all times by OWNER and ENGINEER for the purpose of determining that the work is properly executed in accordance with this specification. Failure to detect defective workmanship or material during any interim inspection shall not constitute acceptance of workmanship and materials.

B. All testing will be done by a testing laboratory at CONTRACTOR'S expense, except as otherwise indicated.

C. Field Tests

1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by ENGINEER.
2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107, at intervals during construction selected by ENGINEER. A set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 31 00 - Cast-in-Place Concrete, at intervals during construction selected by ENGINEER.
4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C 579, Method B, at intervals during construction selected by ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.

D. Construction tolerances shall be as indicated in Section 03 30 00 Cast-in-Place Concrete unless noted otherwise.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cement: Portland cement shall be ASTM C 150 Type II of Type V.

B. Aggregate:

1. General: Aggregate shall be non-reactive and shall be washed before use. When sources of aggregate are changed, test reports shall be provided for the material from the new source prior to commencing grout work.
2. Fine Aggregate: Fine aggregate shall be sand or crush stone conforming to ASTM C 33 as modified herein. When tested in accordance with ASTM C 136, gradation shall be such that 100 percent by weight passes a No. 8 sieve and not less than 45

percent by weight passes a standard No. 40 sieve. Variation from the specified gradation in individual tests will be accepted if the average of three consecutive tests is within the following variation:

Standard Sieve	Permissible Variation in Individual Test
No. 30 or coarser	2% by weight
No. 50 or finer	0.5% by weight

C. Admixtures

1. General: Admixtures shall be compatible with the grout and shall comply with the manufacturer's recommendations. Admixtures shall be added to the grout mix separately.
2. Water Reducing Retarder: Water reducing retarder shall comply with ASTM C 494, Type D and shall be **Master Builders (BASF) MasterSet R 300, Sika Corporation Plastiment**, or approved equal.
3. Lubricant: Lubricant additive for cement pressure grouting shall be **Sika Intraplast**, or approved equal.

D. Water:

1. Water for washing aggregate, for mixing and for curing shall be potable, shall not contain more than 1,000 mg/L of chlorides as Cl, nor more than 1,300 mg/L of sulfates as SO_4, and shall not contain impurities which may change the setting time by more than 25 percent or a reduction of more than 5 percent of the compressive strength of the grout at 14 days when compared to the results for grout made with distilled water.

2.2 CEMENT GROUT

A. Application: Surface repairs of concrete.

B. Cement grout shall be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4000 psi.

C. Cement grout materials shall be as indicated in Section 03 30 00 Cast-in-Place Concrete.

2.3 NON-SHRINK GROUT

A. General

1. Non-shrink cementitious grout shall be a flowable, prepackaged, inorganic, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used. The manufacturer shall have at least 10 years' experience in the manufacture of cement based grouts. The manufacturer shall provide technical services and provide a representative at the jobsite for product training prior to product installation.

2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
3. Grout shall not contain chlorides or additives that may contribute to corrosion.
4. Grout shall be formulated to be used at any consistency from fluid to plastic.
5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:
    a. Minimum tensile splitting strength of 500 psi per ASTM C 496.
    b. Minimum flexural strength of 1,000 psi per ASTM C 580.
    c. Minimum bond strength (concrete to grout) of 1,900 psi per modified ASTM C 882.
    d. Grout shall be certified for use in freeze/thaw environments.

B. Class I Non-Shrink Grout

1. Application: Anchor bolts and reinforcing steel required to be set in grout in which the average working or operating temperature will be over 100 degrees F or in high fire risk areas; Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension; Storage tanks and other non-motorized equipment and machinery under 30 horsepower; Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.; Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material; and any other location not specifically listed in this Section or on the Contract Drawings.
2. Class I non-shrink grout shall have a minimum 28 Day compressive strength of 5,000 psi when mixed at a fluid consistency.
3. Class I non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.
4. Grout shall have a maximum early age height change of 4.0% expansion, and shall have no shrinkage (0.0%) in accordance with ASTM C 827. The grout when tested shall not bleed or segregate at maximum allowed water.
5. Grout shall have no shrinkage (0.0%) and a maximum of 0.3% expansion in the hardened state when tested in accordance with ASTM C 1090.
6. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.
7. Class I Non-Shrink Grout shall be **Five Star Grout by Five Star Products, Sikagrout 212 by Sika Corporation, CB-G PG by Hilti**, or equal.

C. Class II Non-Shrink Grout

1. Application: Column base plates (greater than 2 story or larger than 16-inches in the least dimension); under precast concrete elements; and repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials.
2. Class II non-shrink grout shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7,500 psi, when mixed at a fluid consistency.
3. Grout shall have a maximum early age height change of 4.0% expansion, and shall have no shrinkage (0.0%) in accordance with ASTM C 827.
4. Grout shall have no shrinkage (0.0%) and a maximum of 0.3% expansion in the hardened state when tested in accordance with ASTM C 1090.

5. Class II non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.
6. Class II non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
7. The grout when tested shall not bleed or segregate at maximum allowed water content.
8. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
9. Class II non-shrink grout shall be **Five Star Fluid Grout 100 by Five Star Products**, **Crystex by L&M Construction Chemicals**, or equal.

2.4 NON-SHRINK EPOXY GROUT

A. Application: Pumps over 1,000 horsepower, unless indicated otherwise.

B. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

C. Epoxy grout shall have a maximum early age height change of 4.0% expansion, and shall have no shrinkage (0.0%) in accordance with ASTM C 827, (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).

D. Epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than $18x10^{-6}$ in/in F when tested according to ASTM C 531.

E. The epoxy grout shall develop a minimum compressive strength of 9,000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C 579, method B.

F. The mixed epoxy grout shall have a minimum working life of 90 to 120 minutes at 70 degrees F.

G. The effective bearing area shall be a minimum of 95 percent EBA in accordance with ASTM C 1339.

H. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

I. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:

1. Minimum bond strength to concrete of 3,000 psi per ASTM C 882 modified.
2. Minimum bond strength to steel of 1,700 psi per ASTM C 882 modified.

3. Minimum flexural strength of 2,500 psi per ASTM C 580.
4. Minimum tensile strength of 2,000 psi per ASTM C 307.

J. Non-shrink epoxy grout shall be **Five Star DP Epoxy Grout by Five Star Products, Inc., Sikadur 42 Grout-Pak by Sika Corporation**, or equal.

2.5 EPOXY ANCHOR GROUT

A. Application: Anchor bolts and reinforcing steel required to be set in grout that is not in high temperature or high fire risk areas.

B. Epoxy anchor grout shall conform to ASTM C 881, Type IV, Class A, B, and C, Grade 3 with the exception of gel time.

C. Heat deflection temperature shall be a minimum of 139 °F per ASTM D 648.

D. Manufacturer shall certify that the epoxy anchor grout will maintain 90 percent of its strength up to a temperature of 125 °F.

E. Grout shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.

F. Epoxy anchor grout shall be capable of being used in submersed applications once cured.

G. Minimum compressive strength shall be 12,000 psi per ASTM D 695.

H. Overhead anchors and anchors in fire-resistive construction shall be cast-in anchors.

I. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.

J. Epoxy anchor grout shall be **Epcon C6+ by ITW Ramset/Red Head, Power-Fast Epoxy Injection Gel by Powers Fasteners, RE 500 by Hilti**, or equal.

2.6 TOPPING GROUT AND CONCRETE/GROUT FILL

A. Where fill is thicker than 3-inches, structural concrete as indicated in Section 03 31 00 - Cast-in-Place Concrete, may be used when accepted by ENGINEER.

B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and be mixed as indicated. Materials and procedures indicated for normal concrete in Section 03 31 00 - Cast-in-Place Concrete, shall apply unless indicated otherwise.

C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Topping grout in clarifiers shall contain between 750 and 800 pounds of cement per cubic yard with a maximum water cement ratio of 0.42.

D. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent By Weight Passing
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

E. Final mix design shall be as determined by trial mix design as indicated in Section 03 30 00 - Cast-in-Place Concrete.

F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 30 00 – Cast-in-Place Concrete.

G. **Strength:** Minimum compressive strength of topping grout and concrete/grout fill at 28 Days shall be 4,000 psi.

2.7 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by brushing, hammering, chipping or other similar means until sound, clean concrete surface is achieved.

B. Rough concrete lightly, but not enough to interfere with placement of grout.

C. Remove foreign materials from metal surfaces in contact with grout.

D. Align, level, and maintain final positioning of components to be grouted.

3.2 GENERAL

A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by ENGINEER.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 30 00 – Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.
2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by ENGINEER, alternate grouting methods shall be submitted for acceptance by ENGINEER.
3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

C. Drilled Anchors and Reinforcing Bars

1. General
   a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the manufacturer's instructions.

b. CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

2. Epoxy Adhesive Anchors
   a. Grout shall be proportioned and mixed with automatic equipment.
   b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 8 diameters for threaded rod or 12 diameters for reinforcing or smooth bars.
   c. Holes required for grouting shall be blown or vacuumed clean and are to be free of dust and standing water. Horizontal holes for grouting are to be drilled at a slight downward angle and with the inserted dowel or bolt bent to match.
3. Cement Based Non-Shrink Grout
   a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using cement based non-shrink grout, Class I.
   b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.
   c. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one-inch, the hole diameter should be at least twice the bolt diameter.
   d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
   e. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

D. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively, where accepted by ENGINEER, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.
2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping and fill. No topping concrete shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface

of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots that shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.
6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by ENGINEER, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.4 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

3.5 CURING

A. Cement based grouts shall be cured per 03 30 00 – Cast-in-Place Concrete and per the manufacturer's recommendations.

- END OF SECTION -

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SECTION 05 45 00
MECHANICAL METAL SUPPORTS (PIPE SUPPORTS)

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers materials and installation of mechanical metal supports, pipe supports, hangers, guides, anchors and appurtenances as specified and indicated.

B. CONTRACTOR shall provide mechanical metal supports in accordance with this Section whether shown on the Contract Drawings or not.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 05 50 00 Miscellaneous Metals
3. Section 09 90 00 Painting and Finishes
4. Section 33 05 05 Ductile Iron Pipe
5. Section 33 12 00 Mechanical Appurtenances

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY (MSS)

1. MSS SP-58 Pipe Hangers and Supports – Materials Design and Manufacture
2. MSS SP-69 Pipe Hangers and Supports – Selection and Application
3. MSS SP-89 Pipe Hangers and Supports – Fabrication and Installation Practices
4. MSS SP-127 Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application

C. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. ASME B 31.1 Power Piping

D. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Standard Specification for Carbon Structural Steel
2. ASTM A 47 Standard Specification for Ferritic Malleable Iron Castings
3. ASTM A 48 Standard Specification for Gray Iron Castings
4. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6. ASTM A 575 Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

7. ASTM A 576 Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. CONTRACTOR shall submit complete shop drawings of mechanical supports, pipe supports, hangers and guides. Provide scaled shop drawings showing locations of the supports and detailed drawings for each support. Identify each type of hanger or support by the manufacturer's part number of figure on the drawing.

C. Provide installation drawings and manufacturer's catalog information on each type of hanger and support.

D. Provide structural calculations for special supports and anchors, stamped and signed by a professional engineer registered in the State of Utah.

PART 2 MATERIALS

2.1 GENERAL

A. All pipe hanger and supports shall be manufactured to comply with MSS-SP-58, MSS-SP-569, MSS-SP-89 except as modified herein. Where applicable, design and manufacture must also conform to ANSI/ASME B31.1. Supports for plumbing or fire piping shall be in accordance with the latest edition of the applicable plumbing or fire code and the requirements of the local jurisdiction.

B. Hangers, supports, anchors and restraints must be designed in accordance with MSS-SP-127 to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. Piping supports and equipment must be considered as a total system and appropriate balance calculations made to determine load forces at critical stress points. Loading conditions to be considered may include, but are not limited to:

1. The total load of pipe, fittings, valves, insulation and any expected contents of the pipe.
2. Thermal expansion and contraction
3. Stress from cycling of equipment or process.
4. Vibration transmitted to or from equipment or terminal connection.
5. Wind, snow or ice loading on outdoor piping
6. Loading due to seismic forces

C. Static and dynamic forces at points of attachments must be considered to help ensure structural integrity of buildings or equipment. Hanger and supports must be selected so as to minimize the effect of piping system loading on the structure.

D. In general, piping shall be supported from structural members, such as walls, beams, columns and slabs, using approved structural attachments. In situations where approved attachments cannot be used, alternative attachments or substructure assemblies must receive approval by ENGINEER prior to installation. Prior approval by ENGINEER must be given before any cutting or drilling of building structural steel.

Damage to the structure through welding, cutting or drilling will not be permitted if it reduces the structures strength below the established safety factor for the structure. Any additional structural steel required to properly support piping or equipment shall be furnished and installed by CONTRACTOR at no additional cost to OWNER.

2.2 SUPPORT MATERIALS

A. Pipe supports, hangers, guides, etc. shall be hot-dip galvanized carbon steel, unless noted otherwise on the Drawings. Steel shall be in accordance with ASTM A 36, ASTM A 575, or ASTM A 576. Hot-dip galvanizing shall be in accordance with ASTM A 123 or ASTM A 153. Bases, rollers, and anchors shall be steel as described above or may be cast iron conforming to ASTM A 48. Pipe clamps shall be steel as described above or may be malleable iron conforming to ASTM A 47.

B. Submerged supports, as well as piping in hydraulic structures within 24 inches of the high water level, shall have supports, including hardware and anchors constructed of Type 316 stainless steel, unless noted otherwise on the Drawings.

C. Supports fabricated from other materials specified on the Drawings shall have a protective coating in accordance with the requirements of Section 09 90 00 – Painting and Coatings.

2.3 FLOOR MOUNTED SUPPORTS

A. Floor mounted pipe supports shall be the adjustable saddle support with stanchion, base and U-bolt or adjustable flange support type with stanchion and base. Pipe supports with stanchion and base plate shall be sized for the pipe or mechanical appurtenance it supports. All pipe supports shall have a 1-inch-high grouted pad to be used as a leveling base. Pipe supports shall be secured to the floor. An EPDM Rubber insulation pad shall be provided between the pipe and the U-Bolt.

2.4 CONCENTRATED LOADS

A. Concentrated loads, such as meters, valves, and equipment, on PVC piping systems shall have supports on each side of the concentrated load.

2.5 CONCRETE ANCHORS

A. Anchors shall be in accordance with Section 05 50 00 – Miscellaneous Metals.

2.6 MANUFACTURERS

A. Mechanical Metal Support (pipe support) manufacturers shall be **Anvil International Inc., B-Line by Eaton (Cooper Industries), Utility Coatings & Fabrication, Piping Technology & Products, Inc. (PT&P),** or approved equal. To be considered an approved equal, materials must be of similar diameter, thickness, and strength to the product specified.

PART 3 EXECUTION

3.1 GENERAL

A. Mechanical metal supports, pipe supports, hangers, guides, etc. shall be installed per

the manufacturer's instructions and ASME B31.1 – Power Piping.

B. Pipe supports shall be positioned in order to produce an orderly, neat piping system. Hanger rods shall be vertical without offsets.

C. Set embedded inserts accurately in position and support them rigidly before concrete is placed and prevent displacement during and after placement of concrete.

D. Repair or replace metal items damaged during installation. Follow the manufacturer's procedures for repairing damaged surfaces.

E. Galvanizing Field Repairs

1. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
2. The coating shall be applied to at least 3 mils dry film thickness and shall be **Zinc-Clad XI by Sherwin-Williams, Galvax by Alvin Products, Galvite by ZRC Worldwide**, or approved equal.

3.2 SUPPORT LOCATION AND SPACING

A. Supports for horizontal piping shall be spaced to prevent excessive sag, bending and stresses in the piping. Spacing shall not exceed the maximum indicated spans.

B. Maximum spans indicated in the tables below are for ambient temperatures or the temperatures listed for the materials and pipe wall thicknesses shown. Adjust the span spacing for different temperatures and/or pipe wall thicknesses per the manufacturer's recommendations.

C. Install pipe supports on horizontal and vertical runs at the spacing shown or detailed on the Drawings. If no spacing or rod sizes are given on the Drawings or in the specifications for a particular piping system, use the following tables or the recommendations of the support or pipe manufacturer.

1. Supports for Ductile Iron Pipe (Section 33 05 05 – Ductile Iron Pipe) should be installed in locations shown on the Drawings with a minimum of one support per 20-foot length of pipe. If longer spans are required, the supports should be designed in accordance with DIPRA – Design of Ductile Iron Pipe on Supports and the pipe manufacturer's recommendations. Supports should be cradle type with a saddle angle of 120 degrees. The table below shows the recommended maximum spans per US Pipe – Long Span and Bridge Crossing Pipe guidelines.

Pipe Size (inches)	Maximum Span Water Service (feet)
6	28
8	30
10	30
12	35
14	35
16	40
18	42
20 to 64	45
Note: These spacings do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc. or changes in direction requiring additional supports.	

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SECTION 05 50 00
MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers materials, fabrication, and installation of miscellaneous metals, specialties, and appurtenances as specified and indicated.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.3 RELATED SPECIFICATIONS

A. Fabrication and erection of the platforms, ladders and stairs shall be in accordance with the Specification for the Design, Fabrication and Creation of Structural Steel for Buildings of the latest edition of the A.I.S.C. Manual, and Section 1910.27 of the latest edition of the OSHA standards, except as specified herein.

1.4 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

1. Manual of Steel Construction

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Standard Specification for Carbon Structural Steel
2. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. ASMT A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM A 276 Standard Specification for Stainless Steel Bars and Shapes
6. ASTM A 307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
7. ASTM A 615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
8. ASTM F 593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
9. ASTM F 594 Standard Specification for Stainless Steel Nuts

D. NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

E. AMP 510 Metal Stairs Manual

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. CONTRACTOR shall submit complete shop drawings of fabricated items, such as vents, ladders, stairs, platforms, beams, pipe supports, and miscellaneous metals for approval to Engineer.

C. Shop drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the work.

D. Shop drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

E. Submit manufacturer's catalog data and dimensional drawings for lifting eyebolts and inserts; ladder safety posts, manhole covers and frames, and anchor bolts.

F. Submit ICC ES Evaluation Reports for adhesive and wedge anchors and installer qualifications and procedures.

1.6 QUALITY ASSURANCE

A. Field Measurements: Take field measurement prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

B. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units to the extent necessary for shipping limitations.

C. Fabricator Qualifications: Fabricators shall be regularly engaged in the manufacture of the types of steel specialties they are providing and shall have at least 5 years of experience in this specialty.

D. Qualifications: Qualify welding operators in accordance with requirements of current AWS Standard. Provide certification that all welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within the previous 12 months. Ensure that all certifications are kept current.

PART 2 MATERIALS

2.1 CARBON STEEL

A. Materials for bolted or welded steel construction shall conform to ASTM A 36.

2.2 STAINLESS STEEL

A. All bolts, expansion bolts, nuts, washers, and expansion sleeve inserts used to attach metal supports shall be stainless steel Type 316.

B. All interior tank ladders, wall conduits, louvers, and other items required shall be

stainless steel unless noted otherwise.

2.3 HOT-DIPPED GALVANIZED

A. All vents, stairs, vault ladders, handrail, guardrail, stringers, beams and miscellaneous items shall be galvanized (zinc coated) unless noted otherwise.

B. Zinc coating for plates, bolts, anchor bolts, and threaded parts shall in in accordance with ASTM A 153. Structural steel shall be zinc coated in accordance with ASTM A 123.

2.4 BOLTS

A. Steel anchor and connection bolts for non-corrosive service shall conform to ASTM A 307, Grade A or B, unless otherwise noted. Bolts shall be hot-dip galvanized and provided with self-locking nuts or lock washers and plain nuts.

B. Steel anchor and connection bolts for corrosive service shall be fabricated from stainless steel, unless indicated otherwise in the specifications or on the Contract Drawings. Corrosive service locations are as listed below.

1. Buried locations
2. Submerged locations
3. Locations subject to occasional flooding
4. Inside hydraulic structures
5. Chemical handling areas
6. Inside buried manholes, vaults, and structures that do not have a gravity drain or sump pump
7. Inside trenches, containment walls, and curbed areas.

C. The nuts shall be capable of developing the full strength of the bolts. Bolts and cap screws shall have hexagon heads and nuts shall be heavy hexagon series. Bolts and nuts shall be installed with washers from material matching the base material of bolts. Lock washers fabricated from the material matching the bolts shall be installed where indicated.

D. The length of the bolts shall be such that the bolt extends at least 1/8 inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

2.5 LIFTING EYEBOLTS

A. Locate eyebolts and inserts over the centerline of the piping at locations shown on the Drawings. Eyebolts and inserts shall have a minimum safety factor of 3 and be rated for a working load of 3,000 pounds.

B. Provide inserts of the ferrule wing nut design with threads to match the eyebolts. Cast inserts in the roof slab of the vault at the locations identified on the Contract Drawings.

2.6 THREADED INSERTS

A. Threaded inserts shall be of ductile iron construction with standard National Course (NC) or United National Course (UNC) threads. Inserts shall be cast-in-place at the locations shown on the Contract Drawings. Inserts shall be fabricated by **Meadow Burke**, or

approved equal.

2.7 ADHESIVE ANCHORS

A. Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors. No substitutions will be considered without an ICC ES Report verifying strength and material equivalency.

B. Adhesive anchors shall be a two component system consisting of an all threaded anchor rod with nut and washer, and the adhesive capsule. Anchor rods shall be Type 304 stainless steel conforming to ASTM F 593 with nuts conforming to ASTM F 594. The adhesive capsules shall contain a polyvinyl or urethane methacrylate-based resin and accelerator within a sealed dual chamber foil capsule. Adhesive anchors shall be **Hilti HVA Capsule Adhesive Anchoring System**, or approved equal.

2.8 WEDGE ANCHORS

A. Wedge type anchors shall be used only where indicated on the Contract Drawings. Wedge anchors shall be a stud type expansion anchor, torque controlled, with impact section to prevent thread damage. Stud and wedge shall be Type 304 or Type 316 stainless steel conforming to ASTM A 276. Nut shall be Type 304 or Type 316 stainless steel conforming to ASTM F 594 with washer of similar material. Wedge anchor bolts shall be **Hilti Kwik Bolt 3,** or approved equal. Anchors installed in non-submerged or non-corrosive environments may be carbon steel and be **Simpson Strong-Tie Strong Bolt**, or approved equal.

2.9 STEEL PIPE

A. Pipe for guard posts shall be Schedule 40 and pipe for vault vents shall be Schedule 10 conforming to ASTM A 53, unless noted otherwise on the Contract Drawings, and shall be hot-dip galvanized.

2.10 LADDERS

A. Ladders which may be partially or fully submerged or located inside a manhole or vault without a gravity drain or sump pump shall be fabricated entirely of Type 304 stainless steel. All ladder hardware and supports shall be Type 304 stainless steel. Ladders and hardware fully submerged or located inside a manholes or vault for wastewater facilities shall be Type 316 stainless steel.

B. Other ladders shall be fabricated from carbon steel and hot-dip galvanized after fabrication unless noted otherwise on the Contract Drawings. All ladder hardware and supports shall be the same material as the ladder.

C. All ladders without a permanently mounted exterior ladder extension shall be provided with a telescoping safety post. The post shall be fabricated of steel with telescoping tubular section that locks automatically when fully extended. The upward and downward movement shall be controlled by a stainless steel spring balancing mechanism. The telescoping safety post shall be fabricated from the same material and finish as the ladder. The telescoping posts shall be **LadderUP Safety Post by Bilco**, or approved equal.

2.11 VAULT VENTS

A. Fabricate vault vents as shown on the Contract Drawings. Vault vents shall be welded steel construction and hot-dip galvanized after fabrication. Coating shall be in accordance with Section 09 90 00 – Painting and Finishes.

2.12 COVERS AND FRAMES

A. Manhole covers and frames shall be cast iron and designed for AASHTO HS-20 loading, unless otherwise indicated. Castings shall be smooth, clean and free from blisters, blowholes, and shrinkage. Covers shall seat firmly into the frames without rocking. Covers and frames shall fit together evenly such that the cover fits flush with the surrounding finished surface.

2.13 METAL STAIRS

A. Metal stairs shall be composed of steel stringers and supports, unless otherwise noted on the Drawings. Stairs shall be fabricated in accordance with the standard practice of NAAMM AMP 510.

B. Metal stairs shall be galvanized and as noted on the Drawings.

2.14 POLYPROPYLENE STEPS

A. Polypropylene steps shall have a 1/2-inch ASTM A 615 grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have a tread width of 14-inches nominal.

B. Steps shall be manufactured by **American Step Company, Inc., M.A. Industries, D & L Supply No. F-1981,** or approved equal.

2.15 GRATING

A. Grating shall be supported around all sides of an opening with support members. Unless otherwise indicated, grating supported on concrete shall have embedded angles that match the grating material. Grating shall be serrated bar grating, unless noted otherwise on the Contract Drawings.

B. The grating shall be completely banded at edges and cutouts and the banding shall be welded to each cut bearing bar. The banding material and cross-section shall be the same as the bearing bars.

C. Grating pieces shall be fastened to each support at a minimum of 2 locations.

D. Grating deflection shall not exceed 1/4 inch or the span divided by 180, whichever is less.

E. For standard duty grating, the loading to be used for determining stresses and deflections shall be the uniform load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1000 pounds. For heavy duty grating the loading used shall be in accordance with AASHTO HS-20.

F. Standard duty grating shall be fabricated from steel and hot-dip galvanized, unless noted

otherwise. Standard duty grating that will be submerged, partially submerged, or in a corrosive environment shall be fabricated entirely of Type 316 stainless steel. No single piece of standard duty grating shall weigh more than 80 pounds, unless noted otherwise on the Contract Drawings. All crossbars shall be welded into position.

G. Heavy duty grating shall be fabricated from welded steel and hot-dip galvanized after fabrication. All crossbars shall be welded into position.

H. Bar dimensions shall be 1-1/4 inch by 3/16 inch, minimum and shall be manufactured by **McNICHOLS, AMICO, Robertsons Grating Products**, or approved equal.

2.16 FRP GRATING

A. Grating shall be supported around all sides of an opening with support members. Unless otherwise indicated, grating supported on concrete shall have embedded steel angles.

B. The grating shall be a molded once piece square mesh pattern providing bidirectional strength. Gratings shall be reinforced with rovings of equal number of layers in each direction. The top layer of reinforcement shall be no more than 3/16-inch below the top surface of the grating so as to provide maximum stiffness and prevent resin chipping of unreinforced surfaces. Percentage of glass (by weight) shall not exceed 40% so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements.

C. Non-slip surfacing: Grating shall be manufactured with a secondarily applied grit on the top of each bar providing excellent slip resistance.

D. Fire rating: Grating shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E 84. Certifications shall be dated within the past two years and test data performed only on the resin shall not be acceptable.

E. Resin system: Manufacturer may be required to submit corrosion data from tests performed on actual grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating product corrosion resistance and shall not be accepted.

F. Depth: 1-1/2-inch with a tolerance of plus or minus 1/16-inch.

G. Mesh Configuration: 1-1/2-inch x 1-1/2-inch with a tolerance of plus or minus 1/16-inch mesh centerline to centerline.

H. Design live loads of the FRP gratings for walkway applications shall be 65 psf uniformly distributed load (or as required by the governing building code) with a maximum deflection of 3/8-inch or L/120 at the center of a simple span OR a concentrated load of 250 pounds with a maximum deflection of 1/4-inch at the center of a simple span.

I. FRP grating shall be **Gridwalk High Strength Molded Fiberglass Grating by American Grating**, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Except as otherwise shown, the design, fabrication, and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction".

B. Install miscellaneous specialties as indicated on the Contract Drawings or as recommended by the manufacturer.

C. Store materials above ground on platforms, skids or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

D. Clean surfaces of metalwork to be in contact with concrete of rust, dirt, grease, and other foreign matter before placing concrete.

E. Set embedded metalwork accurately in position and support it rigidly before concrete is placed and prevent displacement during and after placement of concrete.

F. Repair or replace metal items damaged during installation. Follow the manufacturer's procedures for repairing damaged surfaces.

G. Welding shall be performed by metal-arc method or shielded metal arc method as per the American Welding Society's (AWS) "Welding Handbook". During welding component parts shall be adequately clamped or supported. Avoid irregular surface, non-uniform bead pattern, and high crown. Upon completion of welding, remove weld splatter, flux, slag, and burrs. Accomplish repair, chipping, and grinding of welds in a manner that will not gouge, groove, or reduce the base metal thickness.

H. Adhesive Anchors. Do not install anchors until the concrete has reached the required 28-day compressive strength. Drill hole in concrete by means of a percussion hammer drill. Hole shall be roughened with a brush on a power drill and then cleaned and dried. Install anchor in accordance with the manufacturer's instructions. Do not load the anchor until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

I. Wedge Anchors. Do not install anchors until the concrete has reached the required 28-day compressive strength. Drill hole in concrete by means of a percussion hammer drill. Hole shall be roughened with a brush on a power drill and then cleaned and dried. Install anchor in accordance with the manufacturer's instructions.

J. Galvanizing Field Repairs:

1. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
2. The coating shall be applied to at least 3 mils dry film thickness and shall be **Zinc-Clad XI by Sherwin-Williams, Galvax by Alvin Products, Galvite by ZRC Worldwide**, or approved equal.

- END OF SECTION -

SECTION 08 10 00
DOORS, FRAMES, AND HARDWARE

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers all the work necessary to furnish and install the new doors, frames, and hardware, complete and operable.

B. All doors and their pressed steel frames shall be steel, insulated, and the type and size as indicated on the Door Schedule on the Drawings.

1.2 RELATED WORK

A. Related work in other Sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI A 115.IG Installation Guide for Doors and Hardware
2. ANSI A 156.6 Standard for Architectural Door Trim
3. ANSI A 156.16 Standard for Auxiliary Hardware
4. ANSI A 250.8 SDI-100 Recommended Specifications for Standard Steel Doors and Frames
5. ANSI A 250.10 Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
6. ANSI A 250.11 Recommended Erection Instructions for Steel Frames

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Standard Specification for Carbon Structural Steel
2. ASTM A 108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
3. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A 229 Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs
5. ASTM A 653 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
6. ASTM A 1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

7. ASTM A 1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
8. ASTM C 177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
9. ASTM D 256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
10. ASTM D 635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
11. ASTM D 790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
12. ASTM D 792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
13. ASTM D 882 Standard Test Method for Tensile Properties of Thin Plastic Sheeting
14. ASTM D 1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics
15. ASTM D 2583 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
16. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
17. ASTM E 330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

D. AMERICAN WELDING SOCIETY (AWS)

1. AWS D1.1 Structural Welding - Steel
2. AWS D1.3 Structural Welding Code – Sheet Steel

1.4 SUBMITTALS

A. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Manufacturer's catalog data and preprinted installation instructions of doors.

C. A schedule showing the location of each door shall be included with the drawings. Submittal drawings shall include elevations of each door type, details and method of anchorage, details of construction, method of assembling sections, location and installation of hardware, shape and thickness of materials, details of joints and connections.

D. Manufacturer’s certificates that certify products meet or exceed the specified requirements.

E. Warranty: Provide documentation of the manufacturer’s standard written one (1) year warranty.

1.5 DELIVERY AND STORAGE

A. Doors shall be delivered to the job site wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dust or water, and in a manner that permits easy access for inspection and handling. Doors shall be handled carefully to prevent damage to the faces, edges, and ends. Damaged items that cannot be restored to like-new condition shall be replaced.

1.6 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for doors, frames, and hardware. Full compensation for all doors, frames, and hardware shall be considered as included in the contract unit or lump sum bid prices for the various items of the Contract to which doors relate.

PART 2 PRODUCTS

2.1 STEEL DOORS

A. Steel doors and frames shall be of hollow metal construction and shall be full flush design with no visible seams. Interior and Exterior door face sheets shall be hot-dip galvannealed according to the requirements of ASTM A 653. Manufacturer's shall be **Republic Doors and Frames, Steelcraft, Ceco Door Products**, or approved equal. Doors shall conform to ANSI A 250.8 and to the following requirements:

1. Hollow metal door, 1 3/4 inches thick flush type, constructed of two sheets of not less than stretcher leveled, 16-gauge steel sheets formed and welded for flush pan assembly, with internal 20-gauge vertical reinforcing channels spaced not over 8 inches on centers the full height of the door. There shall be no visible joints on the face of the doors. Reinforcing channels shall be uniformly spot welded to face plates at top and bottom of all doors. Filler channels shall be provided at the top and bottom of doors to provide a flush closure. The top of exterior doors shall be provided with flush, water- and weather-tight top enclosures.
2. All interior void spaces shall be completely filled with EPS foam or polyurethane.
3. Concealed sheet or bar steel reinforcement shall be provided for mortise type hardware. Reinforcing shall not be less than the following: 9-gauge for butts, 12-gauge for locksets and 14-gauge for surface applied hardware. Reinforcing shall be drilled and tapped to template requirements. Concealed reinforcing shall be provided for closures. Door bottom weather stripping shall be included to match thresholds.
4. Door frames shall be pressed steel constructed of not less than 16-gauge steel and shall be of the shape indicated on the plans and as required to fit the various wall constructions. Frames shall be of welded unit construction assembled and welded in the shop. Welding shall be to a hairline joint with all exposed beads ground smooth.
5. Concealed reinforcing of the frames for the mortise hardware shall be not less than the following: 3/16 inch for butts, 12- gauge for lock strike, 14-gauge for surface applied items and 18-gauge for plaster guards over mortised hardware reinforcement. Frames shall be mortised drilled, and tapped to template requirements. Lock reinforcing units shall be supplied by finishing hardware supplier. Frames shall be anchored as shown in the drawings.
6. Hinges shall be heavy duty ball bearing hinges with non-removable pins.

7. Pull plates shall be chrome plated or stainless steel and mounted on interior and exterior sides of all doors.
8. All double doors are to be supplied with a “Z” astragal of 14-gage steel for 1-3/4-inch doors and 16-gage for 1-3/8-inch doors.
9. Hardware including locksets and hinges shall be stainless steel.

2.2 DOOR HARDWARE

A. Trim material shall be stainless steel, unless noted otherwise.

B. Pull Plates: 8” CTC pull, 4” x 16” plate, stainless steel, No. 110 x 70C by **Rockwood Mfg. Co**., or approved equal, conforming to ANSI A 156.6.

C. Hinges: satin stainless steel, 5 knuckles minimum, non-rising pin for interior doors and non-removable pin for exterior doors, number of hinges per door manufacturer’s recommendation (minimum of 3 hinges per door). Where necessary to keep door leaf clear of walls, casings, jambs or reveals in door opening, wide throw hinges of an approved type shall be furnished. Finish shall be stainless steel satin (32D or 630). Manufacturer shall be **Mckinney T4A3386, Hager, Stanley Works FBB199 (32D),** or approved equal.

D. Cylinder Lock Set: Best Access Systems, Lockset 47H-7-AB-15-J-630-SH-S6-VT for exterior doors and 45H-7-N-15-M-630 for interior doors. Locks must be compatible with Owners existing keys. Contractor shall provide lock sets and keys that will match Owner’s requirements.

E. Lever Extension Flush Bolt, Upper, **Rockwood No. 555**, or approved equal, cadmium plated finish (inactive leaf only), conforming to ANSI A 156.16.

F. Lever Extension Flush Bolt, Lower, **Rockwood No. 555**, or approved equal, cadmium plated finish (inactive leaf only), conforming to ANSI A 156.16.

G. Threshold: **#277AS by Pemko Corporation**, or approved equal, raised interior, extruded aluminum threshold with neoprene seal.

H. Drip Cap: Provide drip cap on all exterior doors. Drip cap shall be clear anodized aluminum, **Pemko 346C**, or approved equal.

I. Door Closers: Door closers shall be full rack and pinion, cast iron, with adjustable regulators for closing and latching speed, back check and spring power. Closers shall be mounted for 180 degrees of swing whenever possible. All closers shall be LCN Model 4040XP with 4041-3071 DEL cylinder with extra duty hold open arm. Mounting plates shall be supplied as necessary. All door closers attached to mineral core or particle filled doors shall be installed with hex bolts. Cover shall be metal 4040XP-72MC with 689 Aluminum finish.

J. Lock Strikes: Strikes shall have extended curved lips where required to protect trim from being marred by latch bolt. Strike lips shall not protrude more than 1/8-inch beyond door frame trim. Wrought box strikes shall be furnished on all locks, latches and deadlocks.

K. Door Stop: Solid cast brass, DuraFlex bumper, **Rockwood #445**, or approved equal (Inactive leaf only)

L. Non-Mortise Door Edge with Astragal: 0.06” thick stainless steel, **Rockwood HD306B-AST**, or approved equal (double doors only)

M. Kick Plates: Unless otherwise indicated, kick plates shall be provided and shall be satin stainless 18-8, 18 gage, **Rockwood No. K1050F**, or approved equal.

N. Weatherstripping and Seals: silicone gasketing, **Pemko S88D**, or approved equal.

2.3 ACCESS DOORS AND FRAMES

A. Fabricate doors and frames as shown on the drawings and in accordance with best shop practices. Frames shall be rigid, neat in appearance and free from defects. Field measurements shall be taken as required for coordination with adjoining work.

B. Form exposed surfaces free from warp, wave and buckle, with all corners square, unless otherwise shown. Set each member in proper alignment and relationship to other members with all surfaces straight and in a true plane.

C. Reinforce members and joints with plates, tubes or angles for rigidity and strength.

D. Doors and frames shall be mortised and reinforced for hardware in accordance with the hardware manufacturer’s instructions and templates. The reinforcing shall be designed to receive hinges, locks, strikes, closures, etc.

E. Mortar guard boxes shall be provided for hardware cutouts in frames.

F. Furnish at least three (3) metal anchors or polymer spacers in each jamb of frames up to 84" high and one (1) additional anchor for each 24" in height above 84", in shapes, sizes and spacing shown or required for anchorage into adjoining wall construction. Fabricate joint anchor of stainless steel.

G. Terminate bottom of frames at the indicated finished floor level.

H. Provide clearance for doors of 1/8" at jambs and heads; 1/4" clearance above threshold.

I. Where glazing is required, flush integral stops on one side and screw-on stops on the opposite side shall be provided.

2.4 FINISH

A. Surfaces shall be provided with a shop-primed galvannealed finish. Prior to receiving primer, all surfaces shall be cleaned thoroughly and phosphate-treated to assure maximum paint adherence. Primer shall be a metallic oxide or synthetic resin primer of the manufacturer's standard type and shall be applied by dipping or spraying in accordance with ANSI A 250.10.

B. Field painting of doors and frames shall be in accordance with Section 09 90 00 – Painting and Finishes. Finish coat shall be compatible with the shop applied primer coating.

PART 3 EXECUTION

3.1 INSTALLATION

A. Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions and in accordance with ANSI A 115IG. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, doors shall be weather tight and shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

B. Access Door Frame Installation

1. Place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Frame must not be drilled for brace supports as finish may be damaged. Install frames in accordance with ANSI A 250.11.
2. Locate three (3) wall anchors per jamb at hinge and strike levels. Frames may be grouted full of mortar at jambs and anchors shall be built into the joints as walls are laid up. A continuous bead of silicone sealant is to be applied between the head and jamb at the miter joint.

C. Adjust doors for free swing without binding. Adjust hinge sets, locksets, and other hardware. Lubricate using a suitable lubricant compatible with the door and frame coatings.

D. Install work of this Section in strict accordance with approved shop drawings and manufacturer’s recommended installation instructions. Where installations require field welding, all work must be performed by certified welders in accordance with AWS D1.1**/**D1.3.

E. Upon installation, secure the services of a qualified representative of the manufacturer to visit the jobsite and inspect the complete installation of the door and frame assemblies, test all components thru a minimum of ten (10) cycles of operation and direct installer in correcting any non-conforming items found.

F. Remove temporary coverings. Repair or replace damaged installed products. Clean installed products in accordance with the manufacturer’s instructions before acceptance by OWNER.

G. Clearances at edge of doors:

1. Between door and frame at head and jambs: 1/8 inch.
2. At meeting edges pairs of doors and at mullions: 1/8 inch.
3. At transom panels, without transom bars: 1/8 inch.
4. At sills without thresholds: 5/8-inch maximum above finish floor.
5. At sills with thresholds: 1/8-inch above threshold.

3.2 HARDWARE SCHEDULE

A. The hardware schedule is arranged for convenience of locating hardware and does not preclude in any way the requirements that all necessary hardware shall be furnished and

properly installed. Hardware not specifically called out shall be similar to that required for similar uses.

B. Hardware equal in quality and utility will be accepted provided it conforms in operation, quality, weight, size, workmanship, and finish to the products hereinafter described. All component parts of locksets shall be the product of one manufacturer.

Hardware Set 1 (Door 101A)				
Each to Receive:				
Quantity	Item	Model No.	Finish	Manufacturer
3 each*	Hinge	T4A3386 4.5”x4.5”	32D	McKinney
1 each	Lockset	47H-7-AB-15-J-630-SH-S6-VT	630	Best Access Systems
1 each	Closer	4040XP	689	LCN
1 each	Kickplate	K1050F	630	Rockwood
1 each	Wall Stop	409	32D	Rockwood
3 each	Silencer	608	Gray	Rockwood
1 each	Threshold	277AS	Alum	Pemko
1 each	Drip Cap	346C	Alum	Pemko
1 set	Perimeter Seal	S88D	Alum	Pemko
*Five Knuckle, Stainless Steel, Non-removal Pin Hinges (size and quantity by door manufacturer)				

Hardware Set 2 (Door 101B)				
Each to Receive: Five Knuckle, Stainless Steel, Non-removal Pin Hinges (size and quantity by door manufacturer)				
Quantity	Item	Model No.	Finish	Manufacturer
1 each*	Lockset	47H-7-AB-15J-M-630-SH-S6-VT	630	Best Access Systems
3 each***	Hinge	T4A3386-NRP 4.5”x4.5”	32D	McKinney
1 each	Closer	4040XP	689	LCN
1 each	Kickplate	K1050F	630	Rockwood
1 each	Astragal	HD306B-AST	630	Rockwood
1 each**	Flush Bolt, upper	555	626	Rockwood
1 each**	Flush Bolt, lower	555	626	Rockwood
1 each	Threshold	277AS	Alum	Pemko
1 each	Drip Cap	346C	Alum	Pemko
1 set	Perimeter Seal	S88D	Alum	Pemko
* Deadbolt required on Active Leaf only ** Inactive Leaf Only ***Five Knuckle, Stainless Steel, Non-removal Pin Hinges (size and quantity by door manufacturer)				

- END OF SECTION -

SECTION 08 51 13
ALUMINUM WINDOWS

PART 1 GENERAL

1.1 SUMMARY

A. Provide all labor, material, and equipment necessary to furnish and install aluminum windows as shown on drawings and specifications herein. Window shapes and accessories as specified and detailed shall establish the type of units and materials to be used to provide the functional performance and aesthetic requirements desired. Details indicate the required depth and profile.

1.2 RELATED WORK

A. Related work in other sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. American Society for Testing and Materials (ASTM)

1. ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
2. ASTM E 283 Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen
3. ASTM E 330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
4. ASTM E 413 Classification for Rating Sound Insulation
5. ASTM E 547 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Differential
6. ASTM F 588 Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies Excluding Glazing Impact
7. ASTM E 966 Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements”
8. ASTM E 1332 Standard Classification for Determination of Outdoor Indoor Transmission Class
9. ASTM E 1425 Standard Practice for Determining the Acoustical Performance of Windows, Doors, Skylight, and Glazed Wall Systems
10. ASTM E 1886 Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
11. ASTM E 1996 Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

12. ASTM E 2190 Standard Specification for Insulating Glass Unit Performance and Evaluation

C. American Architectural Manufacturers Association (AAMA)

1. AAMA/WDMA/CSA 101/I.S.2/A440-08 Standard/Specification for Windows, Doors, and Unit Skylights
2. AAMA 502 Voluntary Specification for Field Testing of Newly Installed Fenestration Products
3. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum
4. AAMA 701/702 Voluntary Specification for Pile Weather Stripping and Replaceable Fenestration Weather Seals
5. AAMA 1503 Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections
6. AAMA 2603 Voluntary Specification, Performance Requirements, and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
7. AAMA 2604 Voluntary Specification, Performance Requirements, and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
8. AAMA 2605 Voluntary Specification, Performance Requirements, and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

D. Florida Building Code (FBC)

1. FBC TAS 201 Large Missile Impact
2. FBC TAS 202 Uniform Static Air Pressure, Water Resistance, Air Infiltration, Forced Entry
3. FBC TAS 203 Cyclic Wind Pressure Loading

E. National Fenestration Rating Council Incorporated (NFCR)

1. NFCR 100 Procedure for Determining Fenestration Product U-Factors

1.4 PERFORMANCE REQUIREMENTS

A. Uniform Load Structural Test

1. With the primary sash in a closed position, and the secondary (exterior) set of sash in the full open position, test in accordance with ASTM E330. At a static air pressure difference of 60.0 (80 with heavy rails) pounds per square foot with pressure applied both positively and negatively.

2. Static air pressure difference shall be 1.5 times the design pressure used in AAMA/WDMA/CSA 101/I.S.2/A440-08. (1.5 is the factor used to provide a margin of safety in aluminum windows and is the minimum recommended by the AAMA.)

3. At conclusion of test, there shall be no glass breakage; permanent damage to fasteners, hardware parts, support arms or actuating mechanisms, nor any other

damage which would cause the window to be inoperable. Permanent deformation of any frame, sash or ventilator member shall not exceed 0.04% of its span.

B. Air Infiltration

1. With primary sash in a closed and locked position, and the secondary (exterior) sash in the full open position, window shall be tested in accordance with ASTM E283 and shall meet the following performance requirements.

a. Air infiltration on windows with less than 18 feet of operable sash crack perimeter shall not exceed 2.8 cfm per square foot of window area when tested in a static pressure drop of 1.57 psf (equivalent to 25 mph wind velocity) or 6.3 cfm total when tested at 6.24 psf (equivalent to 50 mph wind velocity).

b. Air infiltration on windows with 18 or more feet of operable sash crack perimeter shall not exceed 0.05 cfm per square foot of window area at a static pressure drop of 1.57 psf or 0.15 cfm at 6.24 psf.

C. Water Resistance

1. With the primary set of sash in the closed and locked position, and the secondary (exterior) sash in the full open position, the window shall be subjected to a pressure drop of 8.00 psf. After passing first test, window may also be tested with both sets of sash closed and latched and shall be subjected to a minimum pressure drop of 12.00 psf. All tests shall be performed with the screen removed. Tests shall be conducted in accordance with ASTM E547.

D. Thermal Performance

1. When tested in accordance with AAMA 1503 or according to NFRC 100 the thermal transmittance due to conduction (Uc) shall not exceed 0.33 on the entire specimen.

2. When tested in accordance with AAMA 1503 or according to NFRC 100 the Condensation Resistance Factor (CRF) shall not be less than 64 on the entire specimen.

E. Forced Entry Resistance

1. When tested in accordance with ASTM F588, window shall perform to a minimum Performance Level 10.

F. Sound Transmission

1. Sound Transmission Class (STC). When tested in accordance with ASTM E1425, window shall perform to a minimum STC-44. Testing shall be performed in a NVLAP Certified Test Laboratory.

2. Outdoor Indoor Transmission Class (OITC). When tested in accordance with ASTM E1332, window shall perform to a minimum of OITC-30. Testing shall be performed in a NVLAP Certified Test Laboratory.

G. Windborne Debris

1. When tested in accordance with FBC TAS 201, FBC TAS 202, and FBC TAS 203 or ASTM E1886 and ASTM E1996, windows shall conform to protocol requirements as they relate to the specified basic wind speed/design pressure for the project location.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Window manufacturer shall supply test reports from an AAMA and NVLAP accredited laboratory certifying compliance with performance specifications for each type of window supplied for this project.

C. Window manufacturer shall supply product data for each type of window required, including:

1. Construction details and fabrication methods
2. Data on hardware and accessories
3. Recommendations for maintenance and cleaning of exterior surfaces

D. Before proceeding with the manufacture of windows, the window contractor shall submit complete shop drawings with installation details for the ENGINEER's approval. These drawings shall also show window elevations, details of all window sections, collateral materials, details of anchorage, and associated hardware.

E. Window manufacturer shall submit a copy of the product warranty to be applied to this project.

1.6 QUALITY ASSURANCE

A. All testing shall be performed by an independent architectural testing laboratory accredited by the American Architectural Manufactures Association (AAMA), the National Voluntary Laboratory Accreditation Program (NVLAP), the International Conference of Building Officials (ICBO), and such other accreditation as may be required by state of local building regulations.

B. The manufacturer shall provide the ENGINEER and OWNER a certificate of compliance certifying that the windows furnished for this project are identical in every aspect of design, component parts (including sealants and the application thereof, reinforcing members, etc.) and fabrication techniques as the windows tested in the laboratory for which test reports have been furnished.

1.7 WARRANTY

A. The manufacturer shall warrant the product against material defects or defects in manufacturing. If a defect is discovered and brought to the attention of the manufacturer, the defect will be corrected at no cost to the owner. Warranty shall not be pro-rated. Warranties requiring the owner to return windows to the factory for repair or replacement shall not be accepted.

1. Windows: Warrant for ten (10) years against defects in material or workmanship under normal use.

1.8 MEASUREMENT AND PAYMENT

A. Aluminum windows shall not be measured or paid as a separate item but shall be included as part of the bid item to which it relates.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions

1. Shall be accurately extruded aluminum alloy 6063-T6.
2. All sash, screen, and frame members shall have a minimum wall thickness of 0.062 inches.
3. Sill frame shall be constructed of extruded tubular shapes and shall include an aluminum closed weep system to prevent accumulation of water in sill. Tubular shapes that are formed by snapped-on or slide-together extrusions shall not be accepted.
4. Exterior and interior frame sill shall have a minimum slope of five degrees.

B. Thermal Barrier

1. All frame members shall be thermally broken by an extruded PVC thermal-barrier which shall provide complete metal-to-metal separation between the inner and outer frame members of not less than 1/4 inch. The thermal-barrier shall interlock to both halves of the frame, securely locking them together, though not inhibiting the expansion and contraction of either part. A bead of sealant shall be applied to the complete perimeter of the window to seal the joints between the frame and thermal-barrier. A pour and de-bridge thermal-barrier will not be accepted.

C. Gaskets

1. All corner joints of the master frame shall have neoprene gaskets to insure a weather-tight seal.

D. Weather Stripping

1. All sashes shall be double weather stripped with 100% woven pile and Mylar center fins conforming to AAMA 701/702. Weather stripping to be secured within extruded shapes of the aluminum profiles to prevent movement. Surface applied weather strip shall not be accepted.

E. Glazing

1. All glazing shall comply with the performance requirements outlined in Section 08 80 00 - Glazing.
2. All operable sashes shall be marine-glazed with reusable flexible glazing vinyl.
3. All fixed glass to be set against sealant tape and wet sealed with a cap bead at the exterior. Interior glass lite to be dry sealed with a push-in glazing gasket.
4. Nominal glass thickness and type shall be

a. Exterior glass lite
    1) Thickness: 1/4"
    2) Tint: bronze
    3) Type: annealed

b. Interior glass lite
    1) Thickness: 3/16"
    2) Tint: clear
    3) Type: annealed
    4) Coating: none

F. Muntin

1. Muntin grids shall be extruded aluminum with exposed surfaces finished to match window exterior and interior colors; surface applied to the interior and exterior of the exterior most glass lite.
2. Muntin grids shall be surface applied to the interior and exterior of the glass lite.
3. Grid patterns to be designated by ENGINEER.

G. Acoustic Liner

1. Each master frame shall have an acoustic liner of open-cell absorption foam covered by a perforated aluminum cover. Acoustic liner shall surround the entire inside perimeter of the intermediate frame but shall not prevent or inhibit the drainage of moisture across the sill of the master frame. The open area of perforation shall be not less than 18 percent. Absorption materials within the acoustic liner or master frame that are comprised of cellulose or other organic materials shall not be accepted.

2.2 FABRICATION

A. Window shall consist of two separate frames permanently interlocked by a rigid vinyl thermal-barrier. All joints of the frame and sash shall be butt type, secured by means of thread-cutting type screws anchored into screw ports which shall be an integral part of frame members. All corner joints shall be joined neatly in a manner to provide weather-tight connection. Sash corners to be internally sealed. All sharp milled edges and corners of sash and screen frame shall be de-burred and made smooth. The meeting rail shall be of tubular construction, double weather stripped, and interlocked when in a closed position. Window unit is to be constructed in a manner that will facilitate the replacement of worn or damaged parts, hardware or weather strip.

2.3 FINISH

A. Interior

1. Anodized Finish: Class I (etched and anodized to 0.7 mil), conforming to AAMA 611-98
    a. Color to be: dark bronze

B. Exterior

1. Anodized Finish: Class I (etched and anodized to 0.7 mil), conforming to AAMA 611-98
   a. Color to be: dark bronze

2.4 MANUFACTURER, OR APPROVED EQUAL

A. St. Cloud Window, Inc. (800-383-9311) – Model SCW960 Fixed

PART 3 EXECUTION

3.1 INSTALLATION

A. All window and related window components shall be installed in accordance with requirements of the OWNER and the approved shop drawings of the manufacturer. Installation shall be by a contractor who is experienced and who shall document at least one other projects of similar nature and scope for which the window products were successfully installed.

B. All materials shall be erected plumb, level, and true, relative to the building structure. The maximum variation from plumb and level shall not exceed 1/8 inch (plus or minus) over 10 feet.

C. Approved insulation materials shall be installed in the frame cavity on the interior portion of the window frame. Area adjacent to the exterior of the window frame shall remain un-insulated. The window installer shall use caution in the insulation operation to avoid overlapping insulation materials across the thermal-barrier connector thus bridging the two separate frame members.

3.2 CAULKING

A. A grade “A” type urethane caulking compound: **Pecora, Tremco, Vulkem** or approved equal as approved by the ENGINEER, shall be applied per the installation drawings and details at all points where the aluminum master frame and/or panning intersects the masonry or other exterior wall finish. The caulking material shall be applied in a manner which insures a continuous air-tight and water-tight perimeter seal. Color to match the color of the aluminum windows unless specified otherwise by the ENGINEER.

3.3 ADJUSTMENTS, PROTECTION, AND CLEANING

A. After installation, the erector shall remove all sealants, caulking, and other misplaced materials from all surfaces, including adjacent work. The window frame, sash, and glass shall be cleaned thoroughly with materials and methods recommended by the window and glass manufacturers and shall not cause any defacement of the work.

B. Installer shall make any and all adjustments to window sash and hardware to cause the operating sash to function properly and in accordance with the manufacture’s standards.

C. Protect from contact with contaminating substances resulting from construction operations, after installation and cleaning of windows by window contractor, the general contractor shall be responsible for maintaining the cleanliness and protection of the window from damage from other trades.

D. Remove all sealant, caulking, and other misplaced materials from all surfaces, including adjacent work. The window frames, casing, and glass shall be thoroughly cleaned with materials and methods recommended by the window and glass manufacturers and shall not cause any defacement of the work.

E. The general contractor shall be responsible for the protection of the work from damage by other trades.

- END OF SECTION –

SECTION 08 62 00
SKYLIGHTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers all the Work necessary to furnish and install skylights, complete and in place.

1.2 RELATED WORK

A. Related work in other Sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN ARCHITECTURAL MANUFACTURER'S ASSOCIATION (AAMA)

1. AAMA 1606 Voluntary Uniform Load Structural Standard for Plastic Domed Skylights

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 123 Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
2. ASTM B 221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
3. ASTM D 256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
4. ASTM D 4802 Standard Specification for Poly (Methyl Methacrylate) Acrylic Plastic Sheet

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide unit skylights capable of withstanding loads indicated without failure. Failure includes the following:

1. Thermal stresses transferred to the building structure.
2. Framing members transferring stresses, including those caused by thermal and structural movement, to glazing.
3. Noise or vibration created by thermal and structural movement and wind.
4. Weakening of fasteners, attachments, and other components.

B. Structural Loads: Provide unit skylights that meet the requirements of AAMA 1606-82, which requires acrylic thickness adequate to withstand a positive and negative test pressure of 60 PSF.

1.5 SUBMITTALS

A. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data Sheet: For each type of skylight specified, include details of construction and installation, relative to applicable roofing materials, materials, gauges, sizes, finishes, and fasteners.

C. Samples for Selection: Manufacturer's color charts showing a full range of colors available for each type of skylight glazing and Aluminum Finish.

1.6 DELIVERY AND STORAGE

A. Skylights shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon.

1.7 WARRANTY

A. Manufacturer shall provide to the Owner written guarantee against defects in material or workmanship for a period of five (5) years.

1.8 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for skylights. Full compensation for all skylights shall be considered as included in the contract unit or lump sum bid prices for the various items of the Contract to which they relate.

PART 2 PRODUCTS

2.1 SKYLIGHTS

A. Skylights shall be as noted on the drawings and be manufactured by **Wasco Products, Inc., Aladdin Industries,** or approved equal. Skylights shall be factory assembled with square double-dome type designed to meet applicable OSHA and building code requirements. Skylights shall be watertight with curb frame insulation and meet the requirements specified herein. All hardware shall be stainless steel throughout. Skylights shall be provided with a permanent label showing the manufacturer's name and address and the model number.

1. Curb Frame: High performance PVC with minimum effective thickness of 0.60 inch. Provide integral condensation gutter with corners fully welded for waterproof quality.
2. Retainer Frame: Extruded aluminum alloy 6063-T5 (min) conforming to ASTM B 221 with minimum effective thickness of 0.60 inch.
3. Integral Curbs (Where indicated): Fabricated from double skin of 1100-H14 sheet aluminum, insulated with 1-inch fiberglass insulation. Provide thermal break at top and bottom. Provide minimum 0.025 inch minimum thickness inner and outer skin. Outer skin to be 0.032 inch when length exceeds 48 inches.

4. Plastic Sheets: Monolithic, formable, transparent (colorless – Clear) with good weather and impact resistant.
    a. Acrylic: Conforming to ASTM D 4802, thermoformable, acrylic (methacrylate), Category C-2 or CC-2 Type UVA (formulated with ultraviolet absorber), with Finish 1 (smooth or polished), unless otherwise indicated. Average impact strength of 5.0 ft-lb/in when tested per ASTM D 256 (Charpy unnotched).
    b. Impact Modified Acrylic: Conforming to ASTM D 4802, thermoformable, acrylic (methacrylate) impact modified sheets manufactured by the extrusion process, category C-2 or CC-2, type UVA (formulated with ultraviolet absorber) with Finish 1 (smooth or polished). Average impact strength of 0.75 ft-lb/inch (40 J/m of notch) when tested according to ASTM D 256, Test Method A (Izod).
5. Thermal Break: Fabricate skylight units with thermal barrier separating interior metal framing from materials exposed to outside temperature.
6. Shape and Size: As indicated by model number.
7. Fasteners: Same material as metals being fastened or non-magnetic stainless steel as recommended by the manufacturer.

2.2 SKYLIGHT SCREENS

A. All skylights that do not meet OSHA and building code requirements for opening protection shall be provide with skylight screens. Screens shall be designed to meet OSHA regulation 29 CFR 910.23(e)(8) and shall meet the code requirements for opening protection. The entire assembly and anchoring system shall be designed and tested to withstand a minimum impact load of 300 foot pounds.

B. Screens shall be hot-dip galvanized, 3-inch by 4-inch welded wire mesh with a minimum diameter of 0.195-inch. Galvanizing shall conform to ASTM A 123.

C. Screens shall be manufactured by **Wasco Products, Inc., Aladdin Industries, Plasteco, Inc.**, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Skylights shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, skylights shall be weather tight and shall be free from warp, twist, or distortion.

B. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape as recommended by the manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint. Where aluminum will contact pressure-treated wood, separate dissimilar materials by methods recommended by the manufacturer.

C. Coordinate with installation of the roof deck and other substrates to receive skylights. Coordinate vapor barriers, roof insulation, roofing material, and flashing as required to assure that each element of the work performs properly and that combined elements was waterproof and watertight. Anchor units securely to supporting structure substrates to adequately withstand lateral and thermal stresses as well as inward and outward loading pressures.

D. Where counter flashing is required as a component of the skylight, install to provide adequate waterproof overlap with roofing or roof flashing. Seal with a thick bead of mastic sealant, except where overlap is indicated to be left open for ventilation.

- END OF SECTION -

SECTION 09 90 00
PAINTING AND FINISHES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers furnishing, surface preparation, and applying paints and coatings, complete and in place, to all specified surfaces including exposed valves, piping or fittings.

B. Definitions

1. The term “paint”, “coatings”, or “finishes” as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.
2. The term “DFT” means minimum dry film thickness, without any negative tolerance.
3. The term “mil” means thousandths of an inch.
4. The term “SSPC” means The Society for Protective Coatings.

C. The following surfaces shall not be coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Contract Drawings.
2. Stainless steel
3. Machined surfaces
4. Grease fittings
5. Glass
6. Equipment nameplates
7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The protective coatings applicator (Applicator) shall possess a valid state license as required for the performance of the painting and coating work called for in this specification and shall provide 5 references which show the Applicator has previous successful experience with the indicated of comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the Applicator provided the protective coating.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limit to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 30 00 Cast-in-Place Concrete
3. Section 05 50 00 Miscellaneous Specialties
4. Section 33 05 05 Ductile Iron Pipe
5. Section 33 11 10 Miscellaneous Appurtenances

1.3 REFERENCES AND STANDARDS

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

1. OSHA — Occupation Safety and Health Act: State of Utah and Federal
2. ICRI — International Concrete Repair Institute Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI A 13.1 — Standard for Scheme for the Identification of Piping Systems
2. ANSI Z 535 — Standard for Safety Colors

C. AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

1. ASTM C 309 — Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
2. ASTM D 520 — Standard Specification for Zinc Dust Pigment
3. ASTM D 521 — Standard Test Methods for Chemical Analysis of Zinc Dust (Metallic Zinc Powder)
4. ASTM D 6943 — Standard Practice for Immersion Testing of Industrial Protective Coatings Linings
5. ASTM D 1653 — Standard Test Methods for Water Vapor Transmission of Organic Coating Films
6. ASTM D 2370 — Standard Test Method for Tensile Properties of Organic Coatings
7. ASTM D 2794 — Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
8. ASTM D 4263 — Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
9. ASTM D 4414 — Standard Practice for Measurement of Wet Film Thickness by Notch Gages
10. ASTM D 4417 — Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
11. ASTM D 7234 — Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
12. ASTM D 7682 — Standard Test Method for Replication and Measurement of Concrete Surface Profiles Using Replica Putty
13. ASTM E 96 — Standard Test Methods for Water Vapor Transmission of Materials
14. ASTM F 1869 — Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
15. ASTM F 2170 — Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 210 — Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
2. AWWA C 222 — Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings

E. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 301 Specifications for Structural Concrete

F. NACE International (NACE)

1. NACE RP0287 Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
2. NACE SP0188 Standard Practice for Discontinuity (Holiday) Testing of Protective Linings
3. NACE SP0892 Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service
4. NACE No. 1/SSPC-SP 5 White Metal Blast Cleaning
5. NACE No. 2/SSPC-SP10 Near White Metal Blast Cleaning
6. NACE No. 3/SSPC-SP6 Commercial Blast Cleaning
7. NACE No. 6/SSPC-SP13 Surface Preparation of Concrete

G. SSPC: The Society for Protective Coatings (SSPC)

1. SSPC PA1 - Shop, Field, and Maintenance Painting of Steel
2. SSPC-PA2 – Paint Application Specification No. 2: Measurement of Dry Coating Thickness with Magnetic Gages.
3. SSPC-PA11 - Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
4. SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning.
5. SSPC-SP10/NACE 2 - Near White Metal Blast Cleaning
6. SSPC-SP16 – Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
7. SSPC-VIS 1 - Guide to Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. CONTRACTOR shall supply shop drawings for approval on all paint materials at least 30 days prior to installation. Submittals shall include the following data sheets:

1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers.

C. Where ANSI/NSF 61 approval is required, submit ANSI/NSF 61 certification letter for each coating in the system indicating the product application limits on size of tank or piping, dry film thickness, number of coats, specific product tests, colors certified, and approved additives.

D. Quality Control Submittals:

1. Furnish a list of references for the Applicator substantiating the requirements as specified.

2. Manufacturer's certification stating factory applied coating systems meets or exceeds requirements specified herein.
3. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturers' written confirmation that materials are compatible.

1.5 PAINT DELIVERY, STORAGE, AND HANDLING

A. Deliver paint to the project site in unopened containers that plainly show, at the time of use, the designated name, date of manufacture, color, and name of manufacturer.

B. Store paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the manufacturer.

1.6 QUALITY ASSURANCE

A. All inspection for quality assurance shall ultimately be the responsibility of CONTRACTOR. OWNER retains the right to observe, accept, or reject the work based on the results of CONTRACTOR's inspection or observations by ENGINEER, at OWNER's discretion, in accordance with the specifications.

B. Repair and recoat all runs, overspray, roughness, or any other signs of improper application in accordance with paint manufacturer's instructions and as reviewed by ENGINEER.

C. Observations by OWNER or ENGINEER, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve CONTRACTOR of his responsibility to perform the work in accordance with these specifications.

1.7 MANUFACTURER'S SERVICES

A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

1.8 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. An inspection may be conducted during the eleventh month following completion of coating work. CONTRACTOR and a representative of the coating material manufacturer shall attend this inspection. Defective work shall be repaired in accordance with these specifications and to the satisfaction of OWNER. OWNER may, by written notice to CONTRACTOR, reschedule the inspection to another date within the one-year correction period or may cancel the inspection altogether. CONTRACTOR is not relieved of its responsibilities to correct defects whether or not the inspection is conducted.

PART 2 PRODUCTS

2.1 GENERAL

A. CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.

B. Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and CONTRACTOR shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. In any coating system only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. Colors and shades of colors of coatings shall be as indicated or selected by ENGINEER. Each coat shall be of a slightly different shade to facilitate observation of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by OWNER.

E. Substitute or “Or-Equal” Products

1. Basis of Design: The Coating Systems listed below in paragraph 2.3 are based on products from Tnemec Company Incorporated, except where indicated below.
2. Product Substitution: To establish equality under Section 01 60 00 – Product Requirements, the specified coating systems are the minimum standard of quality for this project. Equivalent materials of other manufacturers may be substituted only by approval of ENGINEER. Requests for material substitutions shall be in accordance with requirements of the project specification.
3. Product Requirements: CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or equal" product that the material meets the indicated requirements and is equivalent or better in the following properties: Quality, Durability, Resistance to abrasion and physical damage, Life expectancy, Ability to recoat in the future, Solids content by volume, Dry film thickness per coat, Compatibility with other coatings, Suitability to chemical attack, Temperature limitations during application and in service, Type and quality of recommended undercoats or topcoats, Ease of repairing damaged areas, and stability of colors.
4. Manufacturers of “or equal” products shall provide direct performance comparison with the materials specified, in addition to complying with all other requirements of these Specifications. “Or equal” products shall employ the same generic type materials and system components as the specified coating systems.
5. Requests for product substitution shall be made and approved at least 10 days prior to bid date.
6. CONTRACTOR shall bear any additional costs, if a proposed substitution requires changes or additional work.

2.2 COLORS

A. Provide colors as selected by OWNER or ENGINEER.

B. Colors shall be formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gas likely to be present at the project.

C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply color matches.

D. Equipment colors;

1. Equipment shall mean the machinery or vessel itself plus the structural supports and fasteners.
2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as indicated below:

a. Dangerous parts of equipment and machinery: OSHA Orange
b. Fire protection equipment and apparatus: OSHA Red
c. Radiation hazards: OSHA Purple
d. Physical hazards in normal operating area: OSHA Yellow

3. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.

E. Piping color coding shall be in accordance with ANSI A13.1, Division of Drinking Water R-309-525, and International Plumbing Code.

1. Color code non-submerged metal piping except electrical conduit. Paint fittings and valves the same color as the pipe unless otherwise specified.
2. Pipe supports: If pipe supports are not galvanized or stainless steel, supports shall be painted ANSI No. 70 light gray as specified in ANSI Z535.
3. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe located outside of buildings and enclosed structures will not require painting, unless noted otherwise on the Contract Drawings.

2.3 COATING SYSTEMS

A. System No. 1 (NOT USED)

B. System No. 2 (NOT USED)

C. System No. 3 (NOT USED)

D. System No. 4 (NOT USED)

E. System No. 5 (NOT USED)

F. System No. 6 (NOT USED)

G. System No. 7 (NOT USED)

H. System No. 8 Galvanized Steel and Cast/Ductile Iron – Interior Exposed

1. Materials

Type	Polyamide Epoxy
VOC content, max, g/L	250
Demonstrated Suitable for	Ferrous, galvanized, nonferrous, cast/ductile iron surfaces in industrial exposure, resistant to mild corrosion and chemical fumes, has good color and gloss retention

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
Galvanized Steel and Non-Ferrous: SSPC-SP16 brush-off blast cleaning of coated and uncoated galvanized steel and non-ferrous metals to achieve a uniform anchor profile of 1.0-2.0 mils. Ductile and Cast Iron: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.	Primer: Tnemec Series 69 Hi-Build Epoxoline II Finish: Tnemec Series 69 Hi-Build Epoxoline II	Primer: 3-5 DFT Finish: 3 – 5 DFT
	Primer: Sherwin Williams Macropoxy 646 Fast Cure Epoxy Finish: Sherwin Williams Macropoxy 646 Fast Cure Epoxy	
	Primer: Carboline Carboguard 60 Finish: Carboline Carboguard 60	

3. Application
   a. Exposed galvanized and cast/ductile iron surfaces located inside of structures requiring painting and the following specific surfaces unless noted otherwise:
      1) All exposed galvanized pipe
      2) All exposed cast/ductile iron pipe
   b. Do not paint galvanized steel mechanical pipe and equipment supports unless noted otherwise.

I. System No. 9 (NOT USED)

J. System No. 10 (NOT USED)

K. System No. 11 (NOT USED)

L. System No. 12 (NOT USED)

M. System No. 13 (NOT USED)

N. System No. 14 (NOT USED)

O. System No. 15 (NOT USED)

2.4 SPECIAL COATING SYSTEMS

A. System 200 (NOT USED

B. System 201 (NOT USED)

C. System 202 – Polyethylene Encasement: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C. Provide polyethylene encasement where indicated on the Contract Drawings or per Section 30 05 05 – Ductile Iron Pipe.

D. System 203 (NOT USED)

E. System 204 – Ductile or Cast-Iron, Valves and Gates - Immersion in Water and Wastewater

1. Materials

Type	High Solids Epoxy
VOC content, max, g/L	285
Demonstrated Suitable for	Ductile or Cast-Iron immersion in water or wastewater
Certification	NSF 61 if used for immersion in potable water

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
Prepare all surfaces by uniformly abrasive blasting the entire exterior surface to ensure cleanliness and to create a minimum angular anchor profile of 2.0 mils.	Primer: Tnemec Hi-Build Epoxoline II Series N69(1) Intermediate: Tnemec Hi-Build Epoxoline II Series N69(1) Finish: Tnemec Hi-Build Epoxoline II Series N69(1)	Primer: 3 - 5 DFT Intermediate: 4 - 6 DFT Finish: 4 - 6 DFT
	Primer: Ameron Amerlock 400 Intermediate: Ameron Amerlock 400 Finish: Ameron Amerlock 400	
	Primer: International Interseal 670 HS Intermediate: International Interseal 670 HS Finish: International Interseal 670 HS	
	Primer/wastewater: Carboline Phenoline 1205	

	Finish/wastewater: Carboline Phenoline 1205 Prime (NSF61): Carboline Carboguard 635VOC Intermediate (NSF 61): Carboline Carboguard 635VOC Finish (NSF 61): Carboline Carboguard 635VOC	
	[1] For NSF 61 certified potable water applications use Tnemec Pota-Pox Plus Series N140.	

3. Application
   a. Ductile or Cast-Iron Slide Gate Covers and Frames

2.5 CONCRETE FINISHES

A. Exterior Above Grade Concrete: Concrete surfaces exposed to view outside the building and including 6 inches below finished grade on the building or structure should be finished with a “Class B” finish. Products for the “Class B” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

B. Interior Exposed Above Floor Concrete: Interior above grade concrete shall be finished with a “Class B” finish. Products for the “Class B” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

C. Interior Concrete Floors: Interior concrete floors shall be finished with a “Trowel” finish. Products for the “Trowel” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

D. Exterior Concrete Flat Surfaces: Exterior concrete flat surfaces shall be finished with a “Broom” finish. Products for the “Broom” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

PART 3 EXECUTION

3.1 GENERAL

A. The intention of this specification is for all new, interior and exterior, masonry, concrete, and metal, whether atmospheric or submerged exposure surfaces to be painted whether specifically mentioned or not, except as modified herein. Concealed structural steel surfaces shall receive a prime coat only unless modified herein.

B. Surface preparation and coating application shall be in accordance with these specifications and the coating manufacturer’s written product data sheets and written recommendations of the manufacturer’s technical representative. Where conflict occurs between the manufacturer’s recommendations and these specifications, the more stringent of the two shall apply unless approved by ENGINEER.

C. For immersion coatings, obtain full cure for completed system before immersing or allowing exposure to water of condensation for more than 12 hours.

3.2 REGULATORY REQUIREMENTS

A. Meet federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.

B. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application, and dust prevention including but not limited to the following Acts, Regulations, Standards, and Guidelines:

1. Clean Air Act
2. National Ambient Air Quality Standard
3. Resource Conservation and Recovery Act (RCRA)
4. SSPC Guide 6

C. Comply with applicable federal, state, and local regulations for confined space entry.

D. Provide and operate equipment that meets explosion proof requirements.

3.3 ENVIRONMENTAL CONDITIONS

A. Do not apply paint in extreme heat, temperatures below 40 degrees F, nor in dust, smoke-laden atmosphere, damp or humid weather. The Applicator shall adhere to the manufacturer's recommendations regarding environmental conditions. The Applicator shall monitor humidity, air temperature, and surface temperature with properly calibrated instruments.

B. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, nor whenever surface temperature is less than 5 degrees F above dew point of ambient air. Strictly adhere to manufacturer's recommendations.

C. Surface preparation power tools and blast equipment shall contain dust collection devices that will prevent discharge of dust particles into the atmosphere around electrical or mechanical equipment unless otherwise permitted by ENGINEER.

D. Where weather conditions or project requirement dictate, the Applicator shall provide and operate dehumidification equipment to maintain environmental conditions suitable for abrasive blasting and coating application as specified.

3.4 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on coating work.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. Damage to other surfaces resulting from the work shall be cleaned, repaired, and refinished to original condition.

3.5 STORAGE, MIXING, AND THINNING OF MATERIALS

A. Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.

B. Coating materials shall be used within the manufacturer's recommended shelf life.

C. Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.6 SURFACE PREPARATION

A. All surfaces which receive paint or other coatings shall be prepared in accordance with the recommendations of the manufacturer of the material being used. The Applicator shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application.

B. Perform sandblasting for piping and any other items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, and procedures shall meet requirements of the Society for Protective Coatings (formerly the Steel Structures Painting Council).

3.7 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Surfaces that are not to receive coatings shall be protected during surface preparation, cleaning, and coating operations.

B. Remove, mask or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

C. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

D. Protect working parts or mechanical and electrical equipment and motors from damage.

E. Care shall be exercised not to damage adjacent work during blasting operations. Spraying shall be conducted under carefully controlled conditions. CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blasting or coating operations.

3.8 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the the Society for Protective Coatings shall form a part of this specification:

1. Solvent Cleaning (SSPC SP1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.
2. Hand Tool Cleaning (SSPC SP2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.
3. Power Tool Cleaning (SSPC SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.
4. White Metal Blast Cleaning (SSPC SP5): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.
5. Commercial Blast Cleaning (SSPC SP6): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.
6. Brush-Off Blast Cleaning (SSPC SP7): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.
7. Near-White Blast Cleaning (SSPC SP10): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.
8. Surface Preparation of Concrete (SSPC-SP13): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.
9. Surface Preparation (SSPC-SP16): Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

3.9 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. Oil, grease, welding fluxes, and other surface contaminants shall be removed by solvent cleaning per SSPC SP1 - Solvent Cleaning prior to blast cleaning.

C. Round or chamfer all sharp edges and grind smooth burrs and surface defects and weld splatter prior to blast cleaning.

D. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

E. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

F. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

G. If the required abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP2 or SSPC SP3 may be used as per manufacturers recommendations.

H. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP1 before the abrasive blast cleaning has been started.

I. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.

J. Exposed ductile iron pipe shall be given a shop coat of rust-inhibitive primer conforming to these specifications. Abrasive blasting of the asphaltic coating on ductile iron pipe will not be allowed.

3.10 FERROUS METAL SURFACE PREPARATION (GALVANIZED)

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system, followed by blast cleaning per SSPC SP16.

B. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer.

3.11 CAST-IN-PLACE CONCRETE SURFACE PREPARATION

A. Concrete surfaces to receive protective coating shall be cast with a Smooth Form Finish in accordance with ACI 301. Surfaces shall not be rubbed, sacked, troweled or otherwise finished in any manner that will obscure or cover the parent concrete surface with materials other than materials as specified in this Section.

B. All surfaces must be clean, dry and free of oil, grease and other contaminants, prior to preparation in accordance with NACE No. 6/SSPC-SP13. Concrete surfaces must be sound and capable of supporting the corrosion protection lining system.

C. Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Abrasive blast, shot-blast, water jet or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers, existing coatings, and other contaminants and to provide the recommended ICRI-CSP Profile.

D. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of sharp edges, ridges, form fins, and other concrete protrusions.

E. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model BD-2100, or equal.

3.12 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color. The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop

primer requires topcoating within a specific period of time, the equipment shall be finish coated in the shop and then be touched up after installation.

B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.

C. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment shall be primed and finish coated in the shop and touched up in the field with the identical material after installation. CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

D. For certain small pieces of equipment, the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

E. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being topcoated, or less time if recommended by the coating manufacturer.

F. CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

G. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

3.13 APPLICATION

A. General

1. Schedule inspection with ENGINEER in advance for cleaned surfaces and all coats prior to each succeeding coat.
2. Apply coatings in accordance with the paint manufacturer’s recommendations and these specifications, whichever is more stringent. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.
4. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.
5. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.
6. Non-buried steel piping shall be abrasive blast cleaned and primed before installation.
7. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.14 CURING OF COATINGS

A. CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air, if necessary, may be required until the coatings have fully cured.

3.15 SHOP AND FIELD OBSERVATION AND TESTING

A. CONTRACTOR shall give ENGINEER a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.

B. Observation by ENGINEER, or the waiver of inspection of any particular portion of the work, shall not relieve CONTRACTOR of its responsibility to perform the work in accordance with these Specifications.

C. CONTRACTOR shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for ENGINEER's use while coating is being done, until final acceptance of such coatings. CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of ENGINEER.

D. CONTRACTOR shall test for continuity (holiday test) all coated surfaces inside reservoirs, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturers' printed instructions and then be retested.

    1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.
    2. Coatings with thickness of 20-mils or less total DFT: Tinker & Rasor Model M1 nondestructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a nonsudsing type wetting agent, such as Kodak Photo-Flo or equal, shall be added to the water prior to wetting the detector sponge.

E. On ferrous and non-ferrous the dry film coating thickness shall be measured in accordance with the SSPC PA 2 using a magnetic type dry film thickness gauge such as Mikrotest Model FM, Elcometer Model 111/1EZ, or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

F. Evaluation of blast cleaned surface preparation will be based upon comparison of the blasted surfaces with the standard samples available from SSPC and NACE, such as using NACE standards TM-01-70 and TM-01-75.

G. Visually inspect concrete, nonferrous metal, plastic, drywall, and wood surfaces to ensure proper and complete coverage has been attained.

3.16 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

D. Damages due to overspray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of CONTRACTOR.

3.17 MANUFACTURER' SERVICES

A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

- END OF SECTION -

SECTION 26 05 00
ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SCOPE

A. This Section consists of the Electrical General Requirements and related items necessary to provide complete and operational electrical system(s) indicated within the Contract Documents.

1.2 APPLICABLE SECTIONS AND REQUIREMENTS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and Addenda, applicable drawings, and the technical specifications herein shall apply to all work specified herein.

B. The CONTRACTOR shall comply with the specifications and accompanying drawings which describe and provide for the furnishing, delivering, installing, testing, and placing in satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete electrical system for power distribution, control, lighting, and auxiliary systems.

C. State Licensed Contractor - All contractors must have a current state contracting license. The CONTRACTOR shall be licensed as such in the CONTRACTOR state of origin and in the state where the work is performed.

D. The electrical contractor shall have a licensed Master Electrician assigned to direct the electrical work and to coordinate work with the General Contractor and other trades. Furthermore, a licensed journeyman electrician shall be assigned to supervise the actual performance of all electrical work specified herein.

E. The licensed journeyman assigned to supervise the performance of all electrical work, shall be required to be on the job site at all times, while electrical work is being performed.

1.3 CONTRACT DOCUMENTS

A. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. Each is complementary and requirements shown, written or reasonably inferred there from on one is considered as written, shown or implied in all. In the event work is called for in more than one place and is of conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

B. The drawings are diagrammatic, intended to indicate the general scope and locations of the work to be installed and are not to be considered as complete in every detail, but shall be followed as closely as actual construction and work of other contractors will permit.

C. Data given herein and on drawings are as exact as could be secured, but their extreme accuracy is not guaranteed. Drawings and specifications are for the assistance and guidance of the CONTRACTOR; but exact locations, distances, and levels will be

governed by actual conditions, and the CONTRACTOR is to verify all dimensions given on the drawings, and to report any discrepancy or inconsistency to the ENGINEER before commencing with the work.

D. The CONTRACTOR shall install all work indicated and/or specified herein, complete to perform the function intended without additional cost. Raceway and conductors to panels from devices referred to as "home runs" are indicated by pointing in the general direction of panels. Construction shall continue such circuits to the panels as though the routes were completely indicated. Home runs shall be installed from devices to panels as indicated.

E. Deviations from the drawings required to make work of this contract conform to actual conditions as constructed, or as to work of other contractors, shall be made by the CONTRACTOR at his expense. The ENGINEER reserves the right to make minor changes in the location of equipment and devices without additional charges.

F. The CONTRACTOR shall familiarize himself with the architectural, structural, and civil/mechanical drawings and shall study drawings and details so that equipment will be properly located and readily accessible. If any conflicts occur necessitating departures from the contract drawings, details of departures and reasons therefore shall be submitted for prior approval.

G. In any case and at any time, a change in material or location is made necessary by CONTRACTOR's failure to take into account obstacles or the installation of other trades shown, whether on electrical drawings or other drawings, in existence at the time bids were received, such changes shall be made without charge to OWNER.

H. Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Where drawings are required for these purposes or have to be made from field measurements, they shall be prepared by the CONTRACTOR, Shop Drawings of various contractors shall be coordinated to take into account all obstacles that will interfere with the installation.

I. Every attempt has been made to indicate the installation and wiring requirements for all equipment to be installed. However, it shall be the CONTRACTOR’s responsibility to coordinate with equipment shop drawings and make adjustments necessary including; power and control wiring sizes and counts, breaker sizes, rough-in locations, etc. for actual equipment provided. The contractor shall provide in his bid the conductors and conduits required for the equipment to be installed. The contractor shall reference the mechanical drawings, the P&ID drawings, the control diagrams, the control drawings, the power drawings, the one line diagrams and all schedules. The contractor shall at his expense provide the conduit and conductors for the equipment installation for a complete and functional system.

J. Every attempt has been made in the drawings to indicate the general installation requirements for the power and control connections for the equipment indicated. However, equipment requirements vary from manufacturer to manufacturer and from date to date for equipment. The responsibility to coordinate the exact requirements of all equipment and install the required systems for these systems shall belong to the contractor, at his expense. No additional costs to the owner shall be incurred for the contractor’s failure to coordinate these equipment requirements at the time of bid.

K. Electrical drawings are diagrammatic in nature and are not intended to show shop drawing style connections, equipment installation coordination or exact conduit and conductor sizes or counts. The contractor shall at his expense coordinate and provide necessary electrical and control components for a complete and functional system. If any conduit, equipment schedule, sizing, capacities, counts, lengths are unclear at the time of bidding or if conflicts exist on the drawings or in the specifications, the owner reserves the right for the installation of the more expensive or the more involved at no additional cost to the owner.

1.4 INFORMATION FOR ENGINEER

A. Submit the required information in accordance with the General Conditions, Section 00 70 00, and the following requirements.

1. The CONTRACTOR shall check all shop drawings for conformance with Contract Documents before submitting. The CONTRACTOR shall note on shop drawings any changes from items specified listing reasons and giving source of change such as "Approved Equal", "Addendum", or "Change Order". The CONTRACTOR shall be responsible for conformance with drawings and specifications; for dimensions to be confirmed and correlated at the job site: for information that pertains solely to the fabrication processes or the techniques for construction; and coordination of the work with other trades. Receipt or approval of shop drawings by the ENGINEER does not relieve the CONTRACTOR of the responsibility of complying with Contract Documents.
2. All shop drawings (drawings and manufacturer’s data) required under each section of this Division 26 shall be submitted at the same time and be bound together in one hard back, three ring binders per copy, properly indexed for the formal submittal. Binder shall be sized to adequately contain all the materials therein and shall be labeled as to the identity of the job and the sub-contractor.
3. Shop drawings shall include functional and descriptive literature of the particular item furnished complete with dimensional drawings, wiring or schematic diagrams, rough-in and installation instructions, knock-out locations, hangers or mounting devices, etc., as required for the proper checking and installation of the equipment. Catalog sheets without any reference made to the particular item will not be acceptable. All special features called for in Contract Documents shall be noted. Where performance test results of a product design are called for in the technical sections of these specifications, test data sheets shall be provided with the shop drawing submittal.

B. Material Lists: Include manufacturer, type and model number of equipment that will be provided as called for under each section of this Division 26.

C. Other Information: As required by the ENGINEER.

1.5 CODES, LICENSES AND STANDARDS

A. Perform work in accordance with best present-day installation and manufacturing practices. Comply with all applicable laws, building and construction codes, and requirements of governmental agencies under whose jurisdiction work is being performed. Unless specifically noted to contrary, conform with and test in accordance with applicable sections of latest revisions of the following codes and standards.

1. American Society for Testing and Materials (ASTM)
2. National Fire Protection Association (NFPA)
3. National Electrical Code (NFPA 70-NEC)
4. Insulated Power Cable Engineers Association (ICEA)
5. Underwriters Laboratories Inc. (UL)
6. American Steel and Iron Institute, "Design Manual on Steel Electrical Raceways"
7. National Electrical Manufacturer's Association (NEMA)
8. National Electrical Contractor's Association (NECA)
9. American National Standards Institute (ANSI)
10. International Building Code (IBC)
11. State of Nevada Electrical, Energy, Building and Safety Codes
12. Institute of Electrical and Electronic Engineers (IEEE)
13. Instrument Society of America
14. US Environmental Protection Agency (EPA)

B. Conflicts Between Above Codes and Standards: The code or standard establishing the more stringent requirements shall be followed.

C. Conflicts Between Codes and Standards and Specifications and/or Drawings: The one establishing the more stringent requirements shall be followed.

1.6 MATERIALS AND WORKMANSHIP

A. Each type of equipment or material shall be the same make and quality. All materials and equipment shall be installed in accordance with the recommendations of the manufacturer as approved by the ENGINEER to conform to the Contract Documents.

B. The installation shall be accomplished by workmen skilled in the type of work involved.

C. All materials and equipment furnished and installed shall be of best quality, new, free from defects and meet the standards of NEMA, ICEA, UL, NFPA, IBC, OSHA, NEC, and shall bear their label wherever standards have been established and label service is available. Where materials and equipment are specified by manufacturer's name, the type and quality required is thereby denoted. The ENGINEER shall be afforded every facility, deemed necessary to observe and examine the materials and apparatus being installed to prove their quality.

D. Workmanship shall be the best quality of its kind for the respective industry crafts and practices, be neat and orderly throughout the project and shall be acceptable in every respect to the ENGINEER. Nothing contained herein shall relieve the CONTRACTOR from making good and perfect work in all details of construction.

E. The CONTRACTOR shall work in harmony with the ENGINEER and with other contractor's, companies or individuals working in connection with this project. Imperfections or discrepancies by other contractors shall not relieve responsibility of this CONTRACTOR. Store materials orderly and clean up without interference with other trades.

1.7 DEFECTIVE EQUIPMENT

A. If equipment fails to conform to detailed specifications or to operate satisfactorily, the OWNER will have the right to operate equipment until defects are corrected.

1. The OWNER will have the right to operate rejected equipment until it is replaced, without cost for depreciation use or wear.
2. Remove equipment from operation for examination, adjustment, alteration or change only at times approved by the OWNER.

1.8 STORAGE AND PROTECTION OF MATERIALS

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work under way, and apparatus against loss or damage.

B. Materials and apparatus shall be stored with environmental protection and other necessary conditions as recommend or required by the manufacturers'.

1.9 RECORD DRAWINGS

A. The Contract Document drawings will be used by the CONTRACTOR who shall accurately and neatly mark in colored pencil all changes or deviations from the drawings as they are made in the work.

B. Refer to Section 01 70 00 Contract Closeout for additional requirements.

1.10 COORDINATION OF CONSTRUCTION

A. Coordinate work with other contractors, the OWNER, and the ENGINEER to assure orderly and expeditious progress of work. Select order of work and establish schedule of working hours for construction. This is subject to review by the OWNER if the work involved is part of a functioning facility. If such is the case, the CONTRACTOR shall carefully coordinate any disruption of service with the OWNER. Any after hours/weekend outages shall be accommodated at no additional cost to the OWNER.

B. The electrical work shall be laid out in advance of construction to eliminate unnecessary cutting, drilling, or channeling, etc. Where such cutting and drilling, or channeling becomes necessary for proper installation; perform with care, use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the OWNER. Cutting work of other trades shall be done only with the consent of the CONTRACTOR. Cutting of structural members shall be done only with the written approval of the ENGINEER.

C. Comply with the following:

1. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
2. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
3. Install systems, materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

D. Cooperate with other trades to coordinate locations of electrical devices and apparatus.

E. Perform for other trades the electrical wiring and connections, for all devices or apparatus where not specified herein or indicated on the drawings. Consult the architectural and mechanical drawings to avoid the location of switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc. Hidden electrical devices and/or connections shall be relocated as directed, at no additional cost to the OWNER.

F. Where conduit, outlets or apparatus is to be cast in concrete or encased, it must be located and secured by a journeyman or foreman present at the point of installation. He shall check the locations of the electrical items before and after the concrete and masonry installation and shall relocate displaced items at no additional cost.

1.11 USE OF SUBSTITUTES

A. Equipment and materials are designated by one or more manufacturer's name brands or numbers. It is not the intent of the specifications to exclude other equipment or materials that equal or exceed the standard of those specified. If the CONTRACTOR desires to use substitute equipment or materials, he must submit for written approval as outlined in the General Conditions of the Contract Documents.

1.12 SITE CONDITIONS

A. Examination of Site: Examination of the site shall be made by the CONTRACTOR, who shall compare it with the drawings and specifications and satisfy himself as to the conditions under which the work is to be performed. He shall, at such time, ascertain and check all conditions which may affect his work. No allowance shall subsequently be made in his behalf for any extra expenses to which he may be put due to failure or neglect on his part to make such examination.

B. Review of Plans: Review all work indicated on drawings and specified herein with proper authorities responsible for interpreting applicable codes, ENGINEER, and local inspector prior to commencement with construction as listed herein, but not necessarily limited thereto:

1. Visit site prior to executing bid.
2. Verify measurements and locations of field measurements of existing conditions and those developed by construction.
3. Confirm requirements of work at off-site, publicly owned property with local authorities
4. Confirm connection requirements, sizes and layout with local public utilities.
5. Conditions discovered in conflict with intent of drawings and/or specifications must be clarified with ENGINEER prior to execution of work.

1.13 CLEAN-UP

A. As the work progresses and on a daily basis, the CONTRACTOR shall remove from the premises and surrounding streets, alleys, etc., all rubbish and debris resulting from his operations and shall leave all equipment and material furnished by him absolutely clean and ready for use.

1.14 SUPERVISION:

A. A competent foreman or superintendent initially approved by the ENGINEER shall be at the site at all times to receive instructions and shall be empowered to act. He shall verify dimensions given on the drawings and report any discrepancies or inconsistencies to the ENGINEER before commencing the work. The ENGINEER, or his representative, will interpret the meaning of the drawings and specifications where questions arise.

1.15 SAFETY REGULATIONS

A. The CONTRACTOR shall comply with OSHA and all other safety codes required by law and shall furnish and place proper protection for prevention of accidents. He/she shall provide and maintain any necessary construction required to secure safety of life or property during the performance of his/her work, including the maintenance of sufficient lights to secure such protection.

1.16 DISPOSITION OF EXISTING EQUIPMENT REMOVED FROM SERVICE

A. Existing equipment and materials such as cables, switches, conductors, etc., which are removed and not reused in the new installation shall remain the property of the OWNER. The CONTRACTOR shall deliver such equipment to storage place as directed. Items not wanted by the OWNER shall be removed from the site and disposed of by the CONTRACTOR.

1.17 PERMITS AND FEES

A. Obtain all permits and pay all fees for inspections, required by code for all the work covered under Division 26 of the specifications. All fees shall be included in the contract price. The CONTRACTOR shall furnish a certificate of approval to the ENGINEER from each inspection authority at completion of the work.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 FIELD DESIGN CHANGES

A. No field changes, additions, or change in locations shall be made without written approval from the ENGINEER.

3.2 EXCAVATION AND BACKFILLING

A. The CONTRACTOR shall perform all excavation, trenching and backfilling work, and remove all debris in connection with his work. Backfilling shall be done with materials acceptable to the ENGINEER and thoroughly tamped in place. All disturbed surfaces shall be restored to their original condition and properly installed to eliminate any settlement. Inside and outside, backfill shall be in 6-inch layers, compacted to 95% of the "standard protector test".

B. Perform excavation in a manner to protect walls, footings and other structural members, from being disturbed or damaged in any way.

3.3 ROUGH-IN REQUIREMENTS

A. Architectural, structural and mechanical drawings shall be continually consulted and referred to. Exact placement of sleeves, conduit, and equipment shall be provided for by checking building and equipment dimensions. Equipment requirements and dimensions related there to shall be determined from detailed rough-in dimensions of each piece of equipment shown on Shop Drawings furnished by manufacturer.

3.4 CUTTING AND PATCHING CHASES AND OPENINGS

A. Provide for all required cutting and patching, anchors, openings, slots, chases, etc., in construction for electrical work. Cutting and patching performed under direction of CONTRACTOR and will leave no discernable scars.

B. The CONTRACTOR shall be responsible for block-outs or demolition work pertaining to the installation of the electrical system.

C. In Remodeling and/or Addition projects, all salvageable electrical equipment and materials that cannot be integrated into the new electrical network becomes the property of the OWNER. Remove from the premises materials which the OWNER decides not to keep, as directed by the ENGINEER.

3.5 WORKMANSHIP

A. The CONTRACTOR shall be held solely responsible for the proper installation of his work. He shall arrange with the proper contractors for the building in of anchors, etc., and for the leaving of required chases, openings, etc., and shall do all cutting and patching made necessary by his failure or neglect to make such arrangements with others. Any cutting or patching done by this CONTRACTOR shall be subject to the directions of the ENGINEER and shall not be started until approval has been obtained.

B. All cutting, welding or drilling of concrete or structural members shall be properly reinforced and patched to match as nearly as possible the surrounding work. Before cutting, welding or drilling any concrete or structural member, the CONTRACTOR shall secure the approval of the ENGINEER.

C. This CONTRACTOR shall assign persons in direct charge of work who are thoroughly experienced in the class of construction work specified herein. All labor shall be performed in a workman like manner by skilled workmen under the supervision of competent foremen.

D. This CONTRACTOR shall periodically remove all debris and waste in order to maintain safe working and operating conditions, and shall dispose of the same in an approved manner. At the completion of work, he shall remove all his rubbish, tools, scaffolds and surplus materials from and about the site, leaving his work clean and the areas ready for occupancy.

3.6 SEISMIC RESTRAINT

A. The International Building Code requires that not only the structure, but also major mechanical and electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most

recent adopted edition of the IBC, and SMACNA "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment so that the final design can be properly reviewed.

3.7 TESTS

A. On completion of the work, the installation shall be tested free from all grounds and short circuits.

B. Normal feeders, circuits, and service entrance conductors with wire size #2 and larger shall be tested for leakage phase-to-ground and phase-to-phase prior to energizing the electrical system. The CONTRACTOR shall submit a written report to the ENGINEER showing methods and readings taken. Voltage applied for testing shall not exceed two times normal operating voltage.

C. Submit a record of voltage readings and amp meter readings on all feeders, motor full load amps, outside lighting, and service conductors to the facility. If there are any abnormal conditions, they shall be brought to the attention of the ENGINEER in writing as a part of this submittal.

D. Refer to Section 26 05 08 Electrical Acceptance Tests for additional requirements.

3.8 SUBSTANTIAL AND FINAL COMPLETION

A. Notify the ENGINEER when work is considered to be complete, in operating condition, and ready for Substantial Completion.

B. The ENGINEER, after determining that installation is ready for Substantial Completion, will make walkthrough and perform operational tests deemed necessary to determine that provisions of specifications are satisfied and prepare a list of outstanding items.

C. The OWNER will not accept work nor make final payment to CONTRACTOR until ENGINEER has certified that work of CONTRACTOR is complete and in conformance with specifications and guarantees.

D. Leave the job in complete order ready for use. All fixtures and equipment shall be tight, fully equipped and completely cleaned. All equipment shall have been operated, checked and approved by the OWNER before the project can be accepted.

E. At the time of the substantial and final walkthroughs, the project foreman shall accompany the party and remove cover plates, panel and enclosure covers, and other access panels for the ENGINEER, to allow complete observation of the entire electrical system(s).

F. Notify the ENGINEER when work is considered to be complete, including list of outstanding items, and is ready for Final Completion. Refer to Section 01 70 00 Contract Closeout for additional requirements.

3.9 TRAINING

A. Instruct OWNER's operating personnel in proper operation of the complete electrical system including all electrical equipment, switching, disconnects, panels, controls, etc., during a scheduled training tour for the OWNER’s personnel of entire project after Substantial Completion and prior to Final Completion. Confirm complete understanding on part of OWNER's operating personnel. Utilize the Operations and Maintenance Manuals specified elsewhere during the instruction process.

3.10 GUARANTEE/WARRANTY

A. The following guarantee is a part of the specification and shall be binding on the part of the CONTRACTOR and shall be submitted by letter to the OWNER prior to acceptance.

B. The CONTRACTOR guarantees that this installation complies with the drawings and specifications in all respects, and is free from defects. He agrees to replace or repair, to the satisfaction of the ENGINEER, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after Final Completion.

C. The CONTRACTOR guarantees that the installation of OWNER furnished equipment is free from defects. He agrees to provide labor to repair or replace to the satisfaction of the ENGINEER any part of his installation of the OWNER furnished equipment (the respective equipment vendor will provide all parts and labor for the equipment), which may fail or be determined to be unacceptable within a period of one (1) year after Final Completion.

D. Electrical and instrumentation systems and equipment shall not be considered acceptable for Substantial Completion until they have performed in service continuously without malfunction for at least ten (10) days.

- END OF SECTION -

SECTION 26 05 05
OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-26 Electrical General Requirements sections apply to work of this section.

1.2 SUMMARY

A. Furnish four sets of bound operation and maintenance manuals. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to maintain and repair the equipment. Copies of approved submittals shall be included for all equipment.

B. Refer to Section 01 34 00 for additional requirements.

1.3 OPERATION AND MAINTENANCE MANUAL FOR ELECTRICAL AND INSTRUMENTATION SYSTEMS

A. General:

1. The "Operating and Maintenance Manual" (Electrical and Instrumentation) is a bound compilation of drawings and data that the owner requires for each building or project. These manuals, complete with drawings and data, shall be furnished to the Owner.
2. The electrical CONTRACTOR has overall responsibility to obtain the necessary data and compile the data as set forth in this specification, including items or equipment purchased by the Owner and delivered to the CONTRACTOR for installation.
3. The number of binders (or "volumes") required will depend on the amount of information to be catalogued. Total "sets" see paragraph 1.02A.
4. Make all information legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of mechanical and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART 2 PRODUCTS

1.1 PAGE SIZE:

A. All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 11 x 17 inches) folded to 8-1/2 x 11 inch.

1.2 DRAWINGS:

A. All drawings larger than 8-1/2" x 11" shall be folded and inserted in individual 8-1/2" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

1.3 BINDERS:

A. Binders shall be Buckram (stiffened fabric), bar-lock type binders with block lettering for sheet size 8-1/2 x 11 inches with 2" to 3-1/2" expandable metal capacity as required for the project. The number of binders, however, shall be based on not filling them beyond 4".

B. Place the following information on the front cover and backbone:

1. "Operation and Maintenance Manual".
2. Project Name and Number (and volume number if more than one volume).
3. Equipment name and number.
4. ENGINEER's name.
5. General CONTRACTOR's name.
6. Electrical CONTRACTOR's name.
7. Items 4 through 6 need not be printed on the backbone.

1.4 CONTENTS AND INDEXING

A. Manuals shall contain descriptions of the electrical, control, and instrumentation systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:

1. Copy of purchase order change (if any).
2. Outline drawings, special construction details, “as-built” electrical wiring and control diagrams with wire and terminal number for panel and field wiring for all major and supplementary systems.
3. Manufacturer’s test or calculated performance data and certified test curves.
4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.
5. Manufacturer’s brochure marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included.
6. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.
7. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:

Part I Building and System Descriptions
Part II Purchased Equipment Data
Part III Test Reports and Charts
Part IV Start-Up and Operation
Part V Preventative Maintenance Recommendations
Part VI Software/Programming Data/Program CD's

8. A copy of the approved submittals for each piece of equipment.
9. A copy of all testing reports.
10. Wiring diagrams, marked with model and size and plan symbol.
11. The index shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.
12. Copies of developed software, programmed setpoints, screens, etc. on C.D.

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SECTION 26 05 07
ELECTRICAL POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SUMMARY

A. The electrical equipment manufacturer shall provide electrical power system studies for the project. The studies shall be prepared by the licensed professional electrical engineer of record for the plant. The type and content of each study is specified in the following articles.

1.2 SUBMITTALS

A. Completed electrical power system studies shall be bound and submitted to the ENGINEER.

1. Five (5) printed copies (hardcopies) of the completed study report shall be provided and one (1) copy in Microsoft Word or Adobe Acrobat format.
2. The software database and library used to model the power system shall be submitted in native file format including all updates to the library necessary to complete the model.

B. The CONTRACTOR shall attach brochures, resumes, references and other information indicating how your firm is qualified to provide the services outlined in this document.

C. The CONTRACTOR is responsible for compliance with all performance specifications in this proposal. Any deviation from complete compliance must be noted on the performance specification submitted for review and approved before work begins.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The analysis software shall be SKM Analysis Software or equal meeting all performance specifications.

2.2 ELECTRICAL POWER SYSTEM STUDIES

A. An electrical arc flash hazard analysis, including:

1. The development of an up-to-date electrical system one-line diagram and model to provide staff members with an accurate representation of the installed electrical system.
2. Determination of system operating modes and conditions that can impact short circuit currents and arc flash hazard energy levels.
3. Short circuit and equipment duty study to verify that equipment is rated to safely handle short circuit currents without creating hazardous conditions.
4. Protective device coordination study and review to help ensure proper electrical system reliability and to determine if arc flash hazard energy levels can be reduced.
5. Arc flash hazard analysis study to determine arc flash energy levels and Personal Protective Equipment (PPE).

6. Power System Modeling and Arc Flash Analysis software for ongoing use by the staff members maintaining and updating the system study as the plant changes.
7. Arc flash and safety program implementation software for ongoing use by the staff members for arc flash and safety program management and tracking.
8. Arc flash hazard labeling.
9. Assistance with the development of Energized Work Permits.
10. Arc flash and electrical safety training.
11. Personal Protective Equipment (PPE) training.

B. An electrical arc flash hazard analysis shall be performed to determine incident energy, arc flash protection boundaries, and required PPE for all electrical equipment in the facility. The calculations shall comply with NFPA-70E 2004, and IEEE-1584-2002. An integral part of NFPA-70E compliance is integrating work permits with arc flash assessment for all equipment in this facility. This section describes in detail the requirements for the study as well as integrating work permits in the system model for 70E compliance.

C. The purpose of this study is to provide a comprehensive software model of the electrical distribution system, which will document facility compliance with NFPA 70E mandates as described below. This model will serve as an integral part of an ongoing safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E 2004 Article 130.1(A)(2) for each electrical equipment in the facility.

1. Article 205.3, 120.2(F)(1): Updated and verified one-line diagram for all electrical distribution voltages including all sources for lock-out and tag out procedures.
2. Article 400.5, 400.6: Updated short circuit and equipment duty verification study showing all electrical equipment is properly rated to withstand and interrupt the available short circuit duty per ANSI Standards and NEMA/UL/NEC requirements.
3. Article 400.6, 410.9: Updated protective device coordination study showing the system protective devices are properly set to coordinate and clear a fault without extensive equipment damage or personnel risk.
4. Article 130.3(A)(B), 110.8: Updated arc flash study providing maximum incident energies, arc flash boundaries, and PPE requirements for each equipment in the system. In addition, these calculations shall be integrated with 70E compliant work permits as part of an ongoing safety program.
5. Article 130.16(E), 400.11, 400.14, 400.21(C)(2), 410.8: Updated labeling displaying the worst-case arc hazard values for each equipment in the facility.

D. The analysis shall consist of the following:

1. Field data collection by qualified personnel (as defined by NFPA 70E).
2. Data entry and system one-line modeling in commercially available power system software.
3. Model verification.
4. Short Circuit and equipment verification study.
5. Protective device coordination study.
6. Arc flash hazard study.
7. Detailed report and findings of the analysis.
8. Electronic copies of the Project Report and the System Modeling File.

E. The analysis and procedures shall comply with the following standards and recommended practices for power system studies.

1. NFPA-70E, 2004 Standard for Electrical Safety in the Workplace
2. IEEE-1584-2002
3. IEEE-242 “Buff Book” Protection and Coordination of Industrial Power Systems
4. IEEE-399 “Brown Book” Power System Analysis
5. IEEE-141 “Red Book” Electric Power Distribution for Industrial Plants

2.3 DATA COLLECTION

A. Field data collection shall be performed by qualified individuals (as defined by NFPA 70E – 2004) to ensure accurate equipment modeling.

B. Field data collection and system modeling shall be based on the system installed.

C. Equipment shall be visually inspected to collect the necessary nameplate data used in the analysis, including transformers, switchgear and breakers, relays, direct-acting trip units, etc. Data that may not be readily accessible or may not have nameplate data such as conductors, busway, etc. can be taken from drawings.

D. Data collection shall include the step down transformer from the utility service (including primary relaying) down through each 480-volt motor control center (MCC) and 240/208 volt panels for all systems served by transformers rated greater than 125 kVA as per IEEE-1584-2002.

E. The CONTRACTOR shall obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

2.4 SYSTEM MODELING

A. The system model shall be developed using a commercially available, fully integrated software package that meets the performance specifications developed in this Section. To ensure compliance with NFPA-70E 2004, ANSI, and IEEE Standards, and OSHA mandates, no exceptions or substitutions to the performance specification are allowed.

B. The system model shall be laid out in one drawing/view and in a manner that provides for easy viewing of all analysis results. The one drawing/view requirement ensures that problem areas found and highlighted by the program are easily seen and not hidden or buried in multiple drawings, eliminating potential human errors where multiple drawing verification is required.

C. All one-line symbols shall be spaced properly to facilitate viewing results on the one-line.

D. Equipment names used in the modeling software shall be identical to the equipment and naming convention shown on the drawings and equipment unless conflicts exist. The CONTRACTOR shall bring all naming convention conflicts or deficiencies to the attention of the ENGINEER for clarification.

E. The facility may have multiple operating conditions, including, but not limited to, generation on/off, shutdown, bus-ties, start-up, emergency operation, etc. Each of the operating modes shall be documented and modeled in the software in order to

determine the worst-case arc flash hazard and associated parameters for the electrical equipment. For the purpose, assume that up to four (4) operating modes are possible.

F. The software shall model each operating mode in a manner such that each mode is a scenario or change case from the base case. Each scenario shall be a simple differential algorithm storing only the difference from the base case and the scenario. Modifications to the base case model shall automatically update all scenarios to eliminate the necessity to store complete databases for each condition, providing for a manageable file size that can be Emailed and eliminating the associated time, man hours, and errors with updating each database individually.

G. Project files created by the software shall be single files and not project directories containing multiple files. The file shall be self-contained and have all necessary information to describe the one-line, system data, settings, and analysis information. Files shall be easily transferable to any site via Email or disk and operable with no setting changes to the database file to eliminate the maintenance and administrative problems associated with multi-file project directories, and to provide an easy method to transfer the file for engineering review.

H. The software shall accurately model daisy-chained MCC's, panels, and sub-transformers without the use of intermediate buses, nodes or fake impedances.

I. Lumped motor groups for MCC's shall be modeled per IEEE standards using groups >50 Hp, and <50 Hp. Where motor list data is not available, single lumped groups may be modeled per IEEE-141 "Red Book".

J. Medium voltage motors greater than 1.0 kV shall be modeled individually on their respective buses including all protective phase and ground overcurrent relays and fuses. This model will provide individual work permits for each starter/motor on the one-line.

K. All low voltage power circuit breaker (LVPCB), insulated case (ICCB), molded case (MCCB) and fuse data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

L. All relay data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

M. All overcurrent relay types for the distribution system shall be modeled on the one-line diagram (and database) including phase and ground overcurrent, differential, residual, ground neutral, etc. to establish a complete and detailed system model where protective device data can be easily modified and updated by the facility and all data is available for a comprehensive protective device coordination study if required in the future.

N. Relay models shall depict the actual connection requirements. See Figure-1.3M. Programs using symbols as shown in Figure-1.3M(na) are not acceptable since they do not depict the actual system and can lead to confusion in determining arc flash results and proper protective device modeling.

O. Multi-function relays shall have all their overcurrent devices modeled in a single device and shall be able to accept multiple CT's.

P. All equipment modeling must have a corresponding one-line diagram symbol. This means that there can be no hidden database models. The purpose is for the facility to easily see all equipment, its associated data, to be able to link documents to the equipment as a data repository, etc. and to see problems right on the one-line.

Q. All system modeling shall conform to accepted modeling practices as outlined in IEEE-399 "Brown Book". Contractor/consultant may provide more advanced modeling techniques where compliance with the specification is maintained.

2.5 MODEL VERIFICATION

A. The system model shall be verified by reviewing the results of short circuit current flows for all buses/equipment in the system. The results shall be viewed on each branch and total flow into a bus/equipment on the system one-line diagram. The purpose is to visually spot check values with recognized industry benchmarks as to the expected amount of short circuit current, and correct any problem areas.

2.6 SHORT CIRCUIT STUDY

A. A short circuit study shall be performed to verify all equipment duties in the system. The calculations shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The short circuit study shall verify the system electrical equipment is properly rated to withstand and interrupt the expected bolted and arcing faults in the system. Improperly rated and applied equipment may not protect personnel against arc flash hazards even if properly applied PPE is used. The software program must comply with the above standards in order to properly verify equipment installed in North America. No substitutions will be allowed.

B. The equipment duty verification shall determine both the line side and load side fault current through each equipment and use the highest current to verify equipment ratings. Standard bus faults are not acceptable for protective devices in that they do not accurately model the current through the device and consequently they provide erroneous results. For solidly grounded systems, both three-phase and single-line-to-ground faults should be modeled. For other grounding configurations only a three-phase fault is required.

C. Equipment duty results shall be graphically displayed on the electrical one-line as well as tabular report format.

D. The results of the equipment duty verification tabular format report shall provide the following data:

1. Equipment name and kV
2. Manufacture, type, style, and ratings of the device
3. Actual line or load side currents through the device and percent over/under duty
4. Flag for the device showing VIOLATION or WARNING level for visual identification

E. A report of all problem areas shall be provided. Contractor shall notify the project management corporation – and owner facility personnel immediately of all problems

found in this system before proceeding in the study. A recommended action list shall be provided for all underrated equipment in the system.

2.7 PROTECTIVE DEVICE COORDINATION (PDC) STUDY

A. A PDC study shall be performed in order to determine if the system protection characteristics are sufficient to provide reliable power to the facility. The PDC study will also determine if the settings entered in the software will provide proper personnel protection in the arc flash portion of this study. For facilities where the main distribution is low voltage (under 600 volts) and only instantaneous breakers or fuses are used, this section may not apply.

B. The PDC study shall consist of system feeders and branch circuits 100amps and larger, and plotting the time-current curves (TCC's) to verify proper selective operation of the protective devices. The study should also determine if the settings can be enhanced to provide increased personnel/equipment protection without sacrificing selective coordination.

C. The CONTRACTOR shall notify the ENGINEER of any potential problems in the protective device settings that affect either selective operation and reliability or personnel protection and shall provide recommendations for changes in writing before continuing with the study.

D. As specified in the data collection and modeling sections, all PDC data shall be modeled on the one-line diagram and in the equipment database.

E. The CONTRACTOR shall contact the serving utility and obtain protective device settings for all service entrance over current devices in series with the facility and affecting coordination with facilities distribution system.

F. TCC Specifics: The TCC's shall graphically illustrate on log-log paper that adequate time separation exists between series devices. The specific time current characteristics of each protective device shall be plotted in such a manner that sufficient upstream devices will be clearly depicted on one sheet to prove selective coordination.

1. TCC's shall include a system one-line diagram and protective device coordination curves for each device in the selected area. The TCC shall be printed in color on 8 ½ x 11" paper – full size portrait mode, using a log-log scale. The one-line diagram shall be part of the TCC and include all protective devices, equipment names, and short circuit currents calculated from the main one-line. The purpose of this requirement is to provide all necessary information on one sheet, in a format easily readable and standard to the industry.
2. For low voltage systems, TCC's shall be developed for both phase and ground protective devices. One phase and one ground TCC should be developed for each unit substation. The TCC should show the largest feeder/motor protective device in the MCC or panel up through the switchgear/switchboard feeder breaker, transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker. For secondary switchboards serving large loads or a wide variety of loads that may affect upstream coordination, additional TCC's may be required.
3. For medium voltage systems, TCC's shall be developed for both phase and ground protective devices. The TCC should show the largest feeder/motor protective device

in the lineup up through the switchgear/transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker.

4. The following specific information shall also be shown on the coordination curves:
   a. Device identification.
   b. Voltage and current ratio for curves.
   c. Transformer three phase and single-line-to-ground ANSI damage curves.
   d. Transformer inrush points.
   e. Minimum melting, and clearing curves for fuses, and if available the no-damage curve.
   f. Cable damage curves.
   g. Motor starting locked rotor curves, and if available the motor locked rotor damage point.
   h. Maximum short circuit cut off point.
   i. Clearly marked short circuit current levels through each protective device/branch, which should be based on the appropriate current through the device, i.e. Momentary, Interrupting or 30 Cycle current.
   j. Protective device one-line diagram clearly showing all protective devices on the time-current curve, labels for each device, open breakers, faulted buses, and the short circuit current flowing in each branch.
   k. Each TCC sheet shall have appropriate identification and a one-line diagram that applies to the specific portion of the system associated with time-current curves on that sheet.
   l. Each protective device curve shall be terminated at a point reflecting maximum symmetrical or asymmetrical fault current through the device.
   m. Identify the device associated with each curve by manufacturer type, function, and setting – i.e. tap, time delay, and instantaneous, pickup, etc.
   n. Primary Protective Device Settings for Delta-Wye Connected Transformer:
      1) Secondary Line-To-Ground Fault Protection: Provide primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.
      2) Secondary Line-To-Line Faults: Provide 16 percent current margin between primary protective device and associated secondary device characteristic curves.
   o. Typical time separations for curves:

      1) Consultant/contractor shall discuss the advantages and disadvantages of various time separation settings between device curves with the project management company and owner facility personnel to help determine how the system settings shall be optimized for selectivity and arc flash hazard reduction.

G. A setting table shall be developed to summarize the settings selected/existing for the protective devices. The table shall include the following:

1. Device identification.
2. For low voltage breakers, the circuit breaker manufacturer, type, and style, sensor rating, long time, short time, instantaneous settings, and time bands. For breakers with ground fault capability, the pickup and time delay.
3. Fuse manufacturer, type, style, and rating.

4. Protective relay manufacturer, type, style, function (51, 50, 67, etc.) pickup, current multiplier, time dial, and delay. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.

H. The software shall provide complete integration of the one-line, database, short circuit, protective device coordination and arc flash analysis functions to provide accurate calculations and avoid errors and inefficiencies associated with multiple data entry programs. Programs using separate PDC or TCC plotting packages are not allowed. Complete PDC integration is defined as the following:

1. TCC's shall be developed by simply selecting (highlighting) with the mouse the one-line area to be coordinated. The TCC shall automatically be plotted for the selected area including all short circuit levels. The TCC plot shall automatically include the selected one-line area in a drag and drop window on the TCC showing all one-line attributes without user additions required. These attributes shall automatically include all short circuit currents and voltages displayed on the main one-line, equipment names, etc. and update automatically without additional user input.
2. Programs requiring the user to build a separate TCC one-line are not integral with system short circuit calculations and do not automatically update as the system one-line changes, requiring additional man-hours for one-line development and are consequently prone to errors as the system changes. These types of programs shall not be considered for the study.
3. Each TCC shall have momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents (tick marks) displayed on the TCC plot for each protective device or as required to properly model the tripping characteristics of the device. The tick marks shall be user adjustable for visual appearance. The purpose is to provide accurate tripping currents for each device.
4. The software model shall allow each protective device to model momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents simultaneously depending on the characteristics of the device.
5. The software shall model remote voltages and currents for any single fault and display them on the TCC showing all trip cutoffs based on the remote currents. The purpose is to accurately model and verify backup relaying to ensure selective operation under all fault conditions. PDC programs that perform only batch faults, or fail to model remote voltages and currents for all fault types shall not be considered.
6. The software shall model and display time difference calculations for any selected pair of protective devices. The difference calculator shall include bracketing bars with the calculated difference to clearly show the selective time between the devices. The calculated time shall update dynamically for instant visual setting as the devices are dragged (settings modified). In addition, tool tips shall clearly show the time difference and the protective device settings for all devices as they are dynamically changed or set to allow the user to accurately determine the proper setting between devices in the most efficient manner, reducing coordination time and providing more accurate results.
7. The software model shall provide for WYSIWYG drag and drop modeling of all protective devices and provide for tool tips and notes to display all settings dynamically. The purpose is to provide accurate adjustments and settings in the most time efficient and accurate manner.
8. TCC's shall have the ability to display short circuit currents and arc flash hazard results within the fully integrated system one-line in the PDC focus. Short circuit currents are available at any equipment with a single mouse click. Short circuit

currents and arc flash hazard values shall change on the fly as the protective device settings change, allowing the user to instantly see the results of PDC changes and the associated impact to short circuit currents and arc flash hazard values.

9. The software model shall provide a detailed library for the most common protective devices available in North America. The library shall be user definable.

2.8 ARC FLASH STUDY

A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with NFPA-70E 2004, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E and to facilitate a safety program for the OWNER, and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Article 130.1(A)(2) for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.

B. The arc flash study shall determine the following results for each system mode of operation. The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:

1. Equipment name and voltage.
2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
4. Equipment arc gap.
5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
6. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
7. Worst-case arc flash boundary for each bus/equipment in the model.
8. Worst-case arc flash hazard incident energy in cal/cm2 for each bus/equipment in the model.
9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance.
11. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm2 and provide recommendations to reduced arc flash energy levels for these areas.
12. Flag results where 85% arcing current provided worst-case results.

C. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.

D. Consultant/contractor shall provide a detailed arc flash analysis report including as a minimum:

1. Introduction.
2. Methodology.
3. Information Sources.
4. Key Assumptions.
5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.).
6. Arc Energy at 100% and reduced currents.
7. IEEE 1584-2002 Considerations.
8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
9. Explanation of Data in Arc Flash Hazard Report Tables.
10. NFPA 70E Information.
    a. Shock Hazards with covers removed.
    b. Shock Hazard Approach Boundaries.
        1) Limited Approach Boundary.
        2) Restricted Approach Boundary.
        3) Prohibited Approach Boundary.
    c. Arc Flash Hazard Boundaries.
11. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    a. Working distances.
    b. Energy Levels.
    c. PPE Requirements.
    d. Recommendations to reduce arc flash hazard energy and exposure.
12. Arc Flash Hazard Report.
    a. 5 Hard Copies.
    b. 1 Electronic Copy in Adobe Acrobat format (5.0 or later).
13. Electronic file for Power System Modeling Software as developed and utilized for this analysis.

E. The CONTRACTOR shall provide printed labels for labels for all equipment in the system from the project study file. Assume three (3) labels per equipment/bus in your estimate using 4” x 6” labels or one (1) 6” x 8” label per equipment bus. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z535. The labels shall be printable directly from the power system software utilized for the study with a Duralabel, Brady PowerMark or GlobalMark printer to ensure that the OWNER’s personnel have the option of printing the labels without the extra expense of going to an outside printing service, converting arc flash results to spreadsheet format or performing tedious manual data entry.

F. Software Requirements: The software shall provide complete integration of the one-line, database, short circuit, PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations are not allowed. The purpose of this section is to ensure that the arc flash hazard

calculations comply with NFPA-70E and IEEE-1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the project management company and owner facility electrical distribution system, which will document compliance with the OSHA requirements and NFPA 70E mandates. This model will serve as an integral part of the OWNER's safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E Article 130.1(A)(2) for each electrical equipment in the facility.

1. Arc flash calculations shall be performed with enhanced IEEE-1584 equations, which eliminate voltage discontinuities and the non-conservative/average results of the standard equations. The purpose of this requirement is to ensure that the calculated incident energies are closer to actual test results insuring a conservative calculation minimizing personnel risk.
2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time. The algorithm shall incorporate a traversing routine that can search back an unlimited number of buses/nodes and consider all series and parallel branches in the comparison to ensure accurate answers and to prevent hazards associated with incorrect results. Software shall not have trace back limits (5-10 buses) that can provide incorrect answers for low voltage faults that require high voltage protective device clearing to prevent potential errors.
3. The arc flash calculations including arc flash boundary, incident energy, PPE requirements, and working distance shall be displayed on the software one-line diagram and TCC simultaneously. The software must show visually the arc flash values as the settings are incrementally changed (dragging curves) so the protection can be optimized in the most efficient manner, allowing the protection engineer to visually balance the competing objectives of personnel protection with that of system selectivity.
4. The arc flash calculations shall include four (4) calculation options to ensure that the software provides the flexibility required to meet any system configuration or training requirement that may be considered. Each calculation option shall comply with the graphic and spreadsheet display requirements of this section. Each option is more specifically described below.
    a. The detailed option shall provide the let-through energy for each protective device in the system. This is the energy on the load side of the protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.
    b. Worst-case including main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the equipment's main protective device. If the equipment is not equipped with a main device, the program must traverse back the entire system to determine the fastest series upstream protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.
    c. Worst-case excluding main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the fastest upstream series protective device in the system. The program shall traverse back the entire system to determine the fastest upstream protective

device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.

d. Worst-case excluding and including the main protective device. A combination of options ‘b’ and ‘c’ as stated above.

5. The arc flash calculations shall provide integral “Work Tasks” for the listed equipment types. The tasks shall be derived from 70E Table 130.7(C)(9)(a) and be specific to the equipment type. Work tasks shall be user definable in the software to allow customization and integral with the “Work Permit” feature of the software. Listed equipment types shall include:
   a. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 100-200 volt equipment.
   b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 200-1000 volt equipment.
   c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 1.0-5.0 kV equipment.
   d. Switchgear, MCC, VFD, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 5.0-15.0 kV equipment.
   e. Switchgear, Interrupting Switch, Conductor, Open Air for 15.0-38.0 kV equipment.
   f. Interrupting Switch, Conductor, and Open Air for 38.0-1500 kV equipment.
6. Work Tasks shall have a user-defined library that provides the following customizable features for each work task:
   a. Work Tasks for each specific equipment type and voltage range.
   b. Working distance units English or Metric.
   c. Work distance for each task.
   d. V-rated gloves and tool requirements.
   e. Job description and procedures.
   f. Safe work practices description.
   g. Hazard Risk Category (HRC) reduction. *Note: HRC reduction can only be used based on a documented risk assessment as an integral part of a safety program.
7. Work tasks shall be accessible from the one-line diagram for any equipment through a mouse click on the equipment in the electrical system model one-line. A dialog box shall appear listing all 70E and user definable work tasks for the specific equipment selected. The work task dialog shall include a user definable working distance for each work task and allow the user to select tasks specific to any equipment feeder or the incoming main. Work tasks for each equipment type shall be voltage specific and user definable in the library. The purpose of these requirements is to integrate 70E work tasks to the one-line diagram for specific equipment types. This will provide the basis for a customized safety program and work permit process compliant with 70E mandates. The level of detailed requirements for the “work task” software is necessary to ensure that any variation of equipment type, equipment layout, or work procedure can be handled and documented in the software.
   a. The software interface shall allow the user to select any breaker fuse or switch on the one-line, and get a specific work task generated for that device showing the load side arc flash hazard (let-through energy) for that device. The purpose of this requirement is to detail specific feeder hazards when work tasks dictate working downstream from a feeder protective device.
   b. The arc flash calculations shall provide integral work permits for compliance with NFPA-70E, 2004 Article 130.1 (A). The work permits shall be integral with the system one-line diagram and the arc flash calculations and shall detect and account for work between feeder and main breaker.

8. Work permits shall be activated by mouse click, for all equipment types listed in K5. Work permits shall have the following calculated values and provide the following information specific to the “work task” and equipment selected:
    a. Shock hazard.
    b. Shock hazard boundaries.
    c. Arc flash boundary – worst-case for each equipment.
    d. Arc flash hazard incident energy in cal/cm2 for the equipment.
    e. Hazard Risk Category (HRC) and any applicable risk reduction.
    f. Required PPE category based on calculated energy level and optional risk reduction.
    g. Required PPE description based on PPE category.
    h. Determination of V-rated gloves and tools.
    i. Auto fill job description and procedures for each work task.
    j. Auto fill safe work practices description for each work task.
    k. Job briefing and planning check list.
    l. Approval sign off section.
    m. Working distance measurements in English or Metric units.
    n. Required work distance for each task.
    o. Documentation for safety program in compliance with 70E 130.1(A).
9. The work permits shall be created by the software in MS Word and have the following user customizable features:
    a. Work Tasks for each specific equipment type and voltage range.
    b. Restricted shock boundary.
    c. Arc flash boundary – worst-case for each equipment.
    d. Arc flash hazard incident energy in cal/cm2 for the equipment.
    e. Hazard Risk Category (HRC) reduction for low risk tasks.
    f. Required PPE category based on risk reduction.
    g. Working distance in English or Metric units.
    h. Working distance for each task.
    i. V-rated gloves and tool requirements.
    j. Flame Resistant clothing requirements.
    k. Job description and procedures for each work task.
    l. Safe work practices description for each work task.
    m. Job briefing and planning check list.
    n. Approval sign off section.
10. The power system software shall allow the created work permits to be linked via Windows “hyperlinks” to each equipment on the one-line diagram. The purpose is to provide a data repository of work permits performed on each equipment for 70E review, as well as providing a one-stop location where documents pertaining to the equipment can be accessed by maintenance and job planning.
11. The power system software shall be fully compatible with facility arc flash hazard and electrical safety implementation software that provides the following capabilities:
    a. Calculates shock hazards, shock hazard boundaries, arc flash boundaries, incident energies, PPE requirements, etc. for power systems modeled in EasyPower or EasyPower EasySolv.
    b. Built in Work Permit Feature for creation of custom Energized Work Permits complying with the NFPA-70E requirements. Work permit feature shall include NFPA risk assessment categories based on the task performed for all types of electrical equipment and voltage ranges. The work permit feature shall include an extensive library of user definable work tasks, safety procedures and safe work practices.

c. Energized work permits, safety procedures, equipment instruction manuals, etc., shall be capable of being directly linked to the equipment one-line through a Hyperlinks feature, providing a one-stop data repository easily accessible to all plant and safety personnel, saving plant personnel and contractors significant productive time in locating the right instruction manual, equipment safety procedure, drawing, pictures and maps for the equipment. This feature shall also help interested parties with OSHA and NFPA 70E record keeping requirements.
d. Additional equipment information and records such as Maintenance Records, Maintenance Manuals, Operations Manuals, Lock out / Tag out procedures, etc. shall also be capable of being Hyperlinked to the equipment on the graphical one-line.
e. Program shall support creation of arc flash labels with direct output to high quality UV resistant vinyl label printers.
f. Program shall also have customizable output. Includes one-line printing, text report creation, export to AutoCAD, etc.
g. Program shall be a Windows based operating system and shall use Windows conventions.
h. Program shall be capable of being installed on stand alone personal computers or on networked systems.
i. Program shall be easily operable by the OWNER's staff without any specialized training.

12. The software shall be licensed to the OWNER and the original software package will be delivered at project completion.

2.9 REPORTING AND ANALYSIS SUMMARY

A. Executive Summary: The executive summary shall be brief 1-2 pages maximum and cover at an executive level the findings of the study, recommendations, and requirements for maintaining NFPA-70E compliance.

B. Scope of studies performed: The scope shall provide details of what actions were intended to be performed for each aspect of the study, including short circuit, protective device coordination, and arc flash.

C. Description of system and explanation of bus and branch numbering system.

D. Modes of operation studied: Each scenario/plant operating condition shall be thoroughly documented.

E. Detailed report and results of short circuit, coordination, and arc flash studies including:

1. Recommendations and additions to equipment rating and/or PDC characteristics.
2. Recommendations to reduce arc flash hazards for equipment with incident energies over 40 cal/cm2.

F. Prioritized recommendations for all studies.

G. Action list and check off column for all recommendations.

2.10 QUALITY ASSURANCE

A. The studies shall be in conformance with the NFPA and ANSI Standards, and IEEE recommended practices detailed in this section. No substitutions in study methods or software conformance will be allowed.

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SECTION 26 05 08
ELECTRICAL ACCEPTANCE TEST

PART 1 GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to provide the inspection and testing services required to place the electrical system into operation.

1.2 GENERAL

A. See General Conditions and Division 01 (Sections 010100 through 017000), GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

B. This work may be conducted by the electrical subcontractors and/or independent testing laboratory but shall be performed by qualified personnel. The decision concerning acceptability of the qualifications of the individual and/or firm conducting the tests shall be determined during submittal review in accordance with Section 01 40 00, Quality Control. The term "testing laboratory" shall unilaterally refer to the firm, subcontractor, etc., approved to conduct the tests.

1. For the purposes of the section the individual performing the testing, whether the electrical subcontractor, manufacturer's representatives or independent testing laboratory, shall be referred to as "testing laboratory."
2. The Contractor shall submit a division of responsibilities that shall detail who is responsible for performing each test.
3. All visual and mechanical inspections shall be conducted by the Contractor and Engineer.

C. The testing laboratory shall provide all material, equipment power, labor and technical supervision to perform such tests and inspections.

D. It is the intent of these tests to assure that all electrical equipment is operational within industry and manufacturer's tolerances.

E. Upon completion of the tests and inspections noted in these specifications, a label shall be attached to all serviced devices. These labels will indicate date serviced and the service company responsible.

F. The tests and inspections shall determine suitability for continued reliable operation.

G. All tests shall be conducted in the presence of the Engineer.

H. Electrical testing specified herein, and functional testing of all power and controls not tested under the Section 40 10 00, Process Control and Instrumentation Systems, shall be completed before commencement of the 7-day test specified in Section 26 05 08, Electrical Acceptance Tests.

I. The work may require the Contractor to activate circuits, shutdown circuits and run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, etc.

J. Specific scope of work:

1. The following items of equipment shall be tested:
   a. Low voltage switchgear
   b. Motor control centers
   c. Transformers
   d. All wires and cables
   e. Motors
   f. Regulators
   g. Grounding system
   h. Entire control system and all process interfaces
   i. Adjustable speed drive (ASD) systems
   j. Reclosers
   k. Switches
   l. Lighting
2. All inspections and tests shall utilize the following references:
   a. Project design specifications
   b. Project design drawings
   c. Manufacturer's instruction manuals applicable to each particular apparatus.

K. Division of responsibility:

1. The Contractor shall perform routing insulation resistance, continuity and rotation tests for all distribution and utilization equipment prior and in addition to tests performed by the testing laboratory specified herein.
2. The Contractor shall supply a suitable and stable source of test power to the test laboratory at each test site. The testing laboratory shall specify requirements.
3. The Contractor shall notify the testing laboratory and schedule with the Engineer when equipment becomes available for acceptance tests.
4. The Contractor shall notify the Engineer prior to commencement of any testing.
5. The testing laboratory shall be responsible for implementing all final settings and adjustments on protective devices and tap changes in accordance with Owner's specified values.
6. Any system material or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the Engineer.
7. The testing laboratory shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.

1.3 REFERENCED STANDARDS

A. See Section 26 05 00, General Electrical Requirements, which lists the standards that apply to the work specified herein.

B. In addition, the following shall apply:

1. Manufacturer's recommended tests
2. ANSI C2, C37.20.1
3. NEMA WC 7, WC 8
4. IEEE 43,48,81,118
5. NETA ATS
6. NFPA 70

1.4 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Division 1, GENERAL REQUIREMENTS and Section 26 05 00, General Electrical Requirements.

B. In addition, the following information shall be provided:

1. Shop drawings:
   a. The testing laboratory shall submit, in conformance with Section 01 30 00, Contractor Submittals, a complete resume and statement of qualifications detailing their experiences in performing the test specified. This statement shall include:
      1) Corporate history and references.
      2) Resume of individual performing test.
      3) Equipment list and test calibration data.
   b. The Contractor shall submit to the Engineer and the testing laboratory, in conformance with Section 01 30 00, Contractor Submittals, complete manufacturer's field testing acceptance testing procedures, as well as expected test results and tolerances for all equipment to be tested.
      1) Administrative Submittals: Submit 30 days prior to performing inspection or tests:
      2) Schedule for performing inspection and tests.
      3) List of references to be used for each test.
      4) Sample copy of equipment and materials inspection form(s).
      5) Sample copy of individual device test form.
      6) Sample copy of individual system test form.
      7) Quality Control Submittals: Submit within 15 days after completion of test: Test or inspection reports and certificates for each electrical item tested.
      8) Contract Closeout Submittals:
         a) Operation and Maintenance Data:
         b) In accordance with Section 26 05 00, Operation and Maintenance Data
         c) After test or inspection reports have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
2. Test Report:
   a. The test report shall include the following:
      1) Summary of project.
      2) Description of equipment tested.
      3) Description of test.
      4) Test results.
      5) Conclusions and recommendations.
      6) Appendix, including appropriate test forms.
      7) List of test equipment used and calibration date.
   b. Furnish six (6) copies of the completed report to the Engineer in conformance with Section 01 30 00, Contractor Submittals.

PART 2 PRODUCTS

2.1 TEST INSTRUMENT TRACEABILITY

A. The testing laboratory shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

B. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.

C. Instruments shall be calibrated in accordance with the following frequency schedule.

1. Field instruments - 6 months maximum.
2. Laboratory instruments - 12 months.
3. Leased specialty equipment - 12 months. (Where accuracy is guaranteed by lessor).

D. Dated calibration labels shall be visible on all test equipment.

E. Records must be kept up-to-date which show date and results of all instruments calibrated or tested.

F. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.

PART 3 EXECUTION

3.1 PREPARATION

A. Safety and Precautions:

1. Safety practices shall include, but are not limited to the following requirements:
   a. Occupational Safety and Health Act - OSHA
   b. Accident Prevention Manual for Industrial Operations, Seventh Edition, National Safety Council, Chapter 4.
   c. Applicable State and Local safety operating procedures.
   d. NETA Safety/Accident Prevention Program.
   e. National Fire Protection Association - NFPA 70E.
2. The testing laboratory shall be solely responsible for safety during all tests.
3. In all cases, work shall not proceed until the testing laboratory, Contractor, and Engineer determine that it is safe to do so.
4. The testing laboratory shall have available sufficient protective barriers and warning signs to conduct specified tests safety.

B. Testing requirements prior to commencing the work:

1. All instruments required must be available and in proper operating conditions.
2. All dispensable materials such as solvents, rags and brushes required must be provided.
3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment must be available or scheduled.
4. All instruction books, calibration curves or other printed material to cover the electrical devices must be available.
5. Data sheets to record all test results must be available before the work is started.

C. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.

2. Installation operates properly.
3. Equipment is suitable to be energized.
4. Installation conforms to requirements of these specifications and NFPA 70, NFPA 70E, and ANSI C2.

D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

E. Adjust all mechanisms and moving parts for free mechanical movement.

F. Adjust all adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance with these specifications.

H. Realign equipment not properly aligned and correct any unevenness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten all accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or otherwise specified.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of all applicable moving parts.

M. Inform Engineer of any working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by the Engineer, door and/or panel sections having dented surfaces.
5. Repair or replace, as determined by the Engineer, poor-fitting doors and/or panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch-up scratches and mars.
    b. If required due to extensive damage, as determined by the Engineer, refinish the entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by these specifications.

Q. Replace transformer insulating oil not in compliance with ASTM D923.

3.2 QUALITY ASSURANCE

A. Testing Firm's Qualifications:

1. Corporately and financially independent organization which can function as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologies (NICET), or International electrical Testing Association and having a minimum of five (5) years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two (2) certified to one (1) noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA 29 CFR Part 1907, "Criteria for Accreditation of Testing Laboratories," or a full-member company of the International Electrical Testing Association.
9. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

3.3 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with Engineer prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Engineer at least 24 hours prior to performing any tests on energized electrical equipment.

3.4 INSPECTION AND TEST PROCEDURES

A. Switchgear Assembly:

1. Visual and mechanical inspection for:
   a. Physical damage
   b. Equipment nameplate information conformance with latest single line diagram and report discrepancies.

c. Proper alignment, anchorage and grounding.
d. Tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instruction for proper foot pound levels.
e. Paint chips, dents, scratches, etc.
f. Insulator damage and contaminated surfaces.
g. Proper barrier and shutter installation and operation.
h. Proper operation of indicating devices.
i. Improper blockage of air cooling passages.
j. Integrity and contamination of bus insulation system.
k. Check nameplates for proper identification of:
    1) Equipment title and tag number with latest one-line diagram.
    2) Pushbuttons.
    3) Control switches.
    4) Pilot lights.
    5) Control relays.
    6) Circuit breakers.
    7) Indicating meters.
l. Verify that fuse and/or circuit breaker ratings, sizes, and types conform to those specified.
m. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
    1) Ohmic value to be zero.
    2) Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
n. Check operation and sequencing of electrical and mechanical interlock systems by:
    1) Closure attempt for locked open devices.
    2) Opening attempt for locked closed devices.
    3) Key exchange to operate devices in off-normal positions.
o. Verify performance of each control device and feature.
p. Control wiring:
    1) Compare wiring to local and remote control and protective devices with elementary diagrams.
    2) Proper conductor lacing and bundling.
    3) Proper conductor identification.
    4) Proper conductor logs and connections.
q. Exercise all active components.
r. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

2. Electrical tests:
    a. Insulation resistance test:
        1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7. 1. 1.
        2) Each phase of each bus section.
        3) Phase-to-phase and phase-to-ground for I minute.
        4) With switches and breakers open.
        5) With switches and breakers closed.
        6) Control wiring except that connected to solid state components.
        7) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
    b. Overpotential test:

1) Applied voltage and test procedure in accordance with ANSIC37.20.1.
2) Each phase of each bus section.
3) Phase-to-phase and phase-to-ground for I minute.
4) Test results evaluated on a pass-fail basis.

c. Current injection tests:
1) For entire current circuit in each section.
2) Secondary injection for current flow of I ampere.
3) Test current at each device.

d. Control wiring:
1) Apply secondary voltage to all control power and potential circuits.
2) Check voltage levels at each point on terminal boards and each device terminal.

e. Operational test:
1) Initiate all control devices.
2) Check proper operation of control system in each section.
3) Test values:

f. Bolt torque levels shall be in accordance with values specified by manufacturer.

g. Insulation resistance test to be performed in accordance with manufacturer's specified values.

B. Grounding Systems:

1. Visual and mechanical inspection for:
a. Compliance with plans and specifications.
b. Equipment and circuit grounds in motor control centers, panelboards, switchgear, and motors for proper connection and tightness.
c. Ground bus connections in motor control centers, panelboards, switchgear, and control panels for proper termination and tightness.
d. Effective transformer core and equipment grounding.
e. Accessible connections to grounding electrodes for proper fit and tightness.
f. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

2. Electrical tests:
a. Perform fall of potential test per IEEE Standard No. 81, Section 9.04 on the main grounding electrode or system.
b. Perform the two (2) point method test per IEEE No. 8 1, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points. Equipment ground resistance shall not exceed main ground system resistance by 0.25 ohms.
c. Alternate method: Perform ground continuity test between main ground system and equipment frame, system neutral and/or derived neutral point. This test shall be made by passing a minimum of test (IO) amperes D.C. current between ground reference system and the ground point to be tested. Voltage drop shall be measured and resistance calculated by voltage drop method.

3. Test values: The main ground electrode system resistance to ground should be no greater than one (1) ohm.

C. Low Voltage Cables - 600 Volts and Below:

1. Visual and mechanical inspection for:

a. Physical damage and proper connection in accordance with single line diagram.
b. Equipment nameplate data compliance with design plans or starter schedule.
c. Overload heaters compliance with motor full load current for proper size.
d. Tightness of bolted connections.
e. Proper barrier and shutter installation and operation.
f. Proper operation of indicating and monitoring devices.
g. Proper overload protection for each motor.
h. Improper blockage of air cooling passages.
i. Proper operation of any draw out elements.
j. Integrity and contamination of bus insulation system.
k. Check door and device interlocking system by:
    1) Closure attempt of device when door is in OPEN position.
    2) Opening attempt of door when device is in ON or CLOSED position.
l. Check nameplates for proper identification of:
    1) Equipment title and tag number with latest one-line diagram.
    2) Pushbuttons.
    3) Control switches.
    4) Pilot lights.
    5) Control relays.
    6) Circuit breakers.
    7) Indicating meters.
m. Verify that fuse and/or circuit breaker sizes and types conform to these specifications.
n. Verify that current and potential transformer ratios conform to these specifications.
o. Check bus connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
    1) Ohmic value to be zero.
    2) Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
p. Check operation and sequencing of electrical and mechanical interlock systems by:
    1) Closure attempt for locked open devices.
    2) Opening attempt for locked open devices.
    3) Key exchange to operate devices in off-normal positions.
q. Verify performance of each control device and feature furnished as part of the motor control center.
r. Control wiring:
    1) Compare wiring to local and remote control, and protective devices with elementary diagrams.
    2) Check for proper conductor lacing and bundling.
    3) Check for proper conductor identification.
    4) Check for proper conductor lugs and connections.
s. Exercise all active components.
t. Inspect contactors for:
    1) Correct mechanical operations.
    2) Correct contact gap, wipe, alignment, and pressure.
    3) Correct torque of all connections.
u. Compare overload heater rating with full-load current for proper size.
v. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper

w. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.
x. Cable connections torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by the manufacturer.
y. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
z. Color coding conformance with specifications.
aa. Proper circuit identification.
bb. Proper lug type for conductor material.
cc. Proper lug installation.
dd. Proper shield grounding on shielded instrumentation cable.
ee. Proper terminations.
ff. Proper circuit identification.
gg. Proper termination of neutrals and grounds for correct operation of protective devices.

2. Electrical tests:
   a. Insulation resistance tests:
      1) Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.
      2) Test each conductor with respect to ground and to adjacent conductors per IEEE I 1 8 procedures for I minute.
      3) Evaluate ohmic values by comparison with conductors of same length and type.
      4) Investigate any values less than 50 megohms.
      5) Measure insulation resistance of each control circuit with respect to ground.
      6) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
      7) Bus section phase-to-phase and phase-to-ground for I minute on each phase.
      8) Contactor phase-to-ground and across open contacts for I minute on each phase.
      9) Starter section phase-to-phase and phase-to-ground on each phase with starter with starter contacts closed and protective devices open.
      10) 1Test values to comply with NETA ATS, Table 10.2.
   b. Overpotential tests:
      1) Maximum applied voltage in accordance with NETA ATS, Table 7.1.2.
      2) Phase-to-phase and phase-to-ground for I minute for each phase of each bus section.
      3) Test results evaluated on pass/fail basis.
   c. Current injection through overload unit at 300 percent of motor full-load current and monitor trip time:
      1) Trip time in accordance with manufacturer's published data.
      2) Investigate values in excess of 120 seconds.
   d. Control wiring tests:
      1) Apply secondary voltage to all control power and potential circuits.
      2) Check voltage levels at each point on terminal boards and each device terminal.
      3) Insulation resistance test at 1,000 volts dc on all control wiring except that connected to solid state components.
      4) Insulation resistance to be I megohm minimum.

3. Test values:
    a. Insulation resistance tests shall be performed at 1,000 volts D.C. for one-half (1/2) minute.
    b. Bolt torque levels shall be in accordance with manufacturer's specifications unless otherwise specified by manufacturer.
    c. Control wiring insulation test voltage shall be 500 V D.C. Manufacturer shall be consulted for test voltage where solid state control devices are utilized.
    d. Overload tests shall be made at three hundred percent (300%) of motor full load current. Trip times shall be in accordance with manufacturers tolerances. Values in excess of one hundred twenty (120) seconds shall be investigated.
    e. Insulation tests shall be made prior to termination.

D. Transformers:

1. General: Inspection and testing limited to motors rated 1/2HP and larger.
2. Visual and mechanical inspection for:
    a. Physical and insulator damage.
    b. Equipment nameplate information compliance with latest single line diagram and report discrepancies.
    c. Perform specific inspections and mechanical tests as recommended by manufacturer.
    d. Proper winding connections.
    e. Bolt torque level in accordance with NETA ATS, Table 1O. 1, unless otherwise specified by manufacturer.
    f. Defective wiring.
    g. Proper operation of fans, indicators, and auxiliary devices.
    h. Removal of shipping brackets, fixtures, or bracing.
    i. Free and properly installed resilient mounts.
    j. Cleanliness and improper blockage of ventilation passages.
    k. Correct tap-changer ratio setting for rated output voltage under normal operating conditions.
    l. Proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.
    m. Dissolved Gas Analysis (DGA Di-electric test, and moisture content test of oil.
3. Electrical tests:
    a. A dielectric absorption test shall be made on motor and starter circuit. Polarization index shall be determined for motor winding.
    b. A dielectric absorption test shall be made on motor winding. The thirty-sixty (30/60) second ratio shall be determined.
    c. Insulation resistance tests:
        1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:
            a) Winding-to-winding.
            b) Winding-to-ground.
        2) 10-minute test duration with resistances tabulated at 30 seconds, I minute, and IO minutes.
        3) Results temperature corrected in accordance with NETA ATS, Table 7.2.4.
        4) Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

5) Insulation resistance test results to compare within I percent of adjacent windings.

d. Perform tests and adjustments for any fans, controls, and alarm functions as suggested by manufacturer.
e. Measure secondary voltages and adjust taps as directed by Engineer.
f. Turn to turn electrical testing for transformer integrity.
g. Measure no load and full load running current and voltage and compare to nameplate.
h. Observe proper operation and sequence of any reduced voltage starters.
i. Perform vibration base line test on motors greater than 50 HP. Amplitude to be plotted vs. frequency.
j. Perform vibration amplitude test on motors greater than 50 HP.
k. Check all protective devices in accordance with other sections of these specifications.
l. Perform over potential test on winding to ground.
m. The measurement shall be made with a 1,000 volt megohmmeter; however, the precautions noted in the tests for conductor test shall also be applied to the motors.
n. Insulation with resistance less than 10 megohms is not acceptable.
o. Measurements shall be recorded in a format similar to Form 26 05 08 - B, contained in this section.
p. After start-up of each motor, the current on each phase shall be measured.
1) At no load.
2) At defined load.
3) In-rush current.
4) Use Form 26 05 08 - B.

4. Test Values:
a. Dielectric absorption tests shall be made in accordance with test voltage listed as specified by manufacturer. Polarization tests shall before a ten (IO) minute duration. Sixty/thirty (60/30) second ratio tests shall be for a one (1) minute duration. Polarization index readings less than threes hall be investigated. Sixty/thirty(60/30)second ratio readings less than 1.4 shall be investigated.
b. Motor measured full load current shall not exceed nameplate value.
c. Over potential test shall be made an eighty percent (80%) of twice rated voltage plus one thousand (1,000) volts.
d. Vibration amplitudes shall not exceed values furnished by manufacturer.

E. Lighting:

1. Verify that the switching, including remote control is as shown.
2. Verify that the circuitry is in accordance with the panel schedules.
3. Verify that load is balanced as closely as possible.
4. Verify that the lighting fixtures are located to minimize obstruction of illumination by liquid-filled mechanical equipment or building structural elements.
5. Verify that photocell operates properly.
6. Replace all lamps that do not operate properly.

F. Switches:

1. Visual and mechanical inspection for:
a. Proper blade pressure and alignment.

b. Proper operation of switch operating handle.
c. Adequate mechanical support for each fuse.
d. Proper contact-to-contact tightness between fuse clip and fuse.
e. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
f. Proper phase barrier material and installation.
g. Proper fuse sizes and types as shown on single line diagram.
h. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
      2) Phase-to-phase and phase-to-ground for I minute on each pole.
      3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Contact resistance tests:
      1) Contact resistance in microhms across each switch blade and fuse holder.
      2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

G. Low Voltage Cables - 600 Volts and Below:

1. Visual and mechanical inspection for:
   a. Physical damage and proper connection in accordance with single line diagram.
   b. Cable connections torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by the manufacturer.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specifications.
   e. Proper circuit identification.
   f. Proper lug type for conductor material.
   g. Proper lug installation.
   h. Proper shield grounding on shielded instrumentation cable.
   i. Proper terminations.
   j. Proper circuit identification.
   k. Proper termination of neutrals and grounds for correct operation of protective devices.
2. Electrical tests:
   a. Insulation resistance tests:
      1) Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.
      2) Test each conductor with respect to ground and to adjacent conductors per IEEE I 1 8 procedures for I minute.
      3) Evaluate ohmic values by comparison with conductors of same length and type.
      4) Investigate any values less than 50 megohms.
   b. Perform continuity test to insure proper cable connection.
   c. Measurements shall be made prior to connection of wires to any equipment. Ends of wires are to be taped with Scotch 33+ and be physically remote from all grounded surfaces by a minimum of 2".

d. Insulation resistance measurements shall be recorded using the following table.

PANEL DESIGNATION: UL4A	LOCATION: West Closet A

CIRCUIT	LOAD	CKT. CONF.	OUTLET TEST	WIRE SIZE	AMPS	MEGOHMS
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

e. Insulation with resistance of less than 10 megohms is typically not acceptable.
f. Insulation resistance test shall be performed at 1,000 volts dc for one-half (1/2) minute. Insulation resistance readings shall be recorded after the one-half minute time interval has elapsed.
g. If in the opinion of the Engineer the test results are unacceptable, the Contractor will correct the installation, material or labor at no additional cost to, and to the satisfaction of, the Engineer.

3. Test values:

a. Insulation resistance tests shall be performed at 1,000 volts D.C. for one-half (1/2) minute.
b. Insulation tests shall be made prior to termination.

H. Dry type Transformers:

1. Visual and mechanical inspection for:
   a. Physical and insulator damage.
   b. Equipment nameplate information compliance with latest single line diagram and report discrepancies.
   c. Perform specific inspections and mechanical tests as recommended by manufacturer.
   d. Proper winding connections.
   e. Bolt torque level in accordance with NETA ATS, Table IO. 1, unless otherwise specified by manufacturer.
   f. Defective wiring.
   g. Proper operation of fans, indicators, and auxiliary devices.
   h. Removal of shipping brackets, fixtures, or bracing.
   i. Free and properly installed resilient mounts.
   j. Cleanliness and improper blockage of ventilation passages.
   k. Correct tap-changer ratio setting for rated output voltage under normal operating conditions.
   l. Proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.
2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:
         a) Winding-to-winding.
         b) Winding-to-ground.
      2) 10-minute test duration with resistances tabulated at 30 seconds, I minute, and IO minutes.
      3) Results temperature corrected in accordance with NETA ATS, Table 7.2.4.
      4) Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
      5) Insulation resistance test results to compare within I percent of adjacent windings.
   b. Perform tests and adjustments for any fans, controls, and alarm functions as suggested by manufacturer.
   c. Measure secondary voltages and adjust taps as directed by Engineer.

I. Lighting:

1. Verify that the switching, including remote control is as shown.
2. Verify that the circuitry is in accordance with the panel schedules.
3. Verify that load is balanced as closely as possible.
4. Verify that the lighting fixtures are located to minimize obstruction of illumination by liquid-filled mechanical equipment or building structural elements.
5. Verify that photocell operates properly.
6. Replace all lamps that do not operate properly.

J. Safety Switches, 600 volts maximum.

1. Visual and mechanical inspection for:
   a. Proper blade pressure and alignment.
   b. Proper operation of switch operating handle.
   c. Adequate mechanical support for each fuse.
   d. Proper contact-to-contact tightness between fuse clip and fuse.
   e. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
   f. Proper phase barrier material and installation.
   g. Proper fuse sizes and types as shown on single line diagram.
   h. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.
2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
      2) Phase-to-phase and phase-to-ground for I minute on each pole.
      3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Contact resistance tests:
      1) Contact resistance in microhms across each switch blade and fuse holder.
      2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

K. Control Stations:

1. Visual and mechanical inspection for:
   a. Physical damage.
   b. Proper installation.
   c. Proper type and gasketing.
   d. Proper operation of pushbutton(s) and/or selector switch(es).
   e. Proper identification on nameplate.
   f. Proper control wiring:
      1) Compare to elementary diagram.
      2) Check for proper termination.
      3) Check for proper conductor identification.
2. Electrical tests:
   a. Control wiring tests:
      1) Apply proper voltage to all circuits.
      2) Check voltage levels at each termination.
      3) Insulation resistance test at 1,000 volts dc on all control wiring except that which is connected to solid state components. Insulation resistance to be one (1) megohm minimum.
   b. Operational test by initiating control devices to affect proper operation.

L. Local Control Panel(s) – LCP

1. Visual and mechanical inspection for:
   a. Physical damage.
   b. Proper type and installation of cabinet.

c. Proper door closure and gasketing.
d. Proper operation of pushbutton(s) and/or selector switch(es).
e. Compliance with elementary diagrams and manufacturer's drawings.
f. Proper identification on nameplates.
g. Proper labeling of all devices both inside and outside.
h. Proper control wiring:
    1) Compare to elementary diagram.
    2) Check for proper termination.
    3) Check for proper conductor identification.
i. Proper overload protection for motor(s) when its starter is included in the panel.
j. Proper breaker size and type.
k. Proper CT when required.
l. Proper terminal blocks.

2. Electrical tests:
    a. Control wiring tests:
        1) Apply proper voltage to all circuits.
        2) Check voltage levels at each termination.
        3) Insulation resistance test at 1,000 volts dc on all control wiring except that connected to solid state components. Insulation resistance to be one (1) megohm minimum.
    b. Operational test by initiating control devices to affect proper operation of each control signal and discrete signal loop.

M. Operating and Control System

1. Visual and mechanical inspection for:
    a. Physical damage.
    b. Proper type and installation of cabinet.
    c. Proper door closure and gasketing.
    d. Proper operation of pushbutton(s) and/or selector switch(es).
    e. Compliance with P&IDs and manufacturer's drawings.
    f. Proper identification on nameplates.
    g. Proper labeling of all devices both inside and outside.
    h. Proper control wiring:
        1) Compare to elementary diagram.
        2) Check for proper termination.
        3) Check for proper conductor identification.
    i. Proper terminal blocks.
    j. Equipment in compliance with these specifications.
    k. Operating equipment in compliance with these specifications.
    l. Operating screens in compliance with approved manufacturer's drawings.
    m. Annunciator screens in compliance with approved manufacturer's drawings.
    n. Alarm logs in compliance with approved manufacturers drawings.
2. Electrical tests:
    a. Control wiring tests:
        1) Apply proper voltage to all circuits.
        2) Check voltage levels at each termination.
        3) Insulation resistance test at 1,000 volts dc on all control wiring except that which is connected to solid state components. Insulation resistance to be one (1) megohm minimum.
    b. Operational test by initiating control devices to affect proper operation.

3.5 ADJUSTING

A. Subsystem Testing:

1. Shall occur after the proper operation of alarm and status contacts has been demonstrated and observed by the Engineer.
2. Shall occur after the process and control devices have been adjusted as accurately as possible.
3. It is intended that the Contractor shall adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.
4. After initial settings have been completed:
   a. Each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract documents.
   b. After the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.
5. Subsystems, in the context discussed here, shall mean individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, blowers, etc.

3.6 DEMONSTRATION

A. Commissioning:

1. Commissioning during the 7-day test as specified in Section 01 65 00 Facility Testing and Plant Start-up, shall not be attempted until all subsystems have been found to operate satisfactorily.
2. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable.
3. Simulation of process parameters shall be considered only upon receipt of a written request by the Contractor.

B. Motor current tabulation report shall reflect the values occurring during commissioning.

C. The indications of all switchgear ammeters and kilowatt meters, shall be recorded every half-hour during commissioning.

- END OF SECTION -

SECTION 26 05 09
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Nameplates.
2. Labels.
3. Wire and cable markers.
4. Conduit markers.

1.2 APPLICABLE SECTIONS:

A. Section 26 05 00 - Electrical General Requirements.

1.3 SUBMITTALS:

A. Submit product literature including manufacturer name, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

PART 2 PRODUCTS

2.1 NAMEPLATES:

A. Nameplates: Engraved stainless nameplates.

B. Locations:

1. Each electrical distribution and control equipment enclosure.
2. Communication cabinets.
3. Each junction box.
4. Each conduit.

C. Letter Size:

1. 1/8" letters for identifying individual equipment and loads.
2. 1/4" letters for identifying grouped equipment and loads.

D. Identify control device stations, motor control equipment, process equipment and instrumentation equipment. All such devices shall be labeled with equipment served, identifying name, and circuit number with panel.

2.2 WIRE MARKERS:

A. Manufacturers:

1. 3M
2. Thomas & Betts
3. Panduit

B. Description: Heat shrink tubing, imprinted, type wire markers.

C. Locations: Each conductor at panel-board gutters, pull boxes, outlet and junction boxes, and each load connection, PLC panels, instrument panels, instruments, MCC's, etc.

D. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number shall be indicated on project Record Drawings.

E. Control Circuits: Control wire number shall be indicated on schematic and interconnection diagrams.

F. Data Wiring: Address number shall be indicated on each end of conductor on the face of the outlet cover, and on the space of the patch panel.

G. All conductor numbers and terminal block numbers shall be reflected on the CONTRACTOR submitted Record Drawings.

2.3 CONDUIT MARKERS:

A. Manufacturers:

1. Tech Products
2. Thomas & Betts
3. Panduit

B. Description: 3/16" poly tag in poly tag holder. Tie wrapped to conduit.

C. Location: Furnish markers for each conduit longer than 6 feet.

D. Spacing: Label at each junction and terminal end.

E. Legend: Number as indicated in contractor prepared Record Drawings.

2.4 UNDERGROUND WARNING TAPE:

A. Description: 4" wide detectable plastic tape, colored red with suitable warning legend describing buried electrical lines.

B. Location: Along length of each underground conduit, 12" above conduit.

2.5 LABELS:

A. Self adhesive, plastic coated, machine printed.

B. Manufacturer: Brother or equal.

C. Locations:

1. Convenience outlet circuit adhered to outlet faceplate showing panel and circuit number.
2. Data address number to outlet faceplate and patch panel face plate.
3. Light switches, indicating lighting switched panel and circuit number.
4. Process wiring indicating connection point terminal block and cabinet.

PART 3 EXECUTION

3.1 PREPARATION:

A. De-grease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION:

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws.

C. Secure nameplate to inside surface of door on panel-board that is recessed in finished locations.

D. Identify each conduit at each end.

E. Identify underground conduits using one underground warning tape per trench at 12" above conduit.

- END OF SECTION -

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SECTION 26 05 19
CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install conductors and cables as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 APPLICABLE SECTIONS

A. Section 26 05 00: Electrical General Requirements.

B. Section 26 05 08: Electrical Acceptance Tests

PART 2 PRODUCTS

2.1 COMPONENTS

A. 600 Voltage Conductors:

1. Copper with AWG sizes as shown or required:
   a. Minimum size shall be No. 12 except where specified otherwise.
   b. Conductors shall be stranded.
      1) Insulation:
         a) Conductor Size No. 2 And Smaller: 600V type THWN or XHHW (75° C). All conductors run in underground conduits shall be XHHW.
         b) Conductor Size No. 1 And Larger: 600V Type XHHW-2 (90° C).

2) Colors:
   a) 120/240 V System
      (1) Black: Line 1.
      (2) Red: Line 2.
      (3) Green: Ground.
      (4) White: Neutral.
   b) 208Y / 120 V System:
      (1) Black: Phase A.
      (2) Red: Phase B.
      (3) Blue: Phase C.
      (4) Green: Ground.
      (5) White: Neutral.
   c) 480Y / 277 Volt System:
      (1) Brown: Phase A.
      (2) Orange: Phase B.
      (3) Yellow: Phase C.
      (4) Neutral: Gray.
      (5) Ground: Green.
   d) Conductors size No. 10 and smaller shall be colored full length. Tagging or other methods for coding of conductors size No. 10 and smaller not allowed.
   e) For feeder conductors larger than No. 10 at pull boxes, gutters, and panels, use taped band or color tag color-coded as specified above.

B. Instrumentation Cables:

1. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.
2. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.
3. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.
4. Pairs shall be assembled with a nominal 2 inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

C. Control Wires:

1. Copper with AWG sizes as shown or required:
   a. Minimum size shall be No. 14 except where specified otherwise.
   b. Conductors shall be stranded.
      1) Insulation:
         a) 600V type THWN or XHHW (75° C). All conductors run in underground conduits shall be XHHW.

2. Control wires may be run in same conduits as instrumentation cables.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Conductors and cables shall be continuous from source to equipment.
2. Do not use direct burial cable.
3. Instrumentation and control wires shall be run in conduits separate from power conduits.

B. 600 Voltage Conductors:

1. Install conductors in raceway except where specifically indicated otherwise. Run conductors of different voltage systems in separate conduits. All raceways shall include an equipment ground conductor.
2. Route circuits at own discretion, however, circuiting shall be as indicated or required. Group circuit homeruns to panels as shown on Drawings. No other groupings of circuits will be allowed.
3. Neutrals:
   a. On three phase, 4 wire systems: Do not use common neutral for more than one three phase circuit.
   b. On single phase, 3 wire systems: Do not use common neutral for more than one circuit per phase.
   c. Run separate neutrals for each circuit where specifically noted on Drawings.
   d. Where common neutral is run for two or three home run circuits, connect phase conductors to breakers in panel which are attached to separate phase legs so neutral conductors will carry only unbalanced current. Neutral shall be sized at 200% of full load.
4. Pulling Conductors:
   a. Do not pull conductors into conduit until raceway system is complete and enclosures, cabinets, and boxes are free of foreign matter and moisture.
   b. Install conductors in accordance with the manufacture's requirements.
   c. Use only listed non-hardening wire pulling lubricants.
5. Provide positive supports for conductors in vertical raceways at following spacing minimum, unless shorter is recommended by manufacturer.
   a. No. 18 to 1/0 — 100 feet.
   b. No. 2/0 to 4/0 — 80 feet.
   c. 250MCM to 350MCM — 60 feet.
   d. 350MCM to 500MCM — 50 feet.

C. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

D. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

E. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. CONTRACTOR shall supply terminal boards as required.
2. Do not field wire directly to devices.

F. Low Voltage Cables In Office Spaces (70 Volts or Less):

1. In inaccessible, concealed spaces, run cables in raceway. In accessible, unfinished areas, cables may be run exposed without raceway.
2. Run exposed cables parallel to or at right angles to building structure lines. Do not run exposed cables on floors or in such a way that they obstruct access to, operation of, or servicing of equipment. Keep cables 6 inches minimum from hot water pipes.
   a. Support cables every 3 feet with permanent clips, straps, staples, or tie wraps approved for application and which will not cause cables to be pinched or deformed.
   b. Securely attach clips and straps with nails or screws. Do not use wire or tape to support cables.
3. Bundle only cables of same systems together.

- END OF SECTION-

SECTION 26 05 22
WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install wiring devices as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device -Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

E. UL - Underwriters Laboratories, Inc.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:

1. Hubbell, Model HBL-1221, 1223, 1224 series.
2. Arrow Hart, Model 1991.

B. Description: NEMA WD 1, Heavy-Duty Specification Grade AC only general-use snap switch.

C. Body and Handle: Gray plastic with toggle handle.

D. Indicator Light: Lighted handle type switch red color handle.

E. Locator Light: Lighted handle type switch; red color handle.

F. Ratings:

1. Voltage: 120-277 volts, AC.
2. Current: 20 amperes.

G. Low-Voltage Lighting control panel switches shall be the same manufacturer as the lighting control panel manufacturer, per manufacturer recommendations.

2.2 RECEPTACLES

A. Manufacturers:

1. Hubbell, Model HBL 5362-SP.
2. Arrow Hart, Model 5362-CR.

B. Description: NEMA WD 1, Heavy-duty specification grade general use receptacle.

C. Device Body: Gray plastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

A. Decorative Cover Plate: Brushed stainless steel in electrical/control/blower rooms.

B. Process Room/Exterior Cover Plate: Gasketed cast metal with hinged gasketed device cover. Lever type switch cover. Classified hazardous as required for process areas per drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that outlet or device boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on bottom.

E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install wall switch 48 inches above finished floor.

B. Install convenience receptacle 18 inches above finished floor unless otherwise indicated.

C. Install convenience receptacle 6 inches above back-splash of counter.

D. Install dimmer 48 inches above finished floor.

E. Install telephone jack 18 inches above finished floor.

F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.

G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

F. Verify that each telephone jack is properly connected and circuit is operational.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

- END OF SECTION -

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SECTION 26 05 24
EQUIPMENT WIRING

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

B. This section includes wiring connections to equipment specified in other sections.

C. Electrical connections to equipment: Provide the materials and make the electrical connections to all equipment having electrical requirements as indicated in the architectural and/or mechanical section of the specifications and drawings.

D. Provide conduit, wiring, connect motors and other mechanical equipment and electrical devices in other sections; also install, provide, support for, and connect starters, other control devices, control panels, furnished for such motors and equipment; complete all circuit leave in satisfactory operating conditions.

E. Provide control devices for equipment in addition to those furnished by the trades providing such equipment; refer to schedules on electrical and mechanical drawings for control devices to be furnished under scope of the electrical work.

F. Control devices and panels furnished by trades providing equipment will be delivered to electrician at site of project; acknowledge acceptance in writing; assume responsibility for particular installation before proceeding with installing and wiring them. Follow each manufacturer's printed installation directions and wiring diagrams for installing and making connections to his equipment and controls.

G. Consult contract drawings and specifications of trades providing equipment and controls, for control wiring diagrams, also refer to their shop drawings in order to become familiar with equipment type and operation of controls, their locations and extent of work required for installing, wiring and connecting them.

H. Starters for all motors requiring same shall be furnished by electrical contractor.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, Special Conditions, alternates, and addenda, applicable drawings, and the specifications including but not limited to the following:

B. Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

A. Section 01 50 00 - Quality Control:

B. NEMA WD 1 - General Purpose Wiring Devices.

C. NEMA WD 6 - Wiring Devices - Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Section 01 30 00 – Submittals: General.

B. Section 26 05 00 - Submittals: Procedures for submittals.

C. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.5 1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.6 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 CORDS AND CAPS

A. Manufacturers:

1. Hubbell.
2. Or equal.

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

D. Cord Construction: NFPA 70, Type SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit over-current protection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energizing.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

- END OF SECTION -

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SECTION 26 05 26
GROUNDING AND BONDING

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Grounding electrodes and conductors.
2. Equipment grounding conductors.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

A. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

B. NFPA 70 - National Electrical Code.

1.4 GROUNDING SYSTEM DESCRIPTION

A. Metal underground water pipe.

B. Metal frame of the building.

C. Concrete-encased electrode. (UFER)

D. Rod electrode.

E. Plate electrode.

F. Active electrode.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 25 ohms maximum.

1.6 SUBMITTALS FOR REVIEW

A. Section 01 30 00 – Submittals: General.

B. Section 26 05 00 - Submittals: Procedures for submittals.

C. Product Data: Provide for grounding and bonding equipment.

D. All submittals shall include a list of all items being submitted by description, manufacturer and catalog number.

1.7 SUBMITTALS FOR CLOSEOUT

A. Section 26 05 05 - Operation and Maintenance Manuals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

C. Certificate of Compliance: Indicate approval of installation by the authority having jurisdiction.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Material: Copper Clad Steel.

B. Diameter: 5/8 inch.

C. Length: 10 feet (3000 mm).

2.2 CONNECTORS

A. Manufacturers:

1. T&B
2. Burndy - Hi-Ground
3. ERICO® - Cadweld®

B. Material: Exothermic Weld.

2.3 WIRE

A. Material: Stranded copper, tinned.

B. Grounding Electrode Conductor: Size as indicated in the Drawings, or if modified or not indicated, size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install electrodes at locations indicated and in accordance with manufacturer's instructions. Install additional rod electrodes as required to achieve specified resistance to ground.

B. Provide grounding electrode conductor (UFER) and connect to reinforcing steel in foundation footing. Bond steel together.

C. Provide bonding to meet Regulatory Requirements.

3.3 FIELD QUALITY CONTROL

A. Perform inspections and tests listed in NFPA ATS, Section 7.13.

- END OF SECTION -

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SECTION 26 05 30
CONDUIT

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install conduits and raceway systems as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

C. Proposed location and details of construction for openings in slabs and walls for conduit runs.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 PROJECT/SITE CONDITIONS

A. GENERAL:

1. Unless otherwise specified, equipment and materials shall be sized and derated for ambient site conditions, but in no case less than an ambient temperature of 40 degrees C at an elevation ranging from seal level to 1,601 feet without exceeding the manufacturer's stated tolerances.

B. AREA CLASSIFICATIONS

1. For the purpose of delineating the basic electrical construction materials and installation requirements for this project, areas of the project have been classified on the contract drawings as defined below. Electrical work within these areas shall

conform to the requirements described below as well as the referenced code requirements.

a. General Purpose (NEMA 1): Areas requiring general purpose (NEMA 1) construction are indoor areas typically architecturally finished and occupied by plant personnel.
b. Outdoor Areas (NEMA 3R): Areas outdoors exposed to the weather, extreme temperatures, sun, and the elements.
c. Corrosive Process Areas (NEMA 4X): Areas requiring corrosion resistant (NEMA 4X) construction are all outdoor areas unless noted otherwise and all indoor corrosive process areas. Corrosive process areas typically contain pumping or piping systems and are subject to spills and washdown. Corrosive process areas shall also include those areas containing corrosive chemicals.
d. Hazardous Areas (NEMA 7): Unless otherwise indicated on the contract drawings, areas requiring hazardous location (NEMA 7) construction are classified as Class 1, Division 2 or Class1, Division 1 hazardous locations per Articles 500 and 501 of the National Electrical Code. See classification drawings.
e. Process Areas (NEMA 12): Areas requiring drip-proof (NEMA 12) construction are indoor process and support system areas and are not typically subject to spills, direct washdown, or corrosive chemicals under normal operating conditions.

C. CONSTRUCTION MATERIALS:

1. Construction materials required for each area classification are listed in table A below. Refer to the individual specification section for each component for material composition and installation practices.

	Area Classification				
Component	NEMA 1 Indoor	NEMA 3R[1] Outdoor	NEMA 4X[1,7] Indoor Corrosive	NEMA 12[1]	NEMA 7 Classified Explosion Proof/Process Area
Conduit (exposed)	GRS	PGRS	PGRS[9]	GRS PGRS	PGRS
Conduit (concealed)[4]	EMT[3]	GRS	HDPE	GRS	GRS
Flexible conduit[5]	LFS	LFS	LFN	LFN	Classified
Support systems	Galvanized Steel	Aluminum	Stainless steel	Aluminum	Stainless steel
Fastening hardware and hanger rods	Cadmium plated steel	Stainless steel	Stainless steel	Cadmium plated steel	Stainless steel
Control Stations[2,6]	Painted Steel	Non-Metallic	Non-Metallic	Painted Steel	Classified
Enclosures[2,6]	Painted Steel	Non-Metallic	Non-Metallic	Painted Steel	Classified

Receptacles[2] Surface Recessed	General General	W[8] WP[8]8	WP[8] N/A	W[8] WP8	Classified N/A
Switches[2] Surface Recessed	General General	W[8] WP[8]	WP[8] N/A	W[8] WP[8]	Classified N/A

Notes:

1. Enclosures, device boxes, control stations and raceway systems shall be mounted with ¼-inch (minimum) space between the electrical system and supporting structure.
2. Conduit terminations to control stations, enclosures, and device boxes in NEMA 4X, 7 and 12 areas shall be made through threaded hubs.
3. Rigid conduit concealed in framed walls, block walls and ceiling spaces shall be electrical metallic tubing, type EMT.
4. Conduit ductbank or beneath slab on grade shall be rigid HDPE conduit, continuous from device to device without pullboxes or conduit splices beneath grade due to high water table.
5. Flexible conduit shall be utilized for final connections to equipment.
6. Control station and enclosure sealing ratings shall meet or exceed the rating designated by the area classification.
7. Exposed conduit systems in areas containing equipment handling Ferric Chloride shall be PGRS.
8. Use gasketed lever type switches and up-in use red dot steel receptacle covers.
9. PVC8 Not accepted. Only PGRS.

Legend:

EMT Electrical Metallic Tubing
GRS Galvanized Rigid Steel
LFS Liquid Tight Flexible Steel
LFN Liquid Tight Flexible Non-Metallic
PGRS PVC Coated Galvanized Rigid Steel (Robroy)
HDPE HDPE Schedule 40
PVC4 PVC Schedule 40
PVC8 PVC Schedule 80
RA Rigid Aluminum
WP Weatherproof – Use cast device boxes with threaded hubs
XP Explosion proof – Approved conduit systems per classification listing
N/A Non applicable

PART 2 PRODUCTS

2.1 CONDUIT AND TUBING

A. GENERAL: Provide conduit and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".

B. ELECTRICAL METALLIC TUBING (EMT) is not accepted for this project.

C. INTERMEDIATE METAL CONDUIT

1. Per USAS C80.1, zinc-coated by hot-dip galvanizing or sherardizing with additional enamel or lacquer coating.
2. Couplings shall be threaded type of same material and finish as conduit. Connectors shall be Myers hubs or equal of same material and finish as conduit.
3. Approved Locations: Interior where exposed, where not exposed to moisture or corrosive atmosphere. Shall not be used in process areas of the plant.

D. GALVANIZED RIGID METAL CONDUIT (GRC): FS WW-C-0581 and ANSI C80.1.

1. Per USAS C80.1, zinc-coated by hot-dip galvanizing or sherardizing with additional enamel or lacquer coating.
2. Couplings shall be threaded type of same material and finish as conduit. Connectors shall be Myers hubs or equal of same material and finish as conduit.
3. Approved Locations: Interior where exposed, where not exposed to moisture or corrosive atmosphere. Shall not be used in process areas of the plant.
4. SCHEDULE 80 approved for above grade installation and for embedding in concrete slabs. Schedule 80 may not be used within the process area of the plant. When used, it shall be supported in frequent intervals, as per NEC, except elbows below concrete and risers through concrete shall be PVC Coated Ridged Conduit.

E. POLYETHYLENE PLASTIC PIPE (PVC), SCHEDULE 80, Based on Outside Diameter: ASTM D 2447

1. PVC SCHEDULE 80 NOT ACCEPTED FOR THIS PROJECT.

F. HIGH DENSITY POLYETHELYNE PLASTIC PIPE (HDPE), SCHEDULE 40, Based on Outside Diameter:

1. High density polyethylene heavy wall (HDPE-40) suitable for direct burial. 1” minimum size.
2. Fittings shall be threaded or heat welded type of same material as conduit. No splices are allowed underground where there is a high water table.
3. Approved for underground direct burial, May be used where buried in earth under floor slabs. Minimum depth of bury under slab shall be 18 inches or of sufficient depth to allow for bending radius to rise out of the slab vertically. Shall have an exposed grounding electrode conductor in each trench.
4. Not approved for above grade installation nor for embedding in concrete slabs
5. Supports at 3’-0” maximum per NFPA 70.

G. PVC COATED GALVANIZED RIGID METAL CONDUIT (PGRC): NEMA RN 1.

1. Rigid galvanized conduit, prior to plastic coating, shall conform to ANSI Standard C80.1, UL 6, and CSA Standard C22.2 #45.
2. Nominal thickness of exterior PVC coating shall be 40 mils. A two-part red urethane coating of 2 mil thickness shall be applied to the interior of all conduits and fittings.
3. All hollow conduit fittings which serve as part of the raceway system shall be coated with exterior PVC coating and red interior urethane coating as described above.
4. Coated conduit shall conform to NEMA Standard No. RN1-1989. Shall be "Plastic-Bond Red" as manufactured by Robroy Industries, Inc.

a. Approved Locations: Shall be used in all locations where conduits are buried, in contact with earth, and in wet and corrosive areas of the plant, and as noted on the drawings. All buried conduit between VFDs and motors. All risers through concrete floors.

H. LIQUIDTIGHT FLEXIBLE METAL CONDUIT: UL 360.

1. Galvanized steel with an extruded liquidtight PVC cover that is moisture and oil-proof, and UV resistant.
2. Fittings shall be liquidtight compression type, listed for grounding. Provide fittings with external bonding jumper where required for bonding.
3. Approved for flexible connections to equipment subject to vibration such as motors, fan, pumps, dry transformers, etc., 36-inch maximum, 18" minimum length for each connection.

I. FLEXIBLE METAL CONDUIT: UL 1.

1. Galvanized steel.
2. Approved for flexible connections to equipment in unclassified areas of the Administration Building.

J. RIDGED ALUMINUM CONDUIT:

1. Couplings shall be threaded type of same material and finish as conduit. Connectors shall be
   a. Myers hubs or equal of same material and finish as conduit.
   b. Approved Locations: Interior where exposed, on the exterior exposed to moisture or corrosive
   c. atmosphere. Approved for above grade installation. May be used within the process area of the
   d. plant.

K. CONDUIT BODIES:

1. Form 7 malleable iron with hot dip galvanized finish, PVC coated in wet or process areas of plant.
2. Gasketed cast iron, zinc plated cover with stainless steel screws.

PART 3 EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS

A. General Requirements: Unless otherwise indicated, wiring shall consist of insulated conductors installed in conduits or raceways.

3.2 CONDUIT AND TUBING SYSTEMS

A. Conduit and tubing systems shall be installed as indicated. Conduit sizes are based on the use of insulated, copper conductors. Minimum size of raceways shall be as noted. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. PVC coated rigid metal conduit will be used in damp, wet or corrosive locations and the conduit or

tubing system will be provided with the appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Any exposed threads or metal shall be touched up with 3 coats of touch up material provided with conduit. Raceways shall be kept 6" away from parallel runs of any mechanical piping. Raceways shall be concealed where possible. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings and will provide continuity for grounding.

3.3 BELOW SLAB-ON-GRADE OR IN THE GROUND

A. All electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing through slabs-on-grade shall be PVC coated rigid metal conduit. PVC conduits shall be installed below slab-on-grade or in the earth. All underground bends over 22º and risers through concrete slab shall be PVC coated GRC.

3.4 INSTALLED IN SLABS INCLUDING SLABS ON GRADE

A. Conduit shall not be embedded in concrete slabs except as specifically detailed.

3.5 EXPOSED RACEWAYS

A. Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above ceilings shall be considered as exposed installations.

3.6 CHANGES IN DIRECTION OF RUNS

A. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field made bends and offsets shall be made with an approved hickey or conduit bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp or wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed from obstructions or shall be replaced.

3.7 SUPPORTS

A. Metallic conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10' and within 3' of boxes, cabinets, enclosures, and fittings, with U-channel support systems, one hole conduit straps with clamp backs, and conduit hangers. All supports mounted in exterior, process, or exposed areas subject to corrosive atmosphere shall be stainless steel. Supports in other areas shall be hot dipped galvanized. C-clamps or beam clamps shall have strap or rod type retainers. Rigid plastic conduits (if permitted as wiring method) shall be supported as indicated above, except that they shall be supported at 3’-0” maximum on centers and as indicated in the NEC (NFPA 70). Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging.

B. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a power charge and provided with lock

washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or supports shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4" in concrete joints shall avoid cutting the main reinforcement bars. Holes not used shall be filled. In partitions of light steel construction, sheet metal screws shall be used. Conduits shall not be supported using wire or nylon ties.

C. Raceways shall be installed as a complete system and shall be independently supported from the structure. Upper raceways shall not be supported of lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts and shall not be fastened to hung ceiling supports.

D. Support Installations:

1. U-channel supports generally are not detailed but must be adequate to support combined weights of conduit and conductors.
2. Clamps: Galvanized malleable iron one-hole straps with clamp backs, beam clamps or other approved device with necessary bolts, expansion shields. Perforated metal straps shall not be used.
3. Adjustable U-channel Supports: Used to support horizontal runs only, use trapeze hangers for parallel runs of conducts.
4. Surface mounted raceway bases shall be anchored to ceiling members or block walls on 5'-0" centers maximum spacing and at all junction and device boxes and at angle fittings. Anchors shall be: Expansion shields on concrete or solid masonry, toggle bolts on hollow masonry units or on suspended ceilings.

3.8 INSTALLATION OF RACEWAYS AND FITTINGS:

A. General:

1. All Conduit: In accordance with requirement of National Electrical Code and applicable local codes.
2. Steel Conduit: In accordance with recommendations of American Iron and Steel Institute "Design Manual on Steel Electrical Raceways," latest edition.

B. Electrical Continuity:

1. All metallic conduit systems shall be electrically continuous throughout.

C. Moisture:

1. All conduit systems shall be essentially moisture tight.

D. Alignment of Exposed Conduit:

1. Parallel with or at right angles to lines of structure.

E. Field Cuts and Threads:

1. Cuts shall be square, threads clean and sharp. Remove sharp or rough edges by reaming burrs. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of rigid steel conduit. Apply coat of red lead, zinc

chromate or special compound recommended by manufacturer of conduit where conduit protective coating is damaged.

F. Bends:

1. Uniform, whether job-fabricated or made with standard fittings or boxes. Do not dent or flatten conduit.
2. Exposed Conduit: Symmetrical insofar as practicable.
3. Materials used in bends and elbows shall be strong enough not to be adversely affected by the abrasion during wire pulls.

G. Location:

1. Routing: Generally shown in schematic fashion, unless dimensioned or noted to contrary. Contractor shall determine actual routing as approved.
2. Conduit Not Shown: Contractor shall route as required to connect equipment as specified.
3. Vertical Risers, Equipment and Device Locations: Approximately as shown. Contractor shall coordinate installation of conduit, in locations indicated, with structure and equipment.
4. Conduit in Relation to Steam or Hot Water Lines or Other Hot Surfaces: Locate minimum of 6" away. If such separation is impracticable, protect from heat as approved.

H. Buried Conduit:

1. Depth of Burial: Minimum of 24" below finished grade.
2. Medium voltage conduit shall be covered with concrete with red dye on top of the concrete.
3. All other buried conduit shall be covered with 3 inches of bedding sand surrounding each conduit.

I. Wall Penetrations: Required for passage of conduits installed by CONTRACTOR through walls, or partitions.

1. Penetrations Through Exterior Building Walls: Cast in sleeve/Core drill wall and provided conduit entrance seals as detailed. All penetrations shall be with rigid steel conduit PVC coated within the plant process areas.
2. Openings Required Through Existing Partitions: Shall be provided at CONTRACTOR's expense. Holes through masonry construction shall be cast/ drilled with suitable coring machine. Perform work neatly. Patches shall match original material in composition and appearance.
3. Provide fire seals where a fire rated partition or wall is penetrated.

J. Expansion Fittings:

1. Install in all conduit runs crossing structural expansion joint or in straight runs 75 feet or more in length.

K. Conduit Ends:

1. Cap spare conduits.

2. Open Conduit Ends Terminating in Switchboards, Cabinets or Similar Locations Where Exposed to Entrance of Foreign Material: Install insulating grounding bushing. Plug space around cables with sealing compound.
3. Cap or plug conduit ends to prevent entrance of foreign material during construction.

L. Conduit Connections:

1. Cabinets, Enclosures, and Boxes: Double lock nuts and insulating bushings for rigid conduits in unclassified areas, NEMA 1. Hubs for rigid conduits in damp, wet, exterior, or corrosive areas, NEMA 12, 3R, 4, 4X. Bushings, insulating type, bell ends, or insulated throat fittings shall be installed on the ends of all conduits. Grounding type fittings and bushings shall be utilized as required for bonding.
2. Metallic Conduit Terminating in Non-Metallic Manholes or Pull Boxes: Insulated grounding bushing with lay-in ground lugs.
3. Flexible conduit for connection to movable equipment shall be liquidtight, utilizing listed liquidtight fittings.

M. Cleaning:

1. Clean and swab inside of conduits by mechanical means to remove foreign materials and moisture before conductors are installed.

N. Spare Conduits:

1. Install nylon pull line for future installation of cables. Cap all conduits and mark where end is located on Record Drawings with dimensions.

- END OF SECTION -

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SECTION 26 05 32
CONDUIT DUCTBANKS

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install conduit ductbanks as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein. All exterior conduit shall be buried underground and embedded in sand as detailed. No splices are allowed underground due to high water table at the site.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

1.3 QUALITY ASSURANCE

A. MATERIAL MANUFACTURERS: Firms regularly engaged in manufacture of duct system components of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to underground ducts. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 APPLICABLE SECTIONS

A. Section 31 22 00 - Earthworks

B. Section 26 05 00 - Electrical General Requirements.

C. Section 26 05 19 – Conductors and Cables.

PART 2 PRODUCTS

2.1 DUCTS

A. Ducts shall be a round-bore, size as indicated, Nonmetallic Conduit, HDPE-40 or PVC-40.

B. Duct elbows, bends, and off-sets shall be per the manufacturer’s requirements PVC Coated RGS or Fiberglass.

C. With high water table, conduit shall be HDPE continuous from device to device in order to minimize the entrance of water.

PART 3 EXECUTION

3.1 CONDUIT BANKS

A. Each ductbank shall be completely encased in sand. Thickness of sand over, under and around ductbank shall be not less than 3 inches as detailed. All ductbanks shall include a grounding electrode conductor as detailed.

B. Unless noted otherwise, the top of the sand envelope shall be not less than 2'-6" below finished grade or paving.

C. Ducts shall be installed to provide a water-tight, continuous length duct. If required, joints in duct shall be as per the manufacturer's requirements, and staggered at least 6 inches.

D. Saddles shall be used for support as indicated on the drawings. Hold down anchors shall be provided as indicated and required to prevent duct from floating on wet concrete.

E. During construction, ends of ducts shall be plugged to prevent debris from entering into ducts. Particular care shall be taken to keep ducts clean of concrete or any other substance during the course of construction.

F. After each duct line has been completed, a mandrel not less than 12 inches long, having a cross section approximately 1/2" less than the inside cross section of the duct, shall be pulled through to clean out the duct of earth, sand or gravel.

G. Trenching, backfilling and surface repair shall be done in accordance with Division 2 of these specifications. Hand dug or vacuum truck dug trenches are required where risk of contact with other underground utilities are present.

H. Ductbanks shall be straight without bends or off-sets if at all possible.

I. Over each ductbank at approximately 12 inches below grade, provide a detectable continuous red plastic warning tape to alert future excavators of the presence of the ductbank.

J. Provide nylon pull line in all ducts.

- END OF SECTION -

SECTION 26 05 34
ELECTRICAL BOXES AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install electrical boxes and electrical fittings as required, and as shown on the Drawings. Materials employed shall be as indicated on the specified herein.

B. Types of electrical boxes and fittings in this section include the following:

1. Outlet boxes
2. Junction boxes
3. Pull boxes
4. Conduit bodies
5. Bushings
6. Locknuts and hubs
7. Knockout closures
8. Miscellaneous boxes and fittings.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings.

B. Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxed, covers and box supports. Provide electrical boxes and fittings, which have been UL listed and labeled.

PART 2 PRODUCTS

2.1 FABRICATED MATERIALS

A. Flush Interior Outlet or Device Boxes: Provide one piece, galvanized flat rolled sheet steel interior wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices; minimum depth 1-1/2". Provide minimum 2-1/8" depth for boxes with three or more conduit entries.

B. Interior Outlet or Device Box Accessories: Provide box accessories as required for each installation, including mounting brackets, hangers, extension or plaster rings, fixture studs, cable clamps and metal straps for supporting boxes, which are compatible with boxes being used and fulfilling requirements of individual wiring applications.

C. Exposed Outlet or Device Boxes: Provide corrosion- resistant cast-metal type FD weatherproof wiring boxes of types, shapes and sizes (including depth) required, with

integral threaded conduit hubs, face plates with spring-hinged waterproof caps suitable configured for each application, with face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Provide junction and pull boxes with covers of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless hardware. Provide underground concrete junction boxes as required or indicated on the Drawings. Provide cast steel boxes with threaded hubs and gasketed cover as required or indicated on the Drawings.

E. Conduit Bodies: Provide galvanized cast-metal Form 7 conduit bodies of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

F. Bushings, Knockout Closures, Locknuts, and Hubs: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and hubs, and conduit bushings and offset connectors of types, and sizes to suit respective uses and installation.

G. All boxes, fittings, and conduit bodies shall be PVC coated wherever PVC coated conduits are required elsewhere in this specification.

PART 3 EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. General: Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

C. Provide cover plates for all boxes. See Section 26 05 22, Wiring Devices.

D. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.

E. Provide knockout closures to cap unused knockout holes where blanks have been removed.

F. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Install recessed boxes with face of box or ring flush with adjacent surface.

G. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them.

H. Provide electrical connections for installed boxes.

- END OF SECTION -

SECTION 26 05 74
ELECTRICAL MOTORS

PART 1 GENERAL

1.1 SCOPE

A. This section specifies alternating current induction motors 300 horsepower and less to be provided with the driven equipment. This section refers to motors by the enclosure type as defined in NEMA MG 1. Compliance by the supplier to the requirement of the specification does not relieve them of responsibility of furnishing motors and motor accessories that are suitable for the specified service conditions.

1.2 QUALITY ASSURANCE

A. General

1. Motors shall be built in accordance with UL 1004, NEMA Standard MG 1, and to the requirements specified herein.

B. References

1. This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference Title	
FORM A-1 1	Motor Data Sheet
IEEE 85	Test Procedure for Airborne Sound Measurements on Rotating Machinery
NEMA ICS 6	Enclosure for Industrial Controls and Systems
NEMA MG 1	Motors and Generators
UL 1004	Motors, Electric
NEC	National Electric Code, Latest Edition

1.3 SUBMITTAL DATA

A. Complete motor data shall be submitted with the driven machinery submittals. Motor data shall include.

1. Machine tag and loop number, as identified in the P&IDs, and specifications number of driven machine.
2. Motor manufacturer.
3. Motor Type or model and dimension drawing.
4. Nominal horsepower at installed altitude.
5. Nominal efficiency.
6. NEMA design.
7. Frame size.
8. Enclosure.
9. Winding insulation class and treatment.
10. Rated ambient temperature.

11. Service factor.
12. Voltage, phase, and frequency rating.
13. Full load current at rated horsepower for application voltage.
14. Starting code letter, or locked rotor KVA, or current.
15. Special winding configuration such as part winding, star-delta.
16. Rated full load speed.
17. Power factor at full load.
18. Power and connection requirements of motor winding heaters.
19. Temperature protective devise ratings and connection information.
20. Recommended maximum size power factor correction capacitor.
21. Motor insulation dielectric withstand rating.
22. If driven from a variable frequency drive:
    a. Certification that the motor meets the requirements of NEMA MG-1 1993 part 31.
    b. Certification that the motor and mechanical drive are matched in design and suitable for use together for the specific installation and driven equipment conditions.

B. The OWNER/CONTRACTOR shall complete the motor data sheet at the end of this Section for each and every motor supplied, and submit the completed forms to the ENGINEER for review, as part of the submittal package for each piece of equipment.

C. Motor insulation resistance test report.

1.4 SERVICE CONDITIONS

A. Environmental Conditions

1. All motors are subject to hose directed spray and up to a temperature 40°C. Motors shall be totally enclosed unless otherwise specified and shall be rated for service at elevation 4,300 feet above mean sea level. Motors shall meet the criteria as specified in NEMA MG 1 for usual environmental conditions.

B. Operating Conditions

1. Motors shall be selected for the operating conditions of the driven equipment in accordance with NEMA MG 1. Motors shall be subject to the vibration performance limits as follows:
    a. The rotor shall be dynamically balanced according to NEMA Standards. Balance limits shall be 1/2 the limits shown on NEMA MG 1-12.06. The depositing of metal on the rotor (solder, weld, etc.) to achieve balance is not acceptable. Pavement metal is to be removed to achieve a balance only without effecting the structural strength of the rotor. Chiseling or sawing parent metal is prohibited. The addition of weights is acceptable.

1.5 PERFORMANCE REQUIREMENTS

A. Motors shall be continuous duty of the type generally described as having normal starting torque with low current, NEMA design “B”.

B. Starting current for fully loaded motors shall be as defined by NEMA design “B”.

C. Motors shall be sized for operation at their respective horsepower rating, never at their service factor rating. All motors shall be rated with a service factor of at least 1.15.

D. The motor must develop sufficient locked rotor torque to provide breakaway of the load and to provide adequate torque during the acceleration period to overcome the load and inertial forces.

E. Acceleration time must be short enough to be within the thermal limits of the motor, but not so short that it over stresses the driven equipment.

F. Overhung load requirements such as the number and pitch radius of the motor-shaft-mounted pulley sprocket, etc., and the distance from the motor front bearing to the center of the pulley, sprocket, etc. must be determined and included in the purchase order.

G. Motors are to be manufactured with multiple dips of Class H varnish in order to accommodate the application of adjustable speed drive systems voltage and severe duty environments.

H. All equipment manufacturers shall provide a totally enclosed fan cooled motor, corrosion resistant and rated for severe, continuous duty operation.

I. Motors shall operate successfully at rated load under the various combinations of voltage and frequency variations specified in section 12.44 of NEMA MG1-1998.

J. Motors shall operate successfully under running conditions at rated load and frequency when the voltage unbalance at the motors terminals does not exceed 1%.

K. Motor balance and vibration shall meet NEMA standards as defined in MG1-1998 part 7. The motor shall be dynamically balanced to meet 0.08 in/s maximum velocity at the bearing housing when measured in the horizontal, vertical and axial plane (0.12 in/s on 2-pole motors frame 280 and above).

L. Unless otherwise specified in the equipment description, the motor rotation shall be possible in either direction – application permitting. See motor data sheet.

1.6 MOTOR CONSTRUCTION

A. Mechanical and Electrical Features:

1. All motors ¼ Hp through 2 Hp may have either NEMA C-Face or floor mounted feet, or both. Motors above 2 Hp shall be foot mounted in preference to any other method. Mounting requirements are provided in the horsepower descriptive section of the documents.
2. All motors controlled by a variable speed drives shall be equipped with motor shaft ground rings.
3. Long shaft motors are preferred over short shaft for close-coupled applications. Shafts shall have Impro seal supplied on both bearings. Motor shaft diameter shall comply with NEMA standard size for the motor frame size specified. Reduced, custom, or special shaft diameter motors are not acceptable unless specifically required by the application and approved, in writing, by project engineer. Notification of such variance must be submitted with bid proposals.

4. Motor speeds are dictated in the equipment descriptive documents included with this specification.
5. The following NEMA frame size shall be provided unless specifically approved by the project engineer (3600, 1800, 1200 & 900 RPM):
   a. 1 Hp through 2 Hp on a 143 T(C) to 213 T (C).
   b. 3 Hp through 5 Hp on a 182 T(C) to 254 T (C).
   c. 7.5 Hp through 10 Hp on a 213 T(C) to 284 TS
   d. 15 Hp through 25 Hp on 254 T to 326TS
   e. 30 Hp through 50 Hp on 286T to 404T
   f. 60 Hp through 100 Hp on a 364 T to 445T
   g. 125 Hp through 300 Hp on a 445TS to 5010 US
   h. Above 200 Hp, frame selection shall be defined on equipment data and motor data sheets.
6. Stator frame, end brackets, fan cover and conduit box shall be manufactured of high 25 grade cast iron. All frames shall be designed and constructed such that on direct-coupled applications the motor can be mounted and aligned without distortion of the feet, and sufficient strength to withstand overhung loads for belt drive applications. The motor shall be designed with the capabilities for mounting the drive side vertically up or down as required by the application.
7. Ventilating fans shall be non-sparking bronze alloy or non-conductive nylon 66 materials. The ventilation shall be such that cool air is drawn in and hot air expelled to avoid mixing with the incoming air.
8. All motors 1 Hp to 250 Hp shall be rated and wired as 3 phase, 60 Hertz 460 volt operation. Exceptions to this requirement must be reviewed and authorized by the project engineer. If wired for 230/460 volt, a wiring diagram shall be illustrated on the inside of the conduit box or name plate.
9. Moisture inhibiting coating shall protect the rotor and stator. These coatings must match or exceed the anticipated full load thermal conditions, vibration, and shock electrical insulation ratings of the motor.
10. All cast iron motor parts shall be primed and painted with epoxy or polyester resin enamel or similar coatings for additional corrosion and moisture protection.
11. Motor stator and rotor steel shall be low-loss C-5 electrical grade silicon steel with interlamination insulation capable of withstanding a minimum of 1000 oF burnout. Stator random windings shall be copper and shall be insulated with class H insulation.
12. Bearings shall be either 300 series ball bearings or cylindrical roller bearings on the drive end and opposite drive end. Bearings shall be selected to provide a minimum L-10 life of 50,000 hours with an external load per NEMA MG 1-14 and a L-10 life of 100,000 hours in direct coupled applications. Bearing type shall be defined on the motor data sheet.
13. Bearings shall have a maximum of 45oC rise at rated horsepower (50 oC for 2-pole motors).
14. Bearings on frames 143T through 5010UZ shall be regreaseable with regreasing instructions labeled on the motors. The bearings found in frames 213T and larger shall have open bearings with cast iron inner bearing caps. If motor is to be operated by a variable frequency drive the manufacturer shall provide optional insulated bearings on both end of direct coupled motors. See motor data sheets for VFD motors.
15. The motor bearing housing shall have an extended automatic grease relief valve to effectively prevent bearings from being over-lubricated.

16. The motor nameplate shall have raised letters stamped on 304 stainless steel and be fastened to the motor frame with four stainless steel drive pins.
17. All motor hardware shall be English type and grade 5 zinc-dichromate plated.
18. The winding insulation system shall be Class H or better, non-hygroscopic, chemical, corrosion, fungus and humidity resistant. The complete insulation system will have a minimum resistance of 1.5 megohms after 168 hours of testing in a humidity chamber maintained at 100% relative humidity and 40º C ambient with both end bells removed. Motors used in adjustable speed drive applications shall have an insulation rating of 1860 vac peak with a 0.1 micro second rise time.
19. Motor leads shall be stranded copper, permanently identified on both ends and are brought out into the motor terminal box through a neoprene lead-positioning gasket with compression type terminal lugs. Each of the three leads shall be brought through a single hole into the conduit and termination box.
20. The conduit box shall be cast iron and threaded for rigid conduit connection. Conduit box shall be located at the F1 position of the motor unless otherwise noted on the motor data sheet. Conduit box volumes shall exceed the NEMA minimum standards by a minimum of 25% and boxes shall be able to rotate 90-degree increments. A bronze ground lug shall be provided in the conduit box.
21. A lifting eyebolt shall be provided for motor lifting (180 frame and larger). Eyebolt holes shall be threaded blind holes.
22. Motors shall be suitable for field configuration to any ceiling, wall, or floor mounting by rotating conduit box, end shield, and rotor – per application requirements (143T through 365T).
23. All motors shall meet the “NEMA Premium” efficiency requirements as outline by NEMA Table 12.12. Any deviation from this specification shall be received in writing from the project engineer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. General Electric Company.
2. Louis Allis (Division of MagneTek, Inc.)
3. U.S. Motors Corporation
4. Toshiba.
5. Reliance.
6. Baldor Gold Series.
7. Or prior-approved equal.

B. The OWNER/CONTRACTOR shall assign to the designated equipment supplier the responsibility to select and supply suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review and acceptance by the ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment.

2.2 MOTORS LESS THAN ½ HORSEPOWER:

A. General

1. Unless otherwise specified, motors less than 1/2 horsepower shall be squirrel cage, single phase, and capacitor start induction run. Small fan motors may be split-phase or shaded pole type. Wound rotor or commentator type single phase motors are acceptable where its characteristics are necessary for the application. Conductors shall be copper.

B. Rating

1. Motors shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1-10.35. Dual voltage rated motors are acceptable if all leads are brought out to the conduit box.
2. Locked rotor current shall not be greater than specified in NEMA Standard MG1-10.36, Design “N”.

C. Enclosures

1. Unless otherwise specified, motors shall be totally enclosed.

D. Bearings

1. Motors shall be provided with sleeve-type or sealed ball bearings lubricated for 5 years normal use.

E. Insulation

1. Comply with NEMA 1-1.65.
2. Motors shall be furnished with Class F insulation, rated to operate at a maximum ambient temperature of 40ºC and at the altitude where the motors will be installed and operated, without exceeding temperature rise limits stated in NEMA MG 1-12.42 for a Class B insulation at ambient temperature of 40°C, and without using the service factor.

2.3 MOTORS 1/2 HORSEPOWER THROUGH 300 HORSEPOWER:

A. General

1. The nominal motor horsepower shall be adequate for the driven machine without infringement upon the motor service factor at the installed altitude and specified ambient conditions.
2. The motor horsepower shall be not more than the estimated maximum specified for each driven machine.
   a. If the estimated maximum horsepower specified is not adequate to satisfy the foregoing restriction or any other requirements of these specifications, the motor with the next larger horsepower shall be supplied at no additional cost to the OWNER.
   b. In addition, any changes caused by increase in motor horsepower shall be made by the OWNER/CONTRACTOR at no additional cost to the OWNER; such changes may involve circuit breakers, motor controllers, VFDs, motor and branch circuit and feeder conductors and conduit sizes, etc.
3. Some requirements of the Section may be excluded for motors which are part of valve operators, submersible pumps, or motors which are an integral part of standard manufactured equipment (i.e., non-NEMA mounting, common shaft with driven

element), to the extent that such variation reflects a necessary condition of motor service or a requirement of the specified driven equipment.

4. Motor Voltage Ratings: The OWNER/CONTRACTOR is required to review the Electrical Drawings and Specifications and to furnish all motors with voltage and phase as shown on the electrical drawings.
    a. The OWNER/CONTRACTOR shall notify the ENGINEER of any discrepancy between any motor sizes indicated by the Drawings and specified elsewhere, and any requirements of the driven equipment and the availability of motors from the manufacturers listed above.
5. Special Requirements: The OWNER/CONTRACTOR shall refer to individual equipment specifications and the Drawings for special requirements such as motor part winding start, multi-speed windings, protective devices, auxiliary devices, etc.
6. Horizontal Motors Installed Outdoors: All horizontal motors which will be installed outdoors shall be totally enclosed, fan cooled (TEFC) severe duty and/or chemical duty rated with a Service Factor of 1.15 unless otherwise noted or if the area classification required a more stringent motor enclosure.
7. Horizontal Motors Installed Indoors: Unless otherwise specified, all horizontal motors which will be installed indoors shall be TEFC (totally enclosed fan cooled) with a service factor of 1.15 minimum.
    a. All motors larger than 1 HP, located in damp environment such as in pump and pipe galleries, tunnels, chemical feed and sludge areas, shall be severe duty and/or chemical duty rated complying with IEEE 45.
8. High Efficiency Motors: Motors with a nameplate rating of 5 HP and above shall be “premium efficiency” units. Criteria stated herein, apply to horizontal motors without exception and apply to vertical motors insofar as they are available at time of construction.
    a. Efficiency shall be determined by the test as set forth in IEEE 112, Method B.
    b. If the inrush current due to the high efficiency design of the motor exceeds the available settings of the motor circuit protector, the motor circuit protector may be changed to a thermal magnetic circuit breaker, with the permission of the ENGINEER, at no additional cost to the OWNER.
        1) If is the OWNER/CONTRACTOR’S responsibility to perform the motor starting requirement coordination, and to notify the ENGINEER of any discrepancies.

B. Three Phase Motors

1. All motors 1/2 HP and larger shall be three phases unless otherwise indicated on Drawings, or specified elsewhere.
2. Voltage: All three phase motors shall be suitable for operation on 208, 230 and 460 VAC, unless otherwise indicated on the electrical plans.
3. NEMA Design:
    a. Electric Motors shall be NEMA Design B, (except as noted in equipment specifications for motors controlled as variable speed operation and other special motors), constant speed squirrel-cage induction motors having normal starting torque with low starting current.
    b. In no case shall starting torque or breakdown torque be less than the value specified in NEMA MG 1.
    c. Starting kilovolt ampere per horsepower shall not exceed values as specified in NEMA MG-1-10.37.

d. Motors shall be suitable for operation on the following starting mechanisms as shown on the drawings:
    1) Across the line.
    2) Reduced voltage solid state starter.
    3) Variable frequency drive-inverter duty rated.
    4) 2 speed 2 winding.

4. Insulation:
    a. Comply with NEMA 1-1.65.
    b. Motors shall be furnished with Class H insulation or with Class F insulation, rated to operate at a maximum ambient temperature of 40ºC and at the altitudes where the motors will be installed and operated, without exceeding temperature rise limits stated in NEMA MG1-12.42 for Class B insulation at a 40º C ambient, and without using the service factor.
5. Motor Bearings:
    a. Antifriction, re-greaseable, and filled initially with grease suitable for ambient temperature to 40ºC.
        1) Suitable for intended application and have AFBMA B-10 rating L-10 life of 60,000 hours or more.
        2) Bearing mounting shall be designed with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.

C. Vertical Motors

1. Comply with the requirements for three phase motors except where the following requirements are more stringent.
2. Enclosure:
    a. All vertical motors installed outdoors shall have Weather Protected Type II (WPII) enclosures.
    b. All vertical motors installed indoors shall have Weather Protected Type I (WP I) enclosures.
3. All vertical motors shall have a Service Factor of 1.15.
4. Motor Bearings:
    a. Antifriction, oil lubricated, and filled initially with oil suitable for ambient temperatures to 40º C.
        1) Suitable for intended application and have AFBMA B-10 rating life of 60,000 hours or more.
        2) Bearing mounting shall be designed with easily accessible oil supply, flush, drain, oil level gauge, and relief fittings using extension tubes where necessary.
    b. Furnished with re-lubricate ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

2.4 COMPONENTS

A. Motor Enclosures:

1. Open Drip Proof:
    a. Stamped steel conduit boxes.
    b. 1.15 service factor at 40º C ambient.
2. Totally Enclosed Fan Cooled:

a. Cast iron conduit box.
b. 1.15 service factor at 40º C ambient
c. Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller.
d. Automatic breather and drain devices for frames 324T and larger.
e. Upgraded insulation by minimum of 3 dips and bakes and sealer coat of epoxy or silicone.

3. Severe Duty:
   a. Corrosion resistant type conforming to motors designated by manufacturer as:
      1) Chemical Duty.
      2) Mill and Chemical.
      3) Custom Sever Duty.
      4) Or similar applicable manufacturer's quality designation.
   b. 1.15 service factor at 40º C ambient.
   c. Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller.
   d. Automatic breather and drain devices for frames 324T and larger.
   e. 2 cycles of vacuum epoxy impregnation of the motor windings.

2.5 ACCESSORIES

A. Conduit Boxes

1. Horizontal motors 3 HP and larger, and all vertical motors, shall have split-type cast metal conduit boxes.
2. Boxes on motors other than open drip-proof shall be gasketed.
3. Boxes shall be furnished with the size and number of openings as required for the conduits indicated on the Drawings.
4. Boxes shall be rotatable through 360 degrees in 90 degree increments.
5. Shall be furnished with an integral equipment ground lug installed and sized as required for the conductors indicated on the Drawings.

B. Lifting Devices: All motors weighing 265 lb (120 Kg) or more shall have suitable lifting devices for installation and removal.

C. Space Heaters:

1. All motors 1 HP and larger shall be furnished with winding heaters where installed outdoors.
2. Space heater ratings shall be 120 volts, single-phase, unless otherwise shown.
3. Bring power leads for heaters into conduit box.

D. Nameplate:

1. All motors shall be fitted with a permanent, stainless steel nameplate indelibly stamped or engraved with:
   a. NEMA Standard motor data.
   b. Bearing description and lubrication instructions.
   c. Insulation class.
   d. Ambient temperature.
   e. Altitude rating.
   f. Power factor at full load.

2.6 CURRENT BALANCE

A. Current unbalance on polyphase motors shall not exceed the values tabulated below when motor is operating at any load within its service factor rating and is fed by a balanced voltage system:

1. Under 5 horsepower: 25 percent
2. 5 horsepower and above: 10 percent

2.7 OVER-TEMPERATURE PROTECTION

A. General

1. Over-temperature protection devices shall provide a normally closed contact rated NEMA ICS Class B1 50. Relays or solid state contacts which are required shall be provided in an enclosure on or near the motor. Relay enclosure shall be in accordance with NEMA ICS-6 and shall be NEMA 4 for all motors.

B. Requirements

1. Over temperature protection is not required for motors rated less than 25 horsepower.
2. Over temperature protection for motors rated 25 horsepower or greater but less than 200 horsepower shall be thermal switches, NEMA MG 1-12.57, Type 2.
3. Over temperature protection for motors rated 200 horsepower or greater shall consist of a minimum of six 100 OHM Platinum RTD's embedded in the motor windings, and one 100 OHM for each bearing. Wiring to an external junction box shall be provided. Motor supplier shall coordinate with motor controller supplier to ensure RTD's match Multilin 369 requirements.

2.8 SHAFT CURRENT PROTECTION

A. All motors coupled with a variable frequency drive (VFD) shall include a shaft grounding system. Acceptable systems include Mercotac Rotary Electrical Connectors, AEGIS SGR, or equal.

PART 3 EXECUTION

3.1 TESTING

A. Each motor shall be given a routine commercial test as required by NEMA MG 1 to demonstrate that it is free from electrical or mechanical defects. Copies of routine test reports shall be submitted in the format specified by NEMA.

- END OF SECTION -

SECTION 26 09 13
CONTROL DEVICES

PART 1 GENERAL

1.1 SCOPE

A. This section sets forth the general specification and requirements for the control devices that shall be provided with control panels, motor starters, and other enclosures in order to assemble a complete and operable control, alarm, or indicating system.

B. The SUPPLIER shall coordinate the installation of items specified herein as required to ensure the complete and proper interfacing of all the components and systems.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.3 APPLICABLE REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1985; Incl. Rev. I and 2; ICS-6) Enclosures for Electrical Equipment

NEMA ICS 1 (1988) General Standards for Industrial Controls and Systems

UNDERWRITERS LABORATORIES, Inc. (UL)

UL 50 Enclosures for Electrical Equipment

UL 508 Industrial Control Equipment

1.4 SUBMITTALS

A. Provide complete submittal information for the control devices in accordance with Section 26 05 00.

B. Comply with the following requirements:

1. Submit certified dimensional drawings and manufacturer's data sheets for each size and type of device specified herein to be utilized. Data sheets are to be highlighted to define the specific materials of construction and features specified herein along with detailed manufacturer's model number.

2. Submit instruction bulletins for each type of control device. The instruction bulletins shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, calibration instructions, and any other details of a specialized nature to the devices furnished.

C. Additional submittal requirements:

1. Circuit Breakers and/or fuses:

    a. Provide a complete schedule showing load and rating of circuit breakers and/or fuses.

2. Control power transformers and/or power supplies:

    a. Provide complete sizing calculations in accordance with the requirements identified herein.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturers have been indicated for various specified devices to establish the standard of quality and performance of the equipment to be supplied.

B. Devices of a given type shall be of the same model, class, or rating, have the same general appearance, and be from the same manufacturer.

2.2 GENERAL REQUIREMENTS

A. Analog measurements and control signals shall:

1. Be electrical as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted.

2. Electrical signals outside control panels shall be 4 to 20 mA DC, except as noted.

3. Signals within enclosures may be 1 to 5 VDC, or 0-10 VDC.

4. Dropping resistors shall be installed at all field side terminations in the control panels to ensure loop integrity.

B. Control panels provided with integral power supplies and control power transformers shall be configured to match the voltage and current requirements of the loads.

C. Each 120 VAC control loop or instrument shall have an individual circuit breaker or fuse within its respective control panel and clearly identified for function.

D. Each PLC output shall have its own individual fuse external of the I/O card, with blown fused indication.

1. Size external fuse to open before any I/O card mounted fuses.

E. Signal isolators, Signal Converters, and Power Supplies:

1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required:

    a. To ensure adjacent component impedance match.

    b. Where feedback paths may be generated.

    c. To maintain loop integrity when the removal of a component of a loop is required.

2. Signal converters shall be included where required to resolve any signal level or signal type incompatibilities.

3. Power supplies shall be included, as required by the device manufacturers' load characteristics, to ensure sufficient power to each loop component.

2.3 CONTROL DEVICES

A. Signal Isolators and Converters.

1. Signal isolators shall have complete isolation of input, output and power input.

a. Signal input shall be 4-20 mA into 50 ohms, maximum.

b. Signal output shall be 4-20 mA into 1000 ohms, minimum.

c. Power input shall be 120 VAC, 60 Hz or 24 VDC.

d. Span and zero shall be adjustable.

e. Accuracy shall be ±1 percent of span.

f. Units shall be surface or DIN rail mounted.

2. Signal Converters

a. Signal inputs of 1-5 V, 0-10 V, ect.

b. Signal output shall be 4-20 mA into 1000 ohms, minimum.

c. Power input shall be 120 VAC, 60 Hz or 24 VDC.

d. Span and zero shall be adjustable.

e. Accuracy shall be ±1 percent of span.

f. Units shall be surface or DIN rail mounted.

3. Acceptable manufacturers:

a. Accromag.

b. AGM Electronics Model TA-4000.

c. Or approved equal.

B. Relays

1. General Purpose Relays:

a. General purpose relays shall be plug-in type.

b. Contacts rated 10 amperes at 120 volts AC.

c. With LED indication when energized.

d. Quantity and type of contacts shall be as shown on the Plans or as needed for system compatibility.

e. Each relay shall be enclosed in a clear plastic heat and shock resistance dust cover.

f. Sockets for relays shall have screw type terminals.

g. Provide transient surge protection across the coil of each relay.

h. Relays shall be:

1) Potter and Brumfield Type KRP or KUP.

2) IDEC.

3) Square D Type K.

4) Allen Bradley.

5) Or approved equal.

2. Slave and Interposing Relays:

a. Additional slave relays shall be provided when the number or type of contacts shown exceeds the contact capacity of the specified relays and timers.

b. Additional relays shall be provided when higher contact rating is required in order to interface with starter circuits or other equipment.

c. Shall be provided to compensate for voltage drop due to long wire runs.

d. The slave and interposing relays shall be as the general purpose relays.

e. Provide transient surge protection across the coil of each relay.

3. Time Delay Relays

a. Time delay relays shall be pneumatic on-delay or off-delay type.

b. Contacts shall be rated 10-amperes at 120 VAC.

c. Units shall be including adjustable dial with graduated scale covering the time range in each case.

d. Provide transient surge protection across the coil of each relay.

e. As manufactured by Agastat, Series 7000.

C. Manual Operators and Interface Devices - Unclassified Areas

1. General Requirements

a. NEMA Type 13 Oil tight.

b. With synthetic rubber gasket.

c. Heavy duty.

d. Industrial grade full size 1 – 13/64” diameter.

2. Pushbutton Units:

a. Contacts rated:

1) NEMA A600.

2) 600 VAC maximum.

b. Color Code:

1) Red - Stop

2) Green - Start

3) Orange - Open

4) Blue - Closed

c. As manufactured by:

1) Allen Bradley 800T.

2) Square D Type K.

3) Cutler-Hammer 10250T Series.

d. Furnish one spare normally open and normally closed contact with each switch.

3. Selector Switches:

a. Contacts rated:

1) NEMA A600.

2) 600 VAC maximum.

b. As manufactured by:

1) Allen Bradley 800T.

2) Square D Type K.

3) Cutler-Hammer 10250T Series.

c. Furnish one spare normally open and normally closed contact with each switch.

4. Pilot Lights:

a. Transformer type LED pilot lights.

b. 120 VAC.

c. Push to Test type.

d. As manufactured by:

1) Allen Bradley.

2) Square D Type K.

3) Cutler-Hammer 10250T Series.

D. Manual Operators and Interface Devices - Corrosive Areas

1. General Requirements:

a. NEMA 4X corrosion resistant.

b. Exterior parts to be made of high impact strength fiberglass reinforced polyester or other corrosion resistant materials.

c. Incorporating an internal neoprene boot which completely encloses all internal parts.

d. Industrial grade full-size 1 – 13/64” diameter.

2. Pushbutton

   a. Having an integral wiping gasket around the pushbutton that cleans the wall of the pushbutton guard of any foreign material accumulation as the button is operated.

   b. Contacts rated:

      1) NEMA A600.

      2) 600 VAC maximum.

   c. Color code:

      1) Red - Stop

      2) Green - Start

      3) Orange - Open

      4) Blue - Closed

   d. As manufactured by:

      1) Allen Bradley NEMA 4, 4X – 800H.

      2) Crouse Hinds NPB1211.

      3) Cutler-Hammer E34 Series.

      4) Square D Type SK.

3. Selector Switches:

   a. Contacts rated:

      1) NEMA A600.

      2) 600 VAC maximum.

   b. As manufactured by:

      1) Allen Bradley NEMA 4, 4X-800H.

      2) Crouse Hinds NW 12221.

      3) Crouse Hinds NSW 12321.

      4) Cutler-Hammer E34 Series.

      5) Square D Type SK.

   c. Furnish one spare normally open and normally closed contact with each switch.

4. Pilot lights:

   a. Transformer type LED pilot lights.

   b. 120 VAC.

   c. Push to test.

   d. Light colors shall be as identified on the Plans.

   e. As manufactured by:

1) Allen Bradley NEMA 4, 4X-800H.

2) Crouse Hinds NW 12221.

3) Crouse Hinds NSW 12321.

4) Cutler-Hammer E34 Series.

5) Square D Type SK.

E. Terminal Blocks

1. Din rail mounted.

2. Terminal to be of the tubular screw type with pressure plate to minimize the possibility of breaking wire strands during tightening.

3. Recessed terminal hardware to minimize the possibility of contact with current carrying parts.

4. Molded of high dielectric material.

5. Minimum rating 600 VAC, 30 amp.

6. External connections to and from all control panel must be via terminal blocks, including power, control, alarm, instrumentation, monitoring, and solenoid circuits.

7. Individual terminals and terminal blocks shall be marked in a permanent manner with printed identification.

8. As manufactured by:

a. Entrelec M 4/6

b. Phoenix Contact UK 5 N

c. Or approved equal

F. Conductors within Control Panels

1. Single conductors shall be as follows:

a. Material: Soft annealed coated copper per ASTMB33 or B189.

b. Standard: ICEA S-19-81.

c. Stranded Wire - Class B.

d. Insulation and Coverings:

1) Thickness: Per ICEA.

2) Material:

a) No. 8 and Smaller: Type XHHW single conductor, copper power cable, moisture resistant, flame retardant thermoplastic insulation, 600 volt, 75 °C.

b) No. 6 and larger: Type XHHW-2 single conductor, copper power cable, heat and moisture resistant, flame retardant, thermoplastic insulation, 600 volt, 75°C.

e. No. 14 AWG minimum, shall be used for field control circuits, unless otherwise noted.

f. No. 16 AWG minimum, Type MTW shall be used for all PLC I/O connections within the panel; between I/O device and field wiring terminal blocks.

2. Instrumentation Cable (Shielded Twisted Pair STP):

a. Minimum conductor size 18 AWG.

b. Stranded and tinned copper conductors.

c. Polyethylene conductor insulated.

d. Foil aluminum-polyester shield – 100% shielding.

e. Minimum 18 AWG, stranded, tinned, copper drain wire.

f. PVC outer jacket.

g. UL Listed, TC rated.

h. 600 volt insulation level.

G. Wire markers:

1. Conductors within the control panel are to be permanently marked with wire numbers at each end.

2. Wire numbers are to correspond to the wire numbers indicated on the submittal drawings and are to correspond to the terminal block number to which they are attached in the control panel.

3. Markers shall be heat shrinkable tubing, imprinted type wire markers.

4. Manufacturers:

a. 3M.

b. Thomas & Betts.

c. Panduit.

H. Nameplates:

1. Nameplates: Engraved three-layer laminated plastic, white letters on black background.

2. Control components within the control panel shall have nameplates secured with stainless steel screws. Nameplates cannot be attached to the covers of the panel wireways.

3. The enclosure and components on the front cover or interior swing out panels shall be identified by nameplates.

a. Use standard manufacturer engraved nameplates for all pushbuttons, and selector switches only if color matches that specified for engraved nameplates. If not, then furnish nameplates to match colors as specified herein.

b. Use engraved plastic laminated nameplates for all other devices, displays, keypads, and annunciator LED’s.

c. For NEMA 12, 4, and 4X enclosures, use an epoxy based adhesive to affix nameplates to enclosure cover.

4. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, power supply, relay, terminal strips, and the like mounted inside the panel. The nameplate nomenclature shall match the component names identified in the submittal drawings.

5. Lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP-60.6 (1984) with an intended viewing distance of 3 to 6 feet for external nameplates and 1 to 2 feet for internal nameplates.

I. Control Circuit Breakers:

1. Each 120 VAC control circuit, instrument, or loop shall be powered from an individual control circuit breaker.

2. Din rail mounted using the same DIN rail as used for the terminal blocks.

3. Manual ON-OFF Switch.

4. Rated 240 VAC.

5. Rated 2000 AIC.

6. Current ratings as needed load served.

7. Provide complete nameplate identifying each circuit.

8. As manufactured by:

a. ABB

b. Phoenix Contact

c. Entrelec

d. Square D

J. Fused Terminals:

1. Isolate all PLC Digital Outputs with fuses.

2. Isolate all PLC Digital Inputs with fuses.

3. Isolate all PLC Analog Inputs and Outputs with fuses.

4. Coordinate fuse size to be as recommended by the manufacturers. For PLCs, the fuse size to be below internal output protection of the PLC output module.

5. Fuses to be terminal block mounted.

6. Furnish nameplate identifying each fused terminal.

7. As manufactured by:

a. Entrelec

b. Phoenix Contact

c. Or approved equal

K. Field / Remote Connections:

1. Field/remote connections shall be made at terminal blocks within the panel.

2. Furnish an individual terminal block space for each wire.

    a. Two wires on one terminal block will not be allowed.

3. Furnish an empty wire channel on the backpanel adjacent to the field/remote terminal block strip to be used to route the field/remote wires to the connection terminal blocks.

4. Provide spare terminal blocks as specified herein.

L. Control Voltages:

1. Control voltage shall be supplied via control circuit breakers in the panel.

2. Control power shall be sourced from the 120V power supplied to the panel, unless otherwise noted in the Plans.

3. AC control voltages other than that supplied shall be transformed via a control power transformer within the panel. DC control voltages shall be supplied by AC to DC power supplies, specified herein.

M. Control Power Transformers:

1. Low impedance type.

2. The control power transformers shall have fused over current protection on both the primary and secondary sides of the transformer.

3. Use actual coil power factors in calculating the VA rating of the transformer. Use a power factor of 35% if power factor of coils is unavailable.

4. Determine the continuous VA rating of the transformer based on maximum sealed VA load current from the coils of the starters, relays, and pilot lights. Maximum inrush current shall be calculated based on the maximum inrush of devices that can be energized at one time plus the load presented by the devices already energized, and the actual power factor of the loads. This maximum inrush current must not cause the secondary voltage of the transformer to fall below 85% of rated voltage when the primary voltage has been reduced to 90% of rated voltage. Based on these calculations then actual transformer size shall be the calculated value times 1.5.

N. Transient / Surge Protection

1. Data and Signal Line Protectors to be used on each and every analog input or output, and on each and every data and signal line external connection point:

    a. Provide electronic circuits and components from damaging surge voltage and currents.

    b. Provide protection of signal and data lines associated with computer, data, communications, instrumentation, broadcasting, and industrial control interfaces.

    c. Shall be used directly with EIA standard interfaces:

1) RS-232

2) RS-422

3) RS-423

4) RS-485

5) 4-20 mA instrumentation loops.

d. Repeatedly provide protection against surge currents in excess of 10,000 Amps.

e. DIN rail mounted.

f. Cable shields shall be passed through and may be either grounded or not grounded at the protector.

g. System:

1) Heavy duty multi-staged protectors.

2) Solid state stage intercepts the leading edge of the surge with sub-nanosecond response time.

3) Within micro-seconds, a 3-pole common chambered gas tube capable of handling 20,000 ampere lightning current operates and crowbars the surge to ground.

4) The protector remains in the crowbar state until the surge has passed and line voltages return to safe levels.

h. Location:

1) Place at each end of a signal line, data line, or current loop.

2) In the case of daisy chain configuration, such as RS-485, protectors shall be placed at each node.

i. Electrical Characteristics:

1) Surge Life:

a) Greater than 1000 operations with 200 Amps, 10 x 100 µsec.

b) Greater than 10 operations with 10,000 Amps, 8 x 20 µsec.

2) Leakage current at rate line to ground voltage < 10 µAmps.

3) Signal/Data attenuation at maximum data rate 3 db with 600 terminations.

4) Operating temperature -40°C to +60°C.

j. As manufactured by:

1) Joslyn:

a) For differential signals, such as RS-422 or RS-485, and current loops – Model 1820.

b) For high frequency differential signals and current loops – Model 1821.

c) For line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1810.

d) For high frequency line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1811.

2. Protection from inductive spikes within the control panel.

a. Provide surge protection across all inductive coils for control relays, starters, solenoids, etc.

O. Power Supplies: Power supplies shall convert 120 VAC ±10% to 24 volt DC or other DC voltages as necessary.

1. Power supplies shall have an excess rated capacity of 40 percent or be rated 100 watt minimum.

2. The failure of a power supply shall be annunciated at the control panel and repeated to the SCADA system through a connection to PLC.

3. Output regulation shall be accurate within ±0.05% for a 10% line change or a 50% load change and shall include remote voltage sensing.

4. The power supply shall be rated for temperatures of 32 to 122 degrees F and shall be UL recognized.

5. Power supplies shall have fully isolated primary and secondary coils which shall be surrounded by an insulating enclosure which shall also provide mechanical isolation.

6. All power supplies shall be designed and configured as fully redundant systems so that the failure of one power supply will automatically transfer to the other power supply with no interruption in power.

a. The power supply failure shall supply a dry contact for connection to a PLC input for an alarm indication.

7. As manufactured by:

a. Power One W Series.

b. Phoenix Contact Quint Series.

c. IDEC Slim Line.

PART 3 EXECUTION

3.1 INSTALLATION

A. Conform to all application provisions of the NEMA and UL standards, NEC and local, state, and federal codes when fabricating the equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Locate devices, including accessories, where they shall be accessible from grade, except as shown otherwise.

C. Mount components in accordance with the installation details as prepared by the manufacturers.

D. Mount equipment so that each device is rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment within the panel.

E. Items, components, devices, and accessories shall be mounted and anchored using stainless-steel hardware, unless otherwise noted.

3.2 SPARES

A. Unused inputs and outputs from the PLC shall be wired to field terminal blocks and identified.

B. Furnish one spare normally open and one spare normally closed dry contact for each push-button, selector switch, relay, etc.

C. Furnish ten spare fuses for each type of fuse in the panel.

D. Furnish 15 spare terminal blocks or 20% whichever is greater.

E. Furnish five spare relays for each type used in the panel.

F. Spare contacts of relays, switches, etc., shall be internally wired to terminal blocks.

- END OF SECTION -

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SECTION 26 16 00
PANELS AND CONSOLES

PART 1 GENERAL

1.1 SUMMARY

A. General: This section sets forth the general specifications and requirements for all the control panels and enclosures being provided under this contract.

1. Including but not limited to all:
   a. All custom built and designed control panels.
2. The CONTRACTOR shall furnish, supply and install all custom panels for this project in accordance Contract documents.
3. This section also covers requirements for local control panels being supplied by the Equipment Manufacturers as part of the packaged equipment.
   a. The CONTRACTOR shall design all interfaces between these control panels and the SCADA/PLC System.
4. This specification covers the requirements for the fabrication of instrument panel boards or enclosures, mounting, finishing, piping and wiring of instrument equipment.

B. Related Sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Section apply. It is the responsibility of the CONTRACTOR and its Sub-Contracts to review all sections to insure a complete and coordinated project.

1.2 1PANEL FABRICATION

A. The following paragraphs describe general fabrication requirements for the instrument panels, enclosures, and subpanels:

1. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90 C.
2. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring and wiring for control circuits shall be minimum 14 AWG. Annunciator and indicating light circuits shall be minimum 16 AWG. Electronic analog circuits shall be 16 AWG twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Wiring for ac power distribution, dc power distribution, and control circuits shall have different colors and shall agree with the color coding legend on the system supplier's panel wiring diagrams.
3. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal clamping voltage of 200 volts. Surge protectors shall be a non-faulting and non-interrupting design with a response time of not more than 5 nanoseconds. Surge protectors shall be Transtector "ACP-I00BW", Power Integrity Corporation "ZTAS", or equal.
4. Terminal blocks for external connections shall be suitable for No. 12 AWG wire, and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be

fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the Supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits plus one ground for each shielded cable. All wiring shall be grouped or cabled and firmly supported to the panel. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

5. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.
6. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends as indicated on the drawings and shall be made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel.
7. All panels shall be thoroughly cleaned, sanded, and given not less than one coat of rust-inhibiting primer both inside and out. The panel interior shall be given not less than one coat of white enamel or lacquer. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be smoothed and given not less than two coats of enamel, polyurethane, or lacquer finish. Color samples shall be submitted to the Engineer for color selection. One quart of finish color paint shall be furnished with the panels to cover future scratches.

B. FACTORY TEST

1. Panels shall be factory-tested electrically and pneumatically by the panel fabricator in the presence of the ENGINEER before shipment.

1.3 SUBMITTALS

A. Control Panel Engineering Submittals: Submit a two phase control panel engineering submittal for each and every control panel and enclosure being provided for this project.

1. Phase I shall be the Control Panel Hardware submittal which shall include but not be limited to:
   a. Enclosure construction details and NEMA type.
   b. Finish, including color chart for ENGINEER selection of color.
   c. Layout.
   d. Power circuits.
   e. Signal and safety grounding circuits.
   f. Fuses.
   g. Circuit breakers.
   h. Signal circuits.
   i. Internally mounted instrumentation.
   j. PLCs.
   k. SCADA system components.
   l. Face plate mounted instrumentation components.
   m. Internal panel arrangements.
   n. External panel arrangements.
   o. Construction drawings drawn to scale which define and quantity.

1) The type and gage of fabrication steel to be used for panel fabrication.
2) The ASTM grade to be used for structural shapes and straps.
3) Panel door locks and hinge mechanisms.
4) Type bolts and bolt locations for section joining and anchoring.
5) Details on the utilization of “UNISTRUT” and proposed locations.
6) Stiffener materials and locations.
7) Electrical terminal box and outlet locations.
8) Electrical access locations.
9) Print pocket locations.
10) Writing board locations.
11) Lifting lug material and locations.

p. Physical arrangement drawing drawn to scale which define and quantity the physical groupings comprising:
1) Control panel sections.
2) Auxiliary panels.
3) Subpanels.
4) Racks.
5) Cutout locations with nameplate identifications shall be provided.

q. A bill of material which enumerates all devices associated with the control panel.

2. Phase II shall be the Control Panel Wiring Diagram submittal which shall include but not be limited to:
a. Schematic/Elementary diagrams shall depict all control devices and circuits and their functions.
b. Wiring/Connection diagrams shall locate and identify:
1) Electrical devices.
2) Terminals.
3) Interconnecting wiring.
4) These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.
c. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment.
1) These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.
d. Control sequence diagrams shall be submitted to portray the contact positions or connections required to be made for each successive step of the control action.

3. All panel drawings shall be 22” x 34” reduced to and fully legible at 11” x 17”, and submitted at 11” x 17” format size, with all data sheets and manufacturer specification sheets being 8.5” x 11”.

4. The submittal shall be in conformance with NEMA Standard ICS-1-1.01, and each phase shall be submitted as a singular complete bound volume or multi-volume package and shall have the following contents.
a. A complete index shall appear in front of each bound volume.
1) All drawings and data sheets associated with a panel shall be grouped.
2) All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.
b. Completed ISA-S20 data sheets for all instrumentation devices associated with each control panel supplemented with manufacturer specification sheets which verify the products conformance to the requirements of the Contract Documents.
c. A listing of spare parts in conformance with each equipment specification section.

1.4 QUALITY ASSURANCE

A. Environmental Suitability:

1. All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designed in the Contract Documents.
2. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices to within a range equal to 20% above the minimum and 20% below the maximum of the rated environmental operating ranges.
3. Provide all power wiring for these devices.
4. Enclosures suitable for the environment shall be furnished.
5. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

B. All control panels and assemblies shall be labeled and listed by a nationally recognized testing laboratory.

1. Underwriters Laboratory, Inc.
2. Or equal.

1.5 DELIVERY, STORAGE AND HANDLING

A. All panels are to be crated for shipment using a heavy framework and skids.

1. The panel sections shall further be cushioned satisfactorily to protect the finish of the instruments and panel during shipment.
2. All equipment which is shipped with the panel shall further have suitable shipping stops and cushioning material installed in a manner to protect instrument parts which could be damaged due to mechanical shock during shipment.

PART 2 PRODUCTS

2.1 CONTROL PANELS

A. The following paragraphs describe specific requirements for the control panels:

B. CONSTRUCTION - NEMA 12 by Hoffman or equal in control room locations. NEMA 4X by Hoffman or equal in process or humid areas or outside.

1. NEMA 12
   a. Seams continuously welded and ground smooth.
   b. Door and body stiffeners as needed to make a rigid enclosure.
   c. Heavy gauge continuous hinge.
   d. Oil-resistant gasket attached to door with oil-resistant adhesive. Gasket to seal against roll lip on the enclosure opening.
   e. Internal mounting panel held in place by collar studs welded to enclosure.
   f. Lockable door latching and handle mechanism to allow easy access to interior of enclosure and keyboard.
   g. Panel cut-outs for instruments, devices, and windows shall be cut, punched, or drilled and smoothly finished with rounded edges.
      1) Reinforce around cut-outs with steel angles or flat bars.

2. Large panel cutouts such as for HMIs.
3. Pilot device groupings where the removed metal exceeds 50% of the available metal in an area bound by a 3" envelope around said pilot devices.
    a. Finish.
        1) Interior, smooth, polyester power coating.
        2) Exterior polyester powder coating gray in color.
            a) Panels that are in the same room as, motor control centers, switchboards, etc shall be of the same color as the motor control center or switchboards so that the control panel blends into the line up.
    b. Manufacturer's standard gauge steel.
    c. Each door to have a three-point latching mechanism and padlocking handle with rollers on the ends of the latch rods.
    d. With heavy duty lifting eyes.
    e. With flange mounted disconnect.
    f. Mounting panel
        1) 10 gauge steel
        2) With stiffeners
4. Water tight corrosion resistant stainless steel
    a. NEMA 4X in design, dust tight, water tight, and corrosion-resistant.
    b. 14 gauge, Type 304 Stainless Steel.
    c. Captive stainless steel cover screws threaded into sealed wells.
    d. Oil resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
    e. Finish
        1) Cover surface and sides, unpainted, brushed finish.
    f. Door fronts ground smooth.
    g. Specifically designed for use with flange mounted disconnect switches.

C. SIZE AND ARRANGEMENT - Panel dimensions and general instrument arrangement shall be as indicated on the drawings.

D. Interconnecting wiring and wiring to terminals for external connection shall be MTW or SIS 16 AWG, stranded copper wire, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90 degrees Celsius except for electronic circuits and special instrument interconnect wiring which shall be in accordance with manufacturer requirements. Provide a switched fluorescent light at every four feet of panel length.

E. PANEL WIRING:

1. Power distribution wiring on line side of panel fuses minimum 12 AWG.
2. Secondary power distribution wiring and wiring for control circuits: Minimum number 14 AWG.
3. Annunciator and indicating light circuits: Minimum 14 AWG.
4. Electronic analog circuits within instrument and control panels: Minimum 16 AWG twisted and shielded pairs or triads rated not less than 16 volts.
5. Provide a 15 amp, 120 volt GFCI service outlet within each panel.
6. Wire Insulation Colors:
    a. Conductors supplying 120-volts AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor.
    b. Grounded circuit conductors shall have white insulation.

c. Insulation for ungrounded 120-volt AC control circuit conductors shall be red.
d. All wires energized by a voltage source external to the control panels shall have yellow insulation.
e. Insulation for all DC conductors shall be blue.

7. Wire Marking:
   a. Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings.
   b. These numbers shall be marked on all conductors at every terminal in accordance with Section 26 05 09.
8. For case grounding, panels shall be furnished with a ¼-inch by 1-inch copper ground bus complete with solderless connectors for all equipment ground conductors.
   a. Refer to Division 26 – Conduit Schedule for size and number of conductors.
9. Power Supply Wiring:
   a. Each and every loop and instrument requiring 120 VAC shall be protected by individual DIN rail mounted circuit breakers.
      1) The number of circuits depends on the circuit load as noted herein.
      2) The circuit load shall not exceed 10 amp.
      3) Different panel section or different process units must not use common branch circuits.
      4) Furnish and install DIN rail mounted circuit breakers for all individual instruments.
         a) Circuit breakers shall be mounted on the back of the panel.
         b) Identified by a service name tag.
   b. Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual DIN rail mounted circuit breaker located within the control panel.
      1) Circuit breakers shall have plastic tags indicating instrument tag numbers.
      2) Individual plug and cord set power supply connections require DIN rail mounted circuit breakers ahead of the receptacle.
10. Furnish circuit breakers for the panel lights, and for the panel receptacle.
11. Alarm Wiring:
   a. Install and wire all alarms including light cabinets, audible signal units, test and acknowledge switches and remote logic units as specified.
   b. Interconnecting wiring to panel mounted initiating devices shall also be wired.
   c. Where plug and cord sets are provided for component interconnection, harness and support the cables in neat and orderly fashion. Where separate wire is required, install No. 16 AWG with MTW or TFFN insulation between all components.
12. Signal Wiring:
   a. Signal Wire – Non Computer Use
      1) Signal wire shall be twisted pair or triads in conduit or troughs. Cable shall be constructed of No. 16 AWG with MTW or TFFN insulation between all components.
      2) Color code for instrument signal wiring shall be as follows:
         a) Positive (+) – Black
         b) Negative (-) – White.
      3) Multiconductor cables where specified shall consist of No. 18 AWG copper signal wires twisted in pairs, pairs, with 90°C, 600 V insulation.
         a) A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC.

4) Use for connections between field terminal blocks and the PLC wiring arms for analog inputs and outputs.

b. Signal Wire – Computer Use
   1) Signal wires shall be similar to those for non-computer use but each pair shall be triplexed with a copper drain wire and aluminum polyester tape shall be applied over the triplexed group.
   2) All cable shields, including thermocouple extension leads shall be terminated at a single point within the control panel.
   3) Continuity of the shield is to be maintained throughout the cable runs.

c. Multi-conductor cables, wireways and conduit shall be sized to allow for 20 percent signal wire.

13. Wiring Installation:
   a. All wires shall be run in plastic wireways.
   b. Exception:
      1) Field wiring.
      2) Wiring run between mating blocks in adjacent sections.
      3) Wiring runs from components on a swing-out panel to components on a part of the fixed structure.
         a) Wiring run from components on a swing-out or front panel to other components on a fixed panel shall be made up in tied bundles.
         b) These bundles shall be tied with nylon wire ties, and shall be secured to panels at both sides of the “hinge loop” so that conductors are not strained at the terminals.
      4) Wiring run to front panel-mounted components.
   c. Signal and low voltage wiring shall be run separately from power and 120 VAC control wiring.
      1) 120 VAC circuits shall be run through grey colored plastic wireways.
      2) 24 VDC circuits shall be run through white colored plastic wireways.
   d. Wiring to rear terminals on panel-mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.
   e. Provide an empty wireway for all field wiring connections.
      1) 120 VAC circuits shall be run through grey colored plastic wireways.
      2) 24 VDC circuits shall be run through white colored plastic wireways.
   f. Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the ENGINEER’s review.

14. Grounding
   a. Furnish equipment ground bus with lugs for connection of all equipment grounding wires.

F. ANALOG CIRCUITS AND AC POWER CIRCUITS: Separated.

G. INTERNAL PANEL WIRING COLORS:

   a. AC Power Distribution: Red
   b. DC Power and Control: Blue
   c. Instrument: Black and white twisted shielded pair.
   d. Other and in agreement with manufacturer's wiring diagrams as stated on manufactured drawing legend.

H. SURGE PROTECTION DEVICE FOR POWER ENTRANCES: Nominal 120 volts AC with a nominal clamping voltage of 200 volts; nonfaulting and noninterrupting design with a response time of not more than 5 nano-seconds. Utilize a branch panel TVSS unit as described in Section 26 35 53.

I. TERMINAL BLOCKS FOR EXTERNAL CONNECTIONS: Suitable for specified AWG wire, rated 30 amperes at not less than 600 volts (for incoming power circuits, and for field 1/0 terminals they shall be Phoenix contact or equal as shown on the drawings); with marking strip, covers, pressure connectors, and labeled terminals, each conductor of external circuits plus one ground terminal for each shielded cable. Provide minimum 25 percent spare terminals.

J. Group cables, and firmly support wiring to the panel. Provide minimum 8 inches clearance between terminal strips and the base of vertical panels for conduit and wiring space. Individually fuse each control loop or system, and clearly label and locate fuses or circuit breakers for maintenance.

K. Furnish and install equipment grounding conductor in accordance with NEC 250. Provide power ground lugs. Provide signal insulated and isolated ground lugs.

L. Nameplates on Internal and External Instruments and Devices: Materials approximate dimensions with legends as indicated on the Drawings made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer; firmly secured to panels.

M. POWER SUPPLIES/FUSING

1. Design and arrange regulated 24 volt DC power supplies for instrument loops so that loss of I loop does not affect more than one instrument loop or system. Provide power supplies suitable for an input voltage variation of plus or minus 10 percent. Fuse or short circuit protects the supply output.
2. Selectively fuse the power distribution from multi-loop supplies so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Label and locate fuses for easy access.
3. Output Voltage Regulation: As required by the instrument or control equipment being supplied.
4. Backup power supply units shall be provided to automatically supply the load upon failure of the primary supply. Design backup supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.
5. Oversize the multi-loop supply systems for an additional 25 percent future load. Indicate failure of a multi-loop supply on the respective instrument panel or enclosure.
6. Furnish and install signal repeaters for instrument loops that exceed the load impedance of the power supplies. Indicating fuses: Neon bulb type for 120 VAC circuit and glass indicating fuse type for 24 VDC circuits.

N. SOURCE QUALITY CONTROL:

1. Functionally factory test instrument and control panel items electrically and pneumatically before shipment.

O. PANEL ACCESSORIES:

1. Manufacturers: Weidmuller SAKS; Entrelec; Phoenix Contact; Wago; or equal.
   a. Terminal Blocks: Nickel plated copper only; DIN rail; universal foot with the following as required for the application.
      Universal type
      1) Feed through
      2) Ground
      3) Neutral disconnect
      4) Intrinsically safe
      5) Explosion-proof
      6) Fuse
      7) Knife disconnect
      8) Ground fault indicator
      9) Bolt connecting
   b. Terminal Block Labeling: Each terminal and each conductor as previously specified with machine labels only.
      1) Manufacturers: Phoenix Contact; Entrelec; or equal.
         a) Signal Interface Modules:
            1. Analog isolating converter
            2. Ground loop isolations
            3. Signal amplification
            4. Signal level matching
            5. 24 VDC power supply (120 VAC input)
2. Disconnect Switches:
   a. Switches shall consist of a thermal magnetic circuit breaker with integral door operator – lockable
      1) Minimum 22 KAIC
      2) Not required for panels fed with 120 VAC or less. A nameplate must be furnished on the cover of the control panel identifying all sources of supply and foreign voltages within the control panel.
   b. The main disconnect shall disconnect all power sources within the control panel.
   c. Sized in accordance with the NEC and total connected horsepower and associated locked rotor currents.
   d. A disconnect shall be provided for each motor controller/starter within the control panel. This disconnecting means shall disconnect power and control power to each motor controller. Each disconnect shall be equipped with a dead front operator through either the cabinet door or a dead front panel.

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 26 20 00
SERVICE AND DISTRIBUTION SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. Provide all operations, methods, labor and equipment and provide and install all materials and incidentals necessary for the completion of the work as specified herein or included on the Drawings.

1.2 WORK INCLUDED

A. Electrical work required is indicated on the Drawings and specified herein and elsewhere includes, but is not necessarily limited to:

1. Complete electrical distribution systems for power, control, and instrumentation as shown.
2. Complete system of raceways, conductors, and equipment for all other auxiliary systems required. If noted, the equipment and wiring of these auxiliary systems will be furnished and installed under their respective sections; however, the conduit or raceway systems will be furnished and installed in accordance with Division 26 05 00.

B. The CONTRACTOR shall furnish and install all component parts of all the systems required for their safe and proper operation, whether or not specifically mentioned or noted on the Drawings, except those items or articles which are specifically noted as being supplied otherwise.

C. Perform all trenching and backfilling required in connection with the work which shall be in strict accordance with the provisions of Division 31 of these specifications.

D. Provide all required electrical conduits, conductors, and connections to items described in all other sections of these specifications.

1.3 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and addenda, applicable drawings and the technical specifications herein shall apply.

B. Section 26 24 17 – Distribution Panelboards.

1.4 ELECTRICAL SERVICE

A. New underground electrical service(s) from the local utility shall be at 480/277 volt, three phase, four wire, 60 hertz AC with current ratings as indicated on the Drawings.

B. The CONTRACTOR shall install service conduits and conductors from the utility transformer location to the service entrance section. The installation shall be in accordance with the utility company's published requirements. The CONTRACTOR shall coordinate the installation with the utility.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation of the service entrance sections shall be in accordance with the manufacture's requirements.

3.2 INSTALLATION OF GROUNDING ELECTRODE SYSTEM

A. The service entrance section shall be bonded to the grounding electrode system (GES). The GES consists of, but not limited to, the metal underground water pipes, metal frame of the building or structure, concrete encased electrode (UFER), ground rings, rods, pipe, or plate electrodes, and other metal underground systems or structures as in compliance with the NEC. Provide bonding jumper same size as system ground to provide ground continuity from customer's side of metallic lines service entrance and street side of metallic mains. The neutral (grounded conductor) and grounding electrode system shall be connected together at the service disconnect only.

B. The UFER ground system consists of a bare copper conductor, size as indicated in the Drawings, concrete encased 2" above the bottom of the foundation footing of the building or structure which is in direct contact with earth. The UFER ground will make a complete loop in the foundation and is bonded to the rebar steel at least in two locations. UFER ground connections shall be exothermic welds.

C. The equipment grounding system shall be such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with the electrical circuits operate continuously at ground potential and provide a low impedance path for the possible ground fault currents. The system shall comply with the National Electrical Code, modified as indicated on the Drawings or specifications.

D. The distributions system shall be provided with a separate equipment grounding conductor for each single or three-phase feeder, each branch circuit, each motor circuit, control or instrument raceways as indicated. The grounding conductor shall be installed in the common raceway with the related phase and/or neutral conductors. Flexible conduit equipment connections utilized in conjunction with branch circuits or feeders shall be provided with suitable bonding jumpers connected to listed grounding type fittings when required.

3.3 TESTING

A. General: Upon completion of this portion of the work, test all parts of the electrical system in the presence of the ENGINEER.

B. Test Requirements: All systems shall test free from short circuits and grounds, shall be free from mechanical and electrical defects, and shall show an insulation resistance between phase conductors and ground of not less than that required by the manufacturers.

3.4 FINAL INSPECTION

A. The CONTRACTOR shall be present at the final acceptance of the work by the OWNER.

B. The CONTRACTOR shall have pad and pencil to list all deficient items noted. Corrections and adjustments of deficient items shall be done after the inspection, not during.

C. See Section 26 05 00 for other requirements for final acceptance.

- END OF SECTION -

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SECTION 26 22 00
DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.1 SCOPE

A. This Section consists of dry type transformers and related items necessary to complete the work indicated within the Contract Documents.

1.2 REFERENCES

A. NEMA ST 1 – Specialty Transformers (Except General – Purpose Type).

B. NEMA ST 20 – Dry Type Transformers for General Applications.

C. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association).

D. NFPA 70 – National Electrical Code.

E. UL – Underwriters Laboratories, Inc.

1.3 SUBMITTALS

A. In accordance with Section 26 05 00.

B. Product Data: provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type and rated temperature rise.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 DRY TYPE TRANSFORMERS

A. Transformers shall be premium high efficiency quiet type with copper windings, and shall be installed where indicated on the Drawings. The primary winding of the transformers shall have two 2 1/2 percent taps above, and below normal.

B. The transformers shall have a BIL of 10 KV with a temperature class of 185 degrees C for transformers up to 25 KVA, and a temperature class of 220 degrees C for larger transformers.

C. The sound level shall not exceed 44 dBa measured at 5 feet from the transformer after installation. Core and coil assemblies 30 KVA and larger, shall be mounted on rubber vibration isolators, designed to reduce harmonics generated noise.

PART 3 EXECUTION

3.1 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, 2 feet minimum length for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

D. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

E. Mount trapeze-mounted transformers as indicated.

F. Provide grounding and bonding in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.

3.3 ADJUSTING

A. Adjusting installed work.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

- END OF SECTION -

SECTION 26 24 16
BRANCH CIRCUIT PANELBOARD

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Lighting and Appliance Panelboard - Furnish and install lighting and appliance panelboard(s) as specified herein and where shown on the associated schedules drawings.

1.2 REFERENCES

A. The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

1. NEMA PB 1 – Panelboards
2. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
3. NEMA AB 1 - Molded Case Circuit Breakers
4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
5. UL 50 - Enclosures for Electrical Equipment
6. UL 67 – Panelboards
7. UL 98 - Enclosed and Dead-front Switches
8. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures
9. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards
10. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers
11. Federal Specification W-P-115C - Type I Class 1
12. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.
13. NFPA 70 - National Electrical Code (NEC)
14. ASTM - American Society of Testing Materials

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

1.4 QUALIFICATIONS

A. Company specializing in manufacturing of panelboard products with a minimum of fifty (50) years documented experience.

B. Panelboards shall be manufactured in accordance with standards listed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

B. Refer to Sections 26 05 00 and 26 05 05 for additional requirements.

1.7 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

1.8 RELATED WORK

A. Section 26 35 53 – Surge Protection Devices

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General Electric.

B. Type THQB circuit breakers.

2.2 LIGHTING AND APPLIANCE PANELBOARD TYPE

A. Fabrication:

1. Interior
   a. Continuous current ratings, as indicated on Drawings, not to exceed 600 amperes maximum for main breaker panelboards and not to exceed 800 amperes for main lug panelboards.
   b. Minimum Short Circuit Rating: as indicated on the Drawings.
   c. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated copper. Bussing rated for 600 and 800 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
   d. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.

e. A solidly bonded copper equipment ground bar shall be provided.
f. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.
g. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.
h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
i. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 125A interiors shall be vertically mounted. Main circuit breakers over 125A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
j. Interior phase bus shall be pre-drilled to accommodate field installable options. (i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs)
k. Interiors shall accept 125 ampere breakers in group mounted branch construction.

2. Main Circuit Breaker
   a. Shall be bolt-on type circuit breakers.
   b. Main circuit breakers shall have an over center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true RMS sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
   c. Two and three pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
   d. Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
   e. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
   f. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
   g. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.
3. Branch Circuit Breakers
   a. Shall match panel manufacture. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules drawings.
   b. Molded case branch circuit breakers shall have bolt-on type bus connectors.

c. Circuit breakers shall have an over center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
d. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.
e. The exposed faceplates of all branch circuit breakers shall be flush with one another.
f. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.
g. Breakers shall be UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.
h. Breaker shall be UL Listed with the following ratings: (15-125A) Heating, Air Conditioning, and Refrigeration (HACR), (15-30A) High Intensity Discharge (HID), and (15-20A) Switch Duty (SWD)

4. Enclosures
   a. Type 1 Boxes
      1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.
      2) Boxes shall have removable end walls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
      3) Box width shall not exceed 26” wide.
   b. Type 1 Fronts
      1) Front shall meet strength and rigidity requirements per UL 50 standards. Shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
      2) Fronts shall be hinged 1-piece with door. Mounting shall be surface as indicated on associated drawings. All covers shall be hinged cover type.
      3) Panelboards rated 250 amperes and below shall have MONO-FLAT fronts with concealed door hinges and trim screws. Front shall not be removable with the door locked. Panelboards rated above 250 amperes shall have vented fronts with concealed door hinges. Doors on front shall have rounded corners; edges shall be free of burrs.
      4) Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.
   c. Type 4, and 12
      1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
      2) All doors shall be hinged cover type. All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59 inches or more in height. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.
      3) Maximum enclosure dimensions shall not exceed 21” wide and 9.5” deep.

5. Surge Protective Device
   a. Integral Surge Suppressor shall be provided for each branch circuit panelboard. See Section 26 35 53 for requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.3 INSTALLATION OF PANELS

A. Installation: Unless otherwise indicated on the drawings, install wall panels with the top of the trim 6'-0" above the finished floor. Panels located in equipment rooms and wire closets shall be surface mounted. Floor mounted panels shall be provided with a 4" concrete housekeeping pad. Floor mounted panels shall be anchored to floor at all four corners and to wall or structural member at top for seismic restraint.

B. Directories: Mount a typewritten directory behind glass or plastic on the inside of each panel door. On the directory, show the circuit number and complete description of all outlets with specific locations on each circuit. In addition, provide a typewritten label inside door showing source of power to panel to feeder switch, panel designation and location within buildings.

- END OF SECTION -

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SECTION 26 24 17
DISTRIBUTION PANELBOARD

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power Distribution Panelboard - Furnish and install distribution panelboard(s) as specified herein and where shown on the associated schedules and drawings.

1.2 REFERENCES

A. The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

1. NEMA PB 1 – Panelboards
2. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
3. NEMA AB 1 - Molded Case Circuit Breakers
4. UL 50 - Enclosures for Electrical Equipment
5. UL 67 – Panelboards
6. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures
7. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards
8. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers
9. Federal Specification W-P-115C - Type I Class 1
10. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.
11. Federal Specification W-C-865C - Fusible Switches
12. NFPA 70 - National Electrical Code (NEC)
13. ASTM - American Society of Testing Materials

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

1.4 QUALIFICATIONS

A. Company specializing in manufacturing of panelboard products with a minimum of fifty (50) years documented experience.

B. Panelboards shall be manufactured in accordance with standards listed Article 1.2 - REFERENCES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment.

D. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

B. Refer to Sections 26 05 00 and 26 05 05 for additional requirements.

1.7 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Square D Company.

B. Cutler Hammer / Eaton.

C. General Electric.

D. Or Equal.

2.2 POWER DISTRIBUTION PANELBOARDS

A. Circuit Breaker Distribution Panelboard

1. Interior
   a. Shall be rated 600 Vac or 250 Vdc maximum. Continuous main current ratings as indicated on associated schedules and drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
   b. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated drawings not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
   c. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

d. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 100 through 600 amperes shall be plated copper. Bussing rated 800 amperes and above shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel mounting pan by fasteners.
e. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
f. A solidly bonded copper equipment ground bar shall be provided.
g. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. As scheduled, UL Listed panelboards with 200% rated solid neutrals shall have plated copper neutral bus for non-linear load applications. Gutter-mounted neutral will not be acceptable.
h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label, and Short Circuit Current Rating shall be displayed on the interior or in a booklet format. Leveling provisions shall be provided for flush mounted applications.

2. Group mounted circuit breakers through 1200A
   a. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
   b. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
   c. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
   d. Line-side circuit breaker connections are to be jaw type.
   e. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
3. Electronic trip molded case 100% rated circuit breakers.
   a. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
   b. Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule and drawing.
   c. Local visual trip indication for overload, short circuit and ground fault trip occurrences.
   d. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
   e. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.

f. Circuit breaker shall be provided with Zone selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as noted on schedules and drawings.
g. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

4. Electronic trip molded case standard function 80% rated circuit breakers.
   a. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
   b. Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule and drawing.
   c. Local visual trip indication for overload, short circuit and ground fault trip occurrences
   d. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
   e. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
5. Thermal magnetic molded case circuit breakers
   a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
   b. Ampere ratings shall be as shown on the Drawings.
6. Enclosures
   a. Type 1 Boxes
      1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvannealed steel will not be acceptable.
      2) Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.
      3) Maximum enclosure dimensions shall be 44” wide and 9.5” deep.
   b. Type 1 Trim Fronts
      1) Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.
      2) Trim front shall be 4-piece with door available in surface mount. Trim front door shall have rounded corners and edges free of burrs. A clear plastic directory cardholder shall be mounted on the inside of the door.
      3) Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.
   c. Type 4, and 12
      1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
      2) All doors shall be gasketed and be equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners. A clear plastic directory cardholder shall be mounted on the inside of door. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.

3) Maximum enclosure dimensions shall not exceed 44” wide and 14.5” deep.

7. Surge Protection Devices: Provide surge suppression equipment (SPD) for each panelboard and service entrance panelboards. See Section 26 35 53.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

- END OF SECTION -

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SECTION 26 28 13
FUSES

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

B. Fuses.

C. Spare Fuse Cabinet.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 05 19 – Conductors and Cables

1.3 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Bussmann.

B. Other acceptable manufacturers: Gould Shawmut, Little Fuse.

C. All fuses shall be of one manufacturer. Fuses shall have a 200,000 ampere RMS symmetrical interrupting rating unless noted otherwise.

PART 2 PRODUCTS

2.1 FUSE TYPES AND RATINGS

A. Fuses from 0 to 600 ampere for each circuit serving a single motor shall be UL Class RK5 dual-element Low Peak, LPN-RK (250 volt), LPS-RK (600 Volt).

B. All other fuses in the 0 to 600 ampere range shall be UL Class RK5, dual-element, time delay, Iow peak, LPN-RK (250 volt), LPS-RK (600 Volt).

C. Fuses larger than 600 ampere shall be UL Class L with time delay, Hi Cap, KRP-C.

D. High voltage fuses - see drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Motor circuits shall be fused. Fuses, 0 to 600 amperes, for 1.15 service factor motors shall be sized not exceeding 125% of motor full load amperes shown on nameplate. Fuses, 0 to 600 amperes, for all other motors shall be sized not exceeding 115% of motor full load amperes. Fuses above 600 amperes for all motors shall be sized up to 150% of motor full load amperes. Abnormal motor starting conditions requiring over sizing shall be coordinated with motor manufacturer.

B. Spare fuses shall be furnished for all fuse types. Spares shall amount to 10% of installed fuses with a minimum of one set of each fuse type and ampere rating. The set shall equal the number of poles in the appropriate switch.

C. Provide Spare Fuse Cabinet equal to Bussmann for storing spare fuses. Mount on wall in Equipment Room as directed by the ENGINEER.

- END OF SECTION -

SECTION 26 28 19
DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Includes But Not Limited To

1. Furnish and install disconnects as described in Contract Documents, except those provided integral with equipment.

B. Related Sections

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 05 09 - Electrical Identification
3. Section 26 28 13 – Fuses

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, ratings, and specifications.

B. Refer to Section 26 05 00 for submittal requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Manufacturer

1. Same MANUFACTURER as Panels.

B. Disconnect Switches:

1. Heavy duty quick-make, quick-break type, fused, unless indicated otherwise. Provide a control switch for VFD fed motors which will disengage the VFD prior to opening the switch.
2. Provide interlock to prevent opening of door when switch is in ON position.
3. Provide means to lock switch in OFF position with padlock.
4. Disconnects for motor circuits shall be horsepower rated.
5. Where indicated on Drawings for small motors, disconnects shall be manual starter with thermal overload relay.
   a. Device shall have one pole per ungrounded conductor of motor.
   b. Provide overload relay to match motor full load amps.
   c. Equip with lockout device.
6. Enclosures:
   a. Interior Dry locations - NEMA Type 1, or upgraded as indicated or required.
   b. Exterior, Damp, or Wet Locations - NEMA Type 3R, or upgraded as indicated or required.
   c. Hose-down areas – NEMA Type 4, or upgraded as indicated or required.
   d. Corrosive areas – NEMA Type 4X Stainless steel, or as indicated or required.
7. Fuses:

a. Fuse fused disconnects with dual-element time delay fuses and equip with rejection type fuse holders.
b. Fuses on shall be from single manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Label disconnects to indicate equipment served, such as Condensing Unit CU-1. Use 1/16 inch (1.6 mm) thick laminated plastic composition material with contrasting color core. Engraved letter shall be 1/4 (6 mm) inch high. Attach labels with screws.

- END OF SECTION -

SECTION 26 29 23
PULSE WIDTH MODULATED VARIABLE FREQUENCY DRIVE

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required and install, place in operation and field test 6 pulse or 18 pulse variable frequency drive.

B. The adjustable frequency controller shall be a flux vector sine-wave, pulse width modulated (PWM) design. A modulation method which incorporates “gear changing” is not acceptable. The final responsibility of the completed drive system is that of the manufacturer. Qualified system integration will be by manufacturers approved and should use methods and procedures approval in writing by the VFD manufacturer prior to shipping the drive system to customer site. One manufacturer shall provide all drives systems under this contract. The drive systems shall be manufactured within the United State of America to alleviate concerns of future spare part availability and technical support. All drive systems shall be purchased and furnished by the CONTRACTOR.

C. Drives for motors up to and including 60 HP shall be supplied with active front end harmonic mitigation.

1.2 QUALITY ASSURANCE STANDARDS

A. The entire VFD system as described herein shall be assembled and factory tested to assure a properly coordinated system.

B. Codes: Provide equipment is full accordance with the latest applicable rules, regulations, and standards of:

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electrical Code (NEC).
4. Underwriters Laboratories (UL).
5. American National Standards Institute (ANSI).
6. National Electrical Manufactures Association (NEMA).
7. Institute of Electrical and Electronic Engineers (IEEE).

C. The complete drive system shall be UL listed.

D. The manufacturer will have a minimum of 12 years experience in Integrated Bi-polar Transistor technology.

1.3 ACCEPTABLE EQUIPMENT MANUFACTURERS

A. ACCEPTABLE EQUIPMENT MANUFACTURERS FOR 18 PULSE DRIVES

1. Toshiba International Corporation
2. Robicon Corporation.
3. Cutler-Hammer
4. Allen Bradley
5. Danfoss

6. ABB
7. Square D
8. General Electric

B. ACCEPTABLE EQUIPMENT MANUFACTURERS FOR 6 PULSE DRIVES

1. Robicon
2. Benshaw
3. Square D
4. Mitsubishi
5. Allen Bradley
6. Danfoss
7. General Electric
8. ABB
9. Toshiba

1.4 SUBMITTALS

A. Submittals shall conform in all respect to this section.

B. Submittals shall be prepared specifically for this project by the VFD manufacturer. For this specific application submittal package will be due three weeks upon request.

C. Submittal information shall include, but not be limited to:

1. Equipment dimensions, including stub-up locations, shipping split and shipping weights.
2. Approval electrical drawings, termination drawings and component location diagrams.
3. Manufactures equipment specification.
4. Catalog cut sheets of major components.
5. Spare parts list, per Paragraph 3.03.
6. Certifications, including:
   a. Warranty, per section 1.04
   b. Efficiencies, per section 2.02. A.1.
   c. Harmonic distortion analysis study, per section 2.01E.

1.5 WARRANTY

A. All equipment furnished under this section shall be warranted for all parts and labor by the CONTRACTOR and the original equipment manufacturer for a period of not less than one (1) year from the date of startup.

B. The manufacturer shall meet the quality and program requirements of ISO 9001.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Any modification to the standard product required to meet this specification shall be performed by the VFD manufacturer or approved systems integrator only. Distributors and panel manufactures changes to the VFD products are specifically disallowed.

B. The VFD system shall consist of harmonic filter unit, input rectifier-grade phase shifting transformer, converter section, output inverter and control logic. All components shall be wired and tested together as a complete system. The labor and materials for field interconnection of the system are to be provided by the VFD manufacturer. Each drive shall be designed for stand alone operation. Multiple drive units shall not utilize shared components. The drive shall be housed in a free standing, front accessible, general purpose indoor enclosure rated NEMA 12, gasketed, with fans and filters. Cabinets shall be single or multi-bay, sheet steel with hinged doors. Doors will have concealed hinges with lockable through-the-door handle operator mechanism. Provisions shall be made for top or bottom entry/exit of incoming line power cables, outgoing load cables and control wiring. All VFD's shall include DC link reactors.

C. Each VFD shall have a molded case, circuit breaker type main power disconnect switch, with an external operating handle. The circuit breaker and the drive unit shall have a minimum short circuit rating of 42,000 amperes RMS symmetrical interrupting capacity and shall be labeled in accordance with UL Standard 489.

D. The following safety features shall be standard on all drives:

1. Provisions to padlock main disconnect handle in the "OFF" position.
2. Mechanical interlock to prevent opening cabinet door with disconnects in the "ON" position, or moving disconnect to the "ON" position while the unit door is open.
3. Auxiliary contact on main disconnects to isolate control when fed from external source.
4. Barriers and warning signs on terminals that are energized with the power disconnect "OFF".

E. Any VFD over 60 horsepower shall meet all requirements as outlined in the 2014 edition of IEEE 519 for each individual and total harmonic voltage and current distortion and as indicated in this specification. As per Table 10.2 of IEEE 519-2014, individual or simultaneous operation of the VFD's shall not add more than 3% total voltage harmonic distortion while operating at full load and speed from the utility source, or more than 5% while operating from a standby generator (if applicable).

1. The VFD manufacturer cannot predict or be responsible for pre-existing voltage distortion on the line or distribution from sources supplied by others. Maximum input voltage unbalance shall be .5% as defined in NEMA MG1 section 14.35.2.
2. As per Table 10.3 of IEEE 519-2014, maximum allowable total harmonic current demand distortion limits for each VFD operation at full load and speed shall not exceed 5% as calculated and measured at the point of common coupling Isc/II>20).
3. The point of common coupling for all harmonic calculation and field measurement for both voltage and current distortion shall be defined as the main bus feeding each drive.
4. The short circuit current used for harmonic calculations shall be defined as the total full load current with all VFD's operating multiplied by twenty. Example (5) 100 HP VFD's Full load current = 5 x 126 amps = 630 amps. Short circuit current = 20x 630 amps = 12600 amps.
5. If harmonic filters are required to meet these requirements, the VFD manufacturer must provide as a minimum 5th, 7th, and 11th harmonics filters and is responsible for the design and manufacturing of the filters. The vendor must supply cabling and installation for the filters. The filters are to be provided with a separate contactor

such that the VFD can operate in the event of a filter failure. Failure of a filter shall not cause the entire drive system to shutdown.

F. Harmonic compliance shall be verified with onsite field measurement of both the voltage and current harmonic distortion on the main bus of the VFD termination without the VFD in operation. A recording of harmonic analysis displaying individual and total harmonic currents and voltage must be utilized.

G. VFD system shall maintain a 95 minimum true power factor throughout the entire speed range.

H. Displacement power factor shall be .95 percent or higher throughout the entire operating speed range, measured at drive input terminals.

I. For motors over 200hp, the drive shall include an RTD monitoring module which shall monitor 8 – 100 ohm platinum RTD's in the motor. The RTD module shall provide a trip and an alarm contact. The RTD alarm contact shall cause an alarm light to illuminate on the VFD front panel. The RTD Trip contact shall cause the VFD to trip, and send the trip status to the PLC. The alarm and trip contacts shall be settable and adjustable to variable trip and alarm settings.

J. For Motors under 200hp, the drive shall monitor overtemperature using temperature monitoring equipment to cause a trip and alarm.

K. Variable Frequency Drive Ratings:

1. The minimum drive efficiency for NEMA 12 enclosed drive shall be 95.0 percent or better at motor base speed and rated torque. Losses shall include all control power and cooling system losses associated with the drive as well as the input phase shifting transformer.
2. Input Power rating shall be 400-460VAC, plus 10 percent, minus 10 percent, 3 phase, 60 Hz, plus 2, minus 2 Hertz.
3. The voltage ride through of the VFD shall be capable of sustaining continued operation with a 40% dip in normal line voltage. Output speed may decline only if current limit rating of VFD is exceeded.
4. Power loss ride through of the VFD shall be capable of a minimum of 3 cycles loss.
5. The output power shall be HP, 460 Volt, 3 Phase, 60 Hertz, per motor nameplate FLA at installed altitude plus service factor of 25%.
6. The operating ambient Temperature -10 to 40oC (14 to 104oF).
7. The storage temperature shall be -20 to 60oC (4 to 140oF).
8. The relative operating humidity shall be 0 to 95% Non-Condensing.
9. The site operating vibration condition shall be acceleration at 0.6 G maximum (10-55 Hz). Amplitude at 0.1mm maximum (50-100 Hz).
10. Drives shall be sized/de-rated to operate at full load at an elevation of 4700 ft.
11. Power unit rating bases shall be 100% rated current continuous and 120% for one minute at rated temperature.

2.2 CONSTRUCTION

A. The controller shall produce an adjustable AC voltage / frequency output. It shall have an output voltage regulation to maintain correct output V/Hz ratio despite incoming voltage variations.

B. The controller shall have a continuous output current rating of 100% of the motor nameplate rating as a minimum.

C. The converter section will incorporate three distinct diode bridges configured in a series connection. The series connection will provide continued balance of the bridges to insure the harmonic litigation remains consistent throughout the life of the drive. The input to the diode bridges will be a full phase shifting isolation transformer with multiple secondaries. The variable frequency drive system shall also include a filter network and a transistorized inverter section. The drive manufacturer will also manufacture the Transistors used in the inverter section of the drive to reduce harmonics to flow back to the incoming power source.

D. The inverter output shall be generated by to be Insulated Gate Bipolar Transistors (IGBT's) with a PIV rating of 1200 volts minimum. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor lines current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for a pure sin wave operation.

E. The controller (s) shall be suitable for operating standard NEMA Design-B induction squirrel-cage motor having a 1.15 service factor. The drive can be located up to 300 feet from the motor without requiring special cabling or a separate motor protection devices. Motor nameplate information shall be provided by the CONTRACTOR, prior to contract award to the VFD manufacture to properly size the inverter. In the future, is shall be possible to substitute any standard inverter rate motor (equivalent house power, voltage and RPM) in the field. Output filters shall be installed for motors over 300 foot from VFD.

F. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors. A power failure will not necessitate a reload of any drive parameter or configuration.

2.3 BASIC FEATURES

A. The door of each adjustable speed drive system shall include an operator interface station (OIT/HMI) and key pad with a manual speed device. Each drive shall have operator interface devices at a minimum as called out in the drawings.

B. For safety the drive will require manual restart for customer programmable faults. The fault displays shall include over current, over voltage, heat sink overheat, load side short circuit, load-side ground fault, inverter overload, stator over-current during start-up, load-side over current during start-up, EEPROM error, RAM error, ROM error, communication error, (Dynamic braking resistor over current), Under voltage, low current, over torque, lose of phase, and motor overload.

C. The door mounted operator interface shall be capable of controlling the VFD and setting the drive parameters. The key pad shall have the following programming features:

1. The digital display must present all diagnostic messages and parameters values in English engineering units when accessed.
2. The digital interface keypad shall allow the operator to enter exact numerical settings in engineering units. A plain English user menu (rather than codes) shall be provided in software in nonvolatile memory as a guide to parameter setting and reset table in

the field through the key pad. The drive set up parameters must be able to be transferred to new boards to reprogram spare boards.

3. The VFD shall have the capabilities of communicating via network to the PLC. All status shall be communication to the PLC including 3 phase voltage, 3 phase current, speed, status alarms, errors, etc.
4. Programmable output relay contacts and inputs shall be rated for 250 VAC, 2 Amps. A separate 24 VDC power supply (50 mA) shall be available to control exterior control devices. Programmable analog output signals shall be available to meet system requirements. Programmable analog input speed signals shall be available to accept a speed command.
5. The principle output frequency shall be programmable from 0-400 Hz and acceleration / deceleration from .1 to 6000 seconds. The PWM carrier frequency shall be adjustable from .5 to 15 kHz and shall be self adjusting.
6. The VFD shall have internal to the drive a proportional gain; integral gain anti-hunting gain, lag time constant and PID error limit adjustments. This shall be programmable through the key pad.

2.4 ENCLOSURE

A. All VFD components shall be factory mounted and wired on a dead front, grounded indoor NEMA Type 12, gasketed enclosure. It shall be suitable for mounting on a concrete house keeping pad. The steel enclosure shall have a minimum of two-layer of primer and one-layer of industrial finished Sherwin Williams Precision enamel paint or equal.

B. A forced air cooling system will automatically start and stop as necessary to extend the life of the fan.

C. VFD systems shall be stand alone system with an integral through the door mounted disconnect switch operator.

D. The dimensions of the VFD enclosure shall be maximum 36” wide, 24” + 8” depth, 90” height.

2.5 PROTECTIVE FEATURES AND CIRCUITS

A. The VFD shall have the following additional protective features that will protect against damage to the motor, load conductor, contactors or solid state soft starts and the VFD internal devices and electronics.

B. Three phase short circuit on the VFD output terminals.

C. Losses of input power due to opening VFD input disconnect device or loss of utility power during VFD operation.

D. A loss of one (1) phase of the input power shall cause the drive to trip off protecting the drive systems electronics.

E. The VFD will run without connection to the motor load.

F. The VFD shall sense an output short circuit that may occur during operation.

G. The key pad display shall provide a minimum of the last 50 system faults.

H. There shall be stall protection on an overload condition with inverse time overcurrent trip. Current limits shall be adjustable from 10 to 215% of the drive current.

2.6 PARAMETER SETTINGS

A. The following system configuring setting shall be provided and field adjustable, without exception, through the keypad/display unit. Except for motor nameplate data, all parameters must be adjustable while the processor is on-line and the drive is running.

1. Motor Nameplate Data.
2. Motor Full Load Amps.
3. Motor Frequency.
4. Number of poles.
5. Full Load RPM's.
6. Motor Voltage.
7. Operating current limits. – Min/Max.
8. VFD Configuration Parameters.
9. Independent accel/decel rates.
10. Min./Max. speed (Frequency
11. Forward or Reverse operation.
12. Catch a spinning load selection.
13. Preset Speed capabilities.
14. Volts per Hertz ratio.
15. No load / Full Load boost.
16. Over current trip selection.
17. Frequency jump selection.
18. Programmable meter output signals (Hz. Speed, RPM, Voltage, Torque, PID feed back, input/output power, and DC bus voltage.

B. Automatic Control

1. 4-20 mA input control signal.
2. PID internal or external set point capabilities.
3. Programmable preset speed operational run conditions.
4. Automatic load reduction during overload condition or soft stall.
5. Programmable loss of signal control: Stop, maintain speed or default to preset speed or set point.

C. All drive setting adjustable and operation parameters shall be restored in a parameter log which allows minimum and maximum points as well as the present set values. This parameter log shall be accessible via a RS-232 or RS485 serial port or other communications method as well as on the keypad or internal to the drive.

D. The drive shall have the following inputs/output features that will provide control and monitoring of the VFD. The analog outputs shall be isolated as required by this specification.

1. Three programmable analog outputs.

2. Two programmable analog inputs. The 4-20mA analog input speed reference signal will be galvanically isolated. Calibration adjustments shall be provided by the keypad.
3. 4-groups of 8 pattern runs or 32 pattern runs shall be available.
4. Three programmable digital output (form C, dry contact relays)
5. One potential pot input (three wire control) +10 V, wiper and common, if specified in drawing.
6. System control program providing built–in drive control or application specific configuration capabilities.
7. Input / output function shall match those indicated in the drawings.
8. Minimum / maximum dry contact output.

2.7 DIAGNOSTIC FEATURES AND FAULT HANDLING

A. The VFD shall include a comprehensive microprocessor based digital diagnostic system that monitors its own control functions and displays faults and operating conditions.

B. A “Fault Log” shall be accessible through the keypad digital illustrations in English. The display shall be capable of illustrating 50 past faults. Optional output shall be through the serial port link. All drive possible fault conditions will be accessible through the fault log.

2.8 DRIVE OPTIONS

A. For drives located more then 300 feet from motor, the drive shall be modified to include a factory or SI wired output line reactor.

B. Information included elsewhere:

1. Drive feed location – See Drawings.
2. Drive overall dimensions allowed – See Drawings.
3. Additional control information – See Drawings.

PART 3 EXECUTION

3.1 FACTORY TESTING

A. The drives will be completely assembled, wired, and tested in the United States of America. The following tests will be performed:

1. The manufacturer shall use the ISO-9001 standards in the purchase, engineering, manufacturing and testing of the VFD system.
2. Upon completion of manufacture and assembly, the drives shall be subjected to a complete factory test to demonstrate compliance with specified features and characteristics of the specification. The purchaser at his option shall be able to witness factory testing of his unit, with factory coordination.
3. The testing procedure shall be the manufacturer’s standard procedure (except for loss of phase) to assure maintenance free service. The buyer shall be given a 5 day notice prior to the start of factory testing for the buyer's representative to witness the testing.
4. All equipment, devices, instrumentation, and personnel required to perform the factory tests shall be supplied by the manufacturer. Upon satisfactory completion of the test, the seller shall upon request submit two (2) certified copies of the test report

to the buyer. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

5. A loss of each phase testing shall be conducted at the factory to guaranty the safe and orderly shutdown of the drive under load. These tests shall conclude that the drive will not fail its electronic circuits or causes sever over heating of the bridges. These tests shall not limit the life of the drive system. There are no exceptions to this test. This test shall be performed and test reports provided to the ENGINEER prior to installation of the drive system package.

3.2 STARTUP AND FIELD TESTING

A. The VFD manufacturer shall provide the services of a factory trained technician for startup assistance, programming and testing. Verification of the VFD input harmonics voltage and current distortion limits specified must be verified as part of the start-up and acceptance. If harmonics distortion requirements are not met, it is the responsibility of the VFD supplier to meet these specifications at the manufacturer's expense. Meg-ohm testing will be done to the load conductors and motor to verify condition of the equipment prior to startup. The VFD manufactures shall certify the VFD and motor system as compatible. UL508 technicians shall not be allowed to perform startup procedures.

B. A 10% payment retention will be released upon factory field test verification of harmonic specifications requirements and final test report and acceptance.

C. Spare Parts

1. The following spare parts shall be furnished. The net price per item shall be provided with the request for proposal. Each spare part shall be package and identified by part number and type for long term customer storage.
   a. Three of each type of fuse rated 480 Volts or less.
   b. Two of each type of converter power semi-conductor.
   c. Two of each type of inverter power semi-conductor.
   d. One of each type of control board, gate firing board and communication board.
   e. One key pad assembly.
   f. OR Replacement VFD for items b. through e.
   g. Five of each type of panel lamp.
   h. Three of each size MOV's.

- END OF SECTION -

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SECTION 26 35 53
SURGE PROTECTION DEVICES

PART 1 GENERAL

1.1 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers. Refer to related sections for surge requirements in:

1.2 RELATED SECTIONS

A. Section 262418 – Switchboards – Low Voltage

B. Section 262417 – Distribution Panelboards – Low Voltage

C. Section 262416 – Branch Circuit Panelboards - Low Voltage (Commercial Metering)

1.3 REFERENCES

A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards

1. ANSI/UL 1449 4th Edition or later
2. ANSI/UL 1283 5th Edition or later (type 2 applications)
3. IEEE C62.41.1
4. IEEE C62.41.2
5. IEEE C62.43-2005
6. EEEE C62.45-2002
7. IEEE C62.48-2005
8. IEEE C62.62-2010
9. UL 96A
10. NFPA 780

1.4 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

1. Provide verification that the SPD complies with the required ANSI/UL 1449 4th Edition or later listing by Underwriters Laboratories (UL). Compliance may be in the form of a file number that can be verified on UL's website www.ul.org, the website should contain the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In).

B. Where applicable the following additional information shall be submitted to the engineer:

1. Descriptive bulletins

2. Product sheets

1.5 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Section 1.04 and shall incorporate all changes made during the manufacturing process

1.6 QUALIFICATIONS

A. The manufacturer of the electrical distribution equipment shall be the manufacturer of the SPD within the electrical distribution equipment.

B. For the equipment specified herein, the manufacturer shall be ISO 14001 and ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of twenty-five (25) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU and have a visible label showing compliance.

E. The SPD shall be UL 1449 current edition listed, 20 kA nominal discharge current, Type 1 or Type 2 for use in UL 96A systems.

1.7 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Shall match the manufacture of the equipment protected.

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.2 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards. End of life mode to be open circuit. Unit with end of life short-circuit mode are not acceptable.
4. Unit shall operate without the need for an external overcurrent protection device, and be listed by UL as such. Unit must not require external overcurrent protective device or replaceable internal overcurrent protective devices for the UL Listing.
5. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

6. Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
7. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable single-mode modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

3. Electrical Noise Filter – Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
   a. Type 2 units with filtering shall conform to UL 1283 5th Edition
   b. Type 1 units shall not contain filtering or have a UL 1283 5th Edition Listing.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
   a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
      1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
      2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes
      3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
   b. Remote Status Monitor (optional) – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
   c. Audible Alarm and Silence Button (optional) – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
   d. Surge Counter (optional) – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
      1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Thermal MOV Protection
   a. The unit shall contain thermally protected MOVs. These self-protected MOVs shall have a thermal protection element integrated with the MOV and a mechanical disconnect with arc quenching capabilities in order to achieve overcurrent protection of the MOV. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. The use of plug in single-mode modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.
8. Safety Requirements
   a. The SPD shall minimize potential arc flash hazards by containing no single-mode plug in user serviceable / replaceable parts and shall not require periodic maintenance. SPDs containing items such as replaceable single-mode plug in modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
   b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.3 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

2.4 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD shall be integral to the panelboard and connected directly to the bus. Alternately, an integral SPD can be connected to a circuit breaker for disconnecting purposes if a disconnect is required.
5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
6. The SPD shall be of the same manufacturer as the panelboard.
7. The complete panelboard including the SPD shall be UL67 listed.

2.5 SWITCHGEAR, SWITCHBOARD, MCC AND BUSWAY REQUIREMENTS

A. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.

B. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, or busway

C. The SPD shall be factory installed integral to the switchgear, switchboard, MCC, and/or bus plug at the assembly plant by the original equipment manufacturer

D. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

E. The SPD shall be connected through a disconnect (30A circuit breaker or as recommended by the manufacturer). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

F. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.

G. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.6 SERVICE ENTRANCE REQUIREMENTS

A. Service entrance located SPDs shall be tested and designed for applications within ANSI/IEEE C62.41 Category C environments.

PART 3 EXECUTION

3.1 EXAMINATION (Not Used)

3.2 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA, IEEE, and UL standards.

3.3 INSTALLATION

A. The installation of the SPD shall be factory installed integral to the distribution equipment. The Contractor shall install all distribution equipment per the manufacturer's recommendations, applicable electrical codes and the contract drawings.

3.4 WARRANTY

A. The manufacturer shall provide a ten (10) year warranty (15 year warranty with registration) that covers replacement of the complete unit from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local electrical code.

- END OF SECTION -

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SECTION 26 41 00
LIGHTNING PROTECTION SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Air terminals and interconnecting conductors.
2. Grounding and bonding for lightning protection.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

1. Section 26 05 00 - Electrical General Requirements.
2. Section 26 05 19 - Conductors and Cables.

1.3 REFERENCES

A. LPI-175 - Lightning Protection Installation Standard.

B. LPI-176 - Lightning Protection System Material and Components Standard.

C. LPI-177 - Inspection Guide for LPI Certified Systems.

D. NFPA 78 - Lightning Protection Code.

E. UL 96 - Lightning Protection Components.

F. UL 96A - Installation Requirements for Lightning Protection Systems.

1.4 SYSTEM DESCRIPTION

A. Lightning Protection System: Conductor system protecting consisting of air terminals on roofs, roof-mounted mechanical equipment, chimneys and stacks, parapets, bonding of structure and other metal objects; grounding electrodes; and interconnecting conductors.

1.5 SUBMITTALS FOR REVIEW

A. Section 26 05 00 – Electrical General Requirements: Procedures for submittals.

B. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

C. Product Data: Provide dimensions and materials of each component, and include indication of listing in accordance with UL 96.

1.6 PROJECT CLOSEOUT SUBMITTALS

A. Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 70.

B. Perform Work in accordance with UL 96A

C. Perform Work in accordance with LPI-175

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum three years experience and member of the Lightning Protection Institute.

B. Installer: Authorized installer of manufacturer with minimum three years experience and certified by the Lightning Protection Institute.

1.9 REGULATORY REQUIREMENTS

A. Product Listing: UL 96 and LPI-176.

B. System shall be UL listed and certified.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.11 COORDINATION

A. Coordinate work with roofing and exterior and interior finish installations.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND INSTALLERS

A. VFC Corporation. North Salt Lake, Utah.

B. Robbins Lightning, Inc.

2.2 COMPONENTS

A. Air Terminals: Copper solid with adhesive bases for single-ply roof installations.

B. Air Terminal for Chimney: Lead-coated copper.

C. Grounding Rods: Solid copper

D. Ground Plate: Copper.

E. Conductors: Copper cable

F. Connectors and Splices: Bronze

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 78, UL 96A and LPI-175.

B. Connect conductors using exothermic welding process. Protect adjacent construction elements and finishes from damage. All welds shall be witnessed by the OWNER.

C. Bond exterior metal bodies on building to lightning protection system and provide intermediate level interconnection loops 60 feet (18 m) on center.

3.2 FIELD QUALITY CONTROL

A. Obtain the services of Underwriters Laboratories, Inc. to provide inspection and labeling of the lightning protection system in accordance with UL 96A.

B. Obtain the services of the Lightning Protection Institute to provide inspection and certification of lightning protection system in accordance with LPI-177.

- END OF SECTION -

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SECTION 26 51 13
INTERIOR LUMINAIRES

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Interior luminaires and accessories.
2. Emergency lighting units.
3. Exit signs.
4. Ballasts.
5. Fluorescent lamp emergency power supply.
6. Lamps.
7. Luminaire accessories.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

B. Section 260500- Electrical General Requirements.

1.3 1REFERENCES

A. ANSI C78.379 - Electric Lamps - Incandescent and Issued October 1993 High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

B. ANSI C82.1 - Ballasts for Fluorescent Lamps -Specifications.

C. ANSI C82.4 - Ballasts for High-Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).

D. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

E. NFPA 70 - National Electrical Code.

F. NFPA 101 - Life Safety Code.

1.4 SUBMITTALS FOR REVIEW

A. Section 260500 - Electrical General Requirements

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.5 SUBMITTALS FOR CLOSEOUT

A. Section 260500 - Electrical General Requirements

B. Submit manufacturer's operation and maintenance instructions for each product.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.8 EXTRA PRODUCTS

A. Section 260500 - Contract Closeout.

B. Furnish 10% or a minimum of two of each lens type.

C. Furnish one case of replacement fluorescent lamps for each lamp type. Furnish two replacement lamps for each size HID lamp type and LED assembly.

D. Furnish 10% or a minimum of two of each ballast type or driver type.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Furnish Products as scheduled. Refer to Section 260500 for substitutions and product options.

B. Lighting Fixtures: Shall be as shown in the Lighting Fixture Schedule on the Drawings.

2.2 LAMPS

A. LAMPS: shall be provided for all lighting fixtures in accordance with the lighting fixtures schedule on the drawings. Unless noted otherwise fluorescent lamps shall be 3000□K "energy saving type". All lamps shall be new at time of final inspection and shall be manufactured by one of the following:

1. CHLORINE BUILDING
    a. Lithonia
    b. General Electric
    c. Venture Lighting International
    d. Phillips
    e. Osram-Sylvania

f. Other Approved Equal

2. HIGHLANDS PUMP BUILDING
   a. Lighting fixtures shall match make and model of existing Grapevine pump building immediately North-East of the Highlands Pump Building.

B. Lamp Types: As specified for luminaire. Refer to Section 260500 for substitutions and product options.

2.3 FLUORESCENT BALLASTS

A. Fluorescent Ballasts: All ballasts shall be electronic type as scheduled on the drawings and shall comply with the following:

1. Fluorescent electronic ballasts: Shall comply with FCC rules and regulations part 18 concerning the generation of both EMI (electromagnetic interference) and RFI (radio frequency interference). Shall be Class "A" sound rated and UL class "P" thermally protected and shall be tested per ETL format. The ballast shall withstand input power line transients as defined in ANSI C62.41. The ballast shall tolerate a line voltage variation of +/-10%, shall have a power factor of 95% or higher and the lamp crest factor shall measure 1.7 or less for rapid start ballasts and 1.85 or less for instant start ballasts. The total harmonic distortion of the input current to the electronic ballast shall not exceed 10% of the input current. The ballast shall operate at 20Khz or higher and shall operate standard lamps at 50 degrees F and energy saving lamps at 60 degrees F. Ballast case temperature shall not exceed 25 degrees C rise above a 40 degrees C ambient temperature. The ballast shall be provided with an internal fuse to protect the electrical power supply from internal component failure. The ballast shall also be short-circuit protected in the event of mis-wiring. The electronic ballast shall be warranted against defects in material and workmanship for three years. The warranty shall include either a $15 replacement labor allowance or complete replacement including labor by an agent of the manufacturer.
2. Emergency Ballasts to provide emergency lighting when power fails to fixture, Bodine ballasts shall be provided for fixtures as scheduled and located on drawings. Ballasts shall light all designated fixture lamps at 5-% of nominal light output.
3. Dual Technology Ceiling Mounted Occupancy Sensors: Install a dual technology occupancy sensor # Omni-DT1000 with MP-120A or MP-277A power pack as manufactured by Mytech or equal of Wattstopper or Novitas as shown on the drawings. Configuration shall be as detailed on drawings. The sensor shall comply with the following specifications:
   a. Dual-element puroelectric sensor, with single-pole, double throw isolated relay.
   b. ASIC for reliability, immunity to RFI & EMI.
   c. Adjustable digital time-delay 15 seconds to 30 minutes.
   d. Shall be compatible of installing up to 3 units per power pack.
   e. UL listed with 5 year warranty.
   f. The power supply shall comply with the following specifications:
   g. Self contained transformer and relay with 24 VDC secondary voltage at an output of 100mA.
   h. Shall be capable of switching 20 amps of electrical load.
   i. Shall be UL listed with 5 year Warranty. Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.4 LED LUMINAIRE WARRANTY

A. Provide a written 5-year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

1. Include finish warranty to include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
2. Material warranty must include:
   a. All drivers.
   b. Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

B. Warranty period must begin on date of beneficial occupancy. Provide the Contracting Officer with signed warranty certificates prior to final payment.

2.5 PROVIDE LUMINAIRE USEFUL LIFE CERTIFICATE

A. Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration.

2.6 LUMINAIRES

A. UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.

2.7 LED LUMINAIRES

A. Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires.

B. LED luminaires must meet the minimum requirements in the following table:

LUMINAIRE TYPE	MINIMUM LUMINAIRE EFFICACY (LE)	MINIMUM COLOR RENDERING INDEX (CRI)
LED TROFFER – 1 x 4300 x 1200 2 x 2600 x 600 2 x 4600 x 1200	90 LPW	80
LED Downlight	50 LPW	90
LED Track or Accent	40 LPW	80
LED Low Bay/High Bay	80 LPW	70
LED Linear Ambient	80 LPW	80

C. LED luminaires must also meet the following minimum requirements:

1. Luminaires must have a minimum 5-year manufacturer's warranty.
2. Luminaires must have a minimum L70 lumen maintenance value of 50,000 hours as calculated by IES TM-21, with data obtained per IES LM-80 requirements.
3. Luminaire drive current value must be identical to that provided by test data for luminaire in question.
4. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.

2.8 FLUORESCENT LUMINAIRES

A. UL 1598. Provide linear and compact fluorescent luminaires complete with housing, ballast and light source. All fluorescent luminaires must be equipped with electronic ballasts.

2.9 DRIVERS, BALLASTS AND GENERATORS (Not Used)

2.10 LED DRIVERS

A. NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:

1. Output power (watts)and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.
2. Factor (PF) greater than or equal to 0.9 over the full dimming range when provided. Current draw Total Harmonic Distortion (THD) of less than 20 percent.
3. Class A sound rating.
4. Operable at input voltage of 120-277 volts at 60 hertz.
5. Minimum 5-year manufacturer's warranty.
6. RoHS compliant.
7. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.
8. UL listed for dry or damp locations typical of interior installations.
9. Non-dimmable, or fully-dimmable to 1% using 0-10V, or 3 wire, control as indicated in luminaire schedule and on drawings.

2.11 LIGHT SOURCES

A. NEMA ANSLG C78.377, NEMA SSL 3. Provide type and wattage as indicated in luminaire schedule on project plans.

1. LED Light Sources
   a. Correlated Color Temperature (CCT) of 3000 or 4000 degrees K as indicated.
   b. Minimum Color Rendering Index (CRI) R9 value of 80.
   c. High power, white light output utilizing phosphor conversion (PC) process or mixed system of colored LEDs, typically red, green and blue (RGB).
   d. RoHS compliant.
   e. Provide light source color consistency by utilizing a binning tolerance within a 3 step McAdam ellipse.

2.12 CONTROLS

A. Outdoor Motion Detection sensors

1. Exterior lighting shall be controlled via motion detection sensors that operate from dusk to dawn.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

B. Support luminaires independent of ceiling grid, if layin type ceilings or concealed spline ceilings ore used.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

3.2 INSTALLATION OF LIGHTING FIXTURES

A. Install all lighting fixtures complete and ready for service, in accordance with the Fixture Schedule on the Drawings:

B. Wire all fixtures with fixture wiring of at least 150 degree C rating. Conductors in wiring channels of fixtures mounted in rows shall be the same size as the circuit wiring supplying the rows.

C. Install all fluorescent fixtures straight and true with reference to adjacent walls.

D. Install all lighting fixtures, including those mounted in continuous rows, so that the weight of the fixture is supported either directly or indirectly by a sound and safe structural member of the building, using adequate number and type of fasteners to ensure a safe installation. Screwed fastenings and toggles through ceiling or wall material are not acceptable. Provide suitable connectors or collars to connect adjoining fixtures in continuous rows.

E. Do not support fixtures from roof deck. Provide unistrut channels spanning space between roof joists to support fixtures and outlets.

F. Fixtures mounted in lay-in grid ceilings shall have safety support wires to structural roof members as detailed for seismic restraint.

G. All single outlets shall be properly centered in each room. Where two or more outlets occur, they shall be spaced uniformly and in straight lines with each other.

H. Provide plaster frames and support channels around ceiling openings for recessed fixtures. Securely fasten to ceiling structural members.

I. Terminate circuits for recessed fixtures in an extension outlet box adjacent to ceiling opening and connect to fixtures with flexible steel conduit.

J. Where lighting fixtures and other electrical items are shown in conflict with locations and structural members and mechanical or other equipment, provide all required supports and wiring to clear the encroachment.

3.3 ADJUSTING

A. Section 260500 Contract Closeout

3.4 CLEANING

A. Section 260500 - Contract Closeout: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 DEMONSTRATION AND INSTRUCTIONS

A. Section 260500 - Contract Closeout - Starting of Systems: Demonstrating installed work.

B. Demonstrate luminaire operation for 12 hours.

3.6 PROTECTION OF FINISHED WORK

A. Re-lamp or repair/replace luminaires that have failed at substantial completion.

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SECTION 26 56 00
AREA LIGHTING

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Exterior area, façade and landscape lighting.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

B. Section 260500- Electrical General Requirements.

1.3 SUBMITTALS FOR REVIEW

A. Section 260500 - Electrical General Requirements

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.4 1SUBMITTALS FOR CLOSEOUT

A. Section 260500 - Electrical General Requirements

B. Submit manufacturer's operation and maintenance instructions for each product.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.7 EXTRA PRODUCTS

A. Section 260500 - Contract Closeout.

B. Furnish 10% or a minimum of two of each lens type.

C. Furnish one case of replacement fluorescent lamps for each lamp type. Furnish replacement lamps for each size LED assembly.

D. Furnish 10% or a minimum of two of each ballast type or driver type.

1.8 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B108/B108M	(2015) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1089	(2013) Standard Specification for Spun Cast Prestressed Concrete Poles
ASTM G154	(2016) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(2008; Effective Jan 2010) California's Energy Efficiency Standards for Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10	(2011; Errata 2015) IES Lighting Handbook
IES LM-79	(2008) Electrical and Photometric Measurements of Solid-State Lighting Products
IES LM-80	(2015) Measuring Lumen Maintenance of LED Light Sources
IES RP-16	(2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering
IES RP-8	(2014) Roadway Lighting
IES TM-15	(2011) Luminaire Classification System for Outdoor Luminaires
IES TM-21	(2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.41	(2006) For Electric Lamps--Guidelines for Low-Pressure Sodium Lamps
ANSI ANSLG C78.42	(2009; R 2016) For Electric Lamps: High-Pressure Sodium Lamps
ANSI C136.13	(2004; R 2009) American National Standard for Roadway Lighting Equipment, Metal Brackets for Wood Poles
ANSI C136.21	(2014) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
ANSI C136.3	(2014) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments

ANSI C78.1381	(1998) American National Standard for Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
ANSI/ANSLG C78.43	(2013) American National Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
ANSI/NEMA C78.LL 1256	(2003; R 2015) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP)
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2015) American National Standard for Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA ANSLG C78.380	(2007) Electric Lamps - High Intensity Discharge Lamps, Method of Designation
NEMA ANSLG C78.44	(2008) For Electric Lamps - Double-Ended Metal Halide Lamps
NEMA ANSLG C82.11	(2011) Lamp Ballasts - High-Frequency Fluorescent Lamp Ballasts
NEMA ANSLG C82.14	(2006) Lamp Ballasts Low-Frequency Square Wave Electronic Ballasts -- for Metal Halide Lamps
NEMA C136.10	(2010) American National Standard for Roadway and Area Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles--Physical and Electrical Interchangeability and Testing
NEMA C136.20	(2012) American National Standard for Roadway and Area Lighting Equipment - Fiber Reinforced Composite (FRC) Lighting Poles
NEMA C136.31	(2010) American National for Roadway and Area

	Lighting Equipment - Luminaire Vibration
NEMA C78.LL 3	(2003; R 2015) Electric Lamps - Procedures for High Intensity Discharge Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure
NEMA C82.77	(2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Industrial Control and Enclosure Systems
NEMA IEC 60529	(2004) Degrees of Protection Provided by Enclosures (IP Code)
NEMA WD 7	(2011; R 2016) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint Dec 2013) High-Intensity-Discharge Lamp Ballasts
UL 1310	(2011; Reprint Dec 2014) UL Standard for Safety Class 2 Power Units
UL 1598	(2008; Reprint Oct 2012) Luminaires
UL 773	(1995; Reprint Jul 2015) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2016) Standard for Nonindustrial Photoelectric Switches for Lighting Control
UL 8750	(2015; Reprint Nov 2016) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products
UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment

UL 935 (2001; Reprint Aug 2014) Standard for Fluorescent-Lamp Ballasts

1.9 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 LED LUMINAIRE WARRANTY

A. Provide Luminaire Useful Life Certificate.

B. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1. Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.
   a. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
   b. Material warranty shall include:
      1) All power supply units (drivers).
      2) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

C. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the Contracting Officer signed warranty certificates prior to final payment.

1.11 ELECTRONIC BALLAST WARRANTY

A. Furnish the electronic ballasts manufacturer's warranty. The warranty period shall not be less than five (5) years from the date of manufacture. Ballast assembly in the lighting fixture, transportation, and on-site storage shall not exceed twelve (12) months, thereby permitting four (4) years of the five (5) year warranty to be in service and energized. The warranty shall state that the malfunctioning ballast shall be exchanged by the manufacturer and promptly shipped to the using Government facility.

B. The replacement ballast shall be identical to, or an improvement upon, the original design of the malfunctioning ballast.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Furnish Products as scheduled. Refer to Section 260500 for substitutions and product options.

B. Lighting Fixtures: Shall be as shown in the Lighting Fixture Schedule on the Drawings.

2.2 GENERAL REQUIREMENTS

A. Housings for luminaires shall be die cast, extruded, or fabricated aluminum. Fabricated aluminum housings shall have all seams and corners internally welded to resist weathering, moisture and dust.

B. Luminaires shall be rated for operation within an ambient temperature range of minus 22 degrees F to 104 degrees F.

C. Luminaires shall be UL listed for wet locations per UL 1598. Optical compartment for LED luminaires shall be sealed and rated a minimum of IP65 per NEMA IEC 60529.

D. LED luminaires shall produce a minimum efficacy as shown in the following table, tested per IES LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

Application	Luminaire Efficacy in Lumens per Watt
Exterior Pole/Arm-Mounted Area and Roadway Luminaires	65
Exterior Pole/Arm-Mounted Decorative Luminaires	65
Exterior Wall-Mounted Area Luminaires	60
Bollards	35
Parking Garage Luminaires	70

E. Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans per IES HB-10.

F. Housing finish shall be baked-on enamel, anodized, or baked-on powder coat paint. Finish shall be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

G. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

H. The finish color shall be as indicated in the luminaire schedule or detail on the project plans.

I. Luminaire arm bolts shall be 304 stainless steel or zinc-plated steel.

J. Lenses shall be constructed of clear or frosted tempered glass polycarbonate vandal-resistant lenses as indicated.

K. The wiring compartment on pole-mounted, street and area luminaires must be accessible without the use of hand tools to manipulate small screws, bolts, or hardware.

L. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, ballasts,

surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

M. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

2.3 LUMINAIRE LIGHT SOURCES (Not Used)

2.4 LED LIGHT SOURCES

A. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:

1. Nominal CCT: 4000 degrees K: 3985 plus or minus 275 degrees K

B. Color Rendering Index (CRI) shall be:

1. Greater than or equal to 70 for 4000 degrees K light sources.

C. Color Consistency:

1. Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

2.5 LUMINAIRE DRIVERS

A. LED POWER SUPPLY UNITS (DRIVERS)

B. UL 1310. LED Power Supply Units (Drivers) shall meet the following requirements:

1. Minimum efficiency shall be 85 percent.
2. Drive current to each individual LED shall not exceed 600 mA, plus or minus 10 percent.
3. Shall be rated to operate between ambient temperatures of minus minus 22 degrees F and 104 degrees F.
4. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.
5. Operating frequency shall be: 50 or 60 Hz.
6. Power Factor (PF) shall be greater than or equal to 0.90.
7. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.
8. Shall meet requirements of 47 CFR 15, Class B.
9. Shall be RoHS-compliant.
10. Shall be mounted integral to luminaire. Remote mounting of power supply is not allowed.
11. Power supplies in luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.
12. Shall be dimmable, and compatible with a standard dimming control circuit of 0 - 10V or other approved dimming system.
13. Shall be equipped with over-temperature protection circuit that turns light source off until normal operating temperature is achieved.

2.6 LED LUMINAIRE SURGE PROTECTION

A. Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install luminaires as detailed on the drawings or to poles as directed.

3.2 INSTALLATION OF LIGHTING FIXTURES

A. Install all lighting fixtures complete and ready for service, in accordance with the Fixture Schedule on the Drawings:

B. Wire all fixtures with fixture wiring of at least 150 degree C rating.

C. Install all fixtures straight and true with site equipment, sidewalks, etc.

3.3 ADJUSTING

A. Section 260500 Contract Closeout

3.4 CLEANING

A. Section 260500 - Contract Closeout: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 DEMONSTRATION AND INSTRUCTIONS

A. Section 260500 - Contract Closeout - Starting of Systems: Demonstrating installed work.

B. Demonstrate luminaire operation for 12 hours.

3.6 PROTECTION OF FINISHED WORK

A. Re-lamp or repair luminaires that have failed at substantial completion.

3.7 FIELD APPLIED PAINTING

A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.8 FIELD QUALITY CONTROL

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test after 100 hours of burn-in time to show that the equipment operates in accordance with the requirements of this section.

- END OF SECTION -

SECTION 26 80 10
HVAC SYSTEMS CONTROL

PART 1 GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Electrical work associated with the systems including, but not necessarily limited to:
   a. All electrical installation including power distribution and special systems, is included in the scope of the general contract. Of specific concern are the control systems related to mechanical equipment. Responsibility for the control work is divided between the project electrician (Division 26) and his controls sub-contractor. HVAC related I/O and Control as indicated in drawings.
   b. All electrical work shall be in accordance with Division 26.
   c. Division 26 shall provide all power to and throughout the building, to include motor control centers, breaker panels, and all other systems designated to Division 26, and specified herein. Division 26 shall install all conduit systems.
   d. Division 26 shall run and connect all wiring and devices which power or control motors and other mechanical or control devices. Where control devices are located in power circuit, the controls contractor shall interrupt the circuit in the mechanical equipment junction box, wire through the control device and back to the junction box.
   e. Breakers and disconnects, auxiliary contacts, standard pilot lights and magnetic starters are the responsibility of Division 26 and shall be as specified herein.
   f. Auxiliary relays, low voltage transformers, control panel switches and devices, thermostats, pressure switches, electric operated valves, etc., are the responsibility of Division 26.
   g. All wiring shall terminate at labeled terminal strips.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

1. Section 26 05 00 - Electrical General Requirements.
2. Section 26 05 19 – Conductors and Cables.

1.3 SUBMITTALS

A. Reference Section 26 05 00

B. The controls contractor shall provide shop drawings for control system circuits.

PART 2 PRODUCTS

2.1 MATERIALS

A. Terminal Blocks: DIN rail mounted, modular type, single layer, non-fused. Entreloc or approved equal.

B. Twisted, Shielded Pair Conductors for Control Wiring: Conductors shall be copper with 100 % shielding, plenum rated. Beldon type 89418 or approved equal. Cables shall be run in conduit.

C. Conductors: All control conductors shall be #14 AWG THWN minimum.

D. Labeling: All control conductors shall be labeled with a number corresponding to the mechanical control system drawings. All labeling shall be heat-shrink ink printed type by Panduit Pan-Quick LS3 system or equal.

PART 3 EXECUTION

3.1 GROUNDING

A. Labeling: All control conductors shall be numerically labeled corresponding to the mechanical control systems record drawings.

B. Grounding Lugs: Ground all shielded pair shields at one end only to avoid ground loops. At terminal block connections, the shield shall be continuous from one conductor to another and shall be isolated from the local ground plane.

C. Conductors: All conductors shall be run in conduit unless specifically noted otherwise. The minimum size of conduit shall be 3/4" unless specifically noted otherwise.

- END OF SECTION -

SECTION 31 05 19
GEOSYNTHETICS

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the manufacturing and installation of geosynthetics.

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 31 22 00 Site Grading
3. Section 31 23 23 Excavation and Backfill for Structures

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. B16.1/ASTM D 751 Standard Test Methods for Coated Fabrics
2. ASTM D 1777 Standard Test Method for Thickness of Textile Materials
3. ASTM D 3786 Standard Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Tester Method
4. ASTM D 4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
5. ASTM D 4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
6. ASTM D 4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
7. ASTM D 4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
8. ASTM D 5034 Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
9. ASTM D 5035 Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
10. ASTM D 5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Quality Control Certificates shall be provided at a minimum frequency of one (1) per every hundred thousand (100,000) square feet of geosynthetics produced consecutively, and which is supplied to the project. These certificates shall be supplied only for the individual rolls of geosynthetics sampled and tested by the Manufacturer or his

representative. An individual Quality Control Certificate shall be provided for each roll of geosynthetics provided to the project, which was not produced consecutively within the hundred thousand (100,000) square foot lot. Quality Control Certificates shall be submitted two (2) weeks prior to installation of geosynthetics and shall state that the geosynthetics meets the requirements of these specifications for:

1. Mass per Unit Area
2. Grab Tensile Strength
3. Mullen Burst Strength
4. Equivalent Opening Size

C. Geosynthetics shall not be accepted and/or incorporated into the project without the approved quality control documentation.

D. Certification stating that all geosynthetics is furnished by one manufacturer shall be submitted two (2) weeks prior to installation.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and handling of the geosynthetics shall be the responsibility of CONTRACTOR.

B. During shipment, handling and storage, the geosynthetics shall be protected from ultraviolet light exposure, precipitation, or other inundation, mud, dirt, dust, puncture, cutting or any other damage or deleterious conditions. To that effect, geosynthetics rolls shall be shipped and stored in relatively opaque and watertight wrappings. An opaque tarp shall be placed over all rolls where the outer wraps are removed or damaged and where the geotextile is exposed. CONTRACTOR shall be responsible for the replacement of damaged or unacceptable materials at no cost to OWNER.

C. Storage of Materials: A storage area shall be provided on site by OWNER. The storage of geosynthetic materials shall be the responsibility of CONTRACTOR until the completed installation is accepted by ENGINEER.

D. Damaged Geosynthetics: Damaged geosynthetic materials shall be repaired, if possible, in accordance with these specifications, or shall be replaced at no additional cost to OWNER.

1.6 MEASUREMENT AND PAYMENT

A. Geosynthetics shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 GEOSYNTHETICS (FILTER FABRIC)

A. The geosynthetics shall be 10-ounce (or heavier) non-woven filter fabric.

B. Geosynthetics shall be provided in rolls.

C. Each roll of geosynthetics shall be externally labeled or tagged to provide product identification sufficient for field determination as well as inventory and quality control purposes. Each roll shall be labeled with the name of manufacturer, roll number,

physical dimensions (length and width) and the material type. Any roll of geosynthetics from which the labeling has been removed or has become illegible, shall not be used, but shall be removed from the site and replaced at the expense of CONTRACTOR.

D. The geosynthetics shall be sampled, tested, and certified by the manufacturer for the following properties:

MATERIAL PROPERTIES FOR NON-WOVEN GEOTEXTILE FILTER FABRIC		
Property	Specification	ASTM Test Method
Mass per Unit Area (min)	10.0 oz./S.Y.	D-5261
Grab Tensile Strength (min)	250 lbs.	D-4632
Elongation at Break	50 %	D-4632
Tear Strength (min)	100 lbs	D-4533
Apparent Opening Size (maximum U.S. Sieve size)	100 mesh	D-4751

E. Filter Fabric shall be **Mirafi 1100N by TenCate, 250NW by U.S. Fabrics**, or approved equal.

2.2 GEOSYNTHETIC (DRAINAGE COMPOSITE)

A. Geosynthetic drainage composite materials shall be provided in rolls. The system shall have a polypropylene dimpled core bonded to a non-woven filter fabric.

B. Each roll of geosynthetic material shall be externally labeled or tagged to provide product identification sufficient for field determination as well as inventory and quality control purposes. Each roll shall be labeled with the name of manufacturer, roll number, physical dimensions (length and width) and the material type. Any roll of geosynthetic material from which the labeling has been removed or has become illegible, shall not be used, but shall be removed from the site and replaced at the expense of CONTRACTOR.

C. The geosynthetic materials shall be sampled, tested, and certified by the manufacturer for the following properties:

MATERIAL PROPERTIES PREFABRICATED DRAINAGE COMPOSITE		
Property	Specification	ASTM Test Method
Mass per Unit Area (min)	15.8 oz./S.Y.	D-5261
Grab Tensile Strength of Geotextile (min)	100 lbs.	D-4632
Puncture of Geotextile	30 lbs	D-4833
AOS of Geotextile (min)	70	D-4751
Thickness	0.40 inch	D-1777
Compressive Strength of Core	15,000 psf	D-1621
Flow (gal/min/ft)	17.5	D-4716 @ 4000 psf and i=1

D. Prefabricated Drainage Composite shall be **J-DRain 420 by JDR Enterprises, Inc., Delta-Drain 6000 by Cosella-Dorken**, or approved equal.

PART 3 EXECUTION

3.1 DEPLOYMENT

A. Prior to deployment, CONTRACTOR shall inspect each roll of geosynthetics to verify that the roll has a valid Quality Control Certificate and that has been previously approved by ENGINEER.

B. Adjacent rolls shall be joined by overlapping the edges a minimum of twelve (12) inches.

C. The overlap shall be glued, sewn or otherwise fastened or secured at intervals no greater than two feet along a line through the midpoint of the overlap. Additional fasteners shall be installed as necessary to prevent slippage of the geosynthetics regardless of location.

D. CONTRACTOR shall visually inspect the geosynthetics during deployment for holes, tears or improperly formed geosynthetics. Defective areas shall be repaired or removed and replaced by CONTRACTOR at no additional cost to OWNER.

E. Smoking shall not be permitted on the geosynthetics.

F. CONTRACTOR shall be responsible to provide adequate loading (e.g., sand bags or similar items that will not damage the underlying geosynthetic) to prevent movement of the geosynthetics. Any damage to the geosynthetics shall be repaired at CONTRACTOR's expense.

G. The geosynthetics shall not be exposed to the sun and elements for more than 72 hours unless the filter fabric has ultraviolet inhibitors. Fabric with ultraviolet inhibitors shall not be exposed for a period in excess of the manufacturer's recommendations, in which case manufacturer shall provide prior to product delivery.

H. Any damage to the geosynthetics during installation or any fabric that has been exposed to the sun or elements for longer than the 72 hours, or as specified by the manufacturer, shall be replaced by CONTRACTOR at no additional cost to OWNER.

I. CONTRACTOR shall be responsible to observe placement of geosynthetics. CONTRACTOR shall provide a daily inventory of all geosynthetics deployed to ENGINEER.

3.2 REPAIRS

A. Any holes, tears or defective areas in the geosynthetics shall be repaired by patching with same type of geosynthetics. The patch shall extend a minimum of twelve (12) inches in all directions beyond the area to be repaired. The patch shall be secured in place by gluing, sewing, or securing the fabric as per these specifications.

- END OF SECTION -

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SECTION 31 11 00
CLEARING, GRUBBING, AND STRIPPING

PART 1 GENERAL

1.1 SUMMARY

A. This Work shall consist of removing and disposing of all trees; shrubs; brush; stumps; windfalls; roots; and other vegetation, including dead and decayed matter; and debris that exist within the designated construction limits, borrow areas, and soil stockpile areas and which are not specifically designated to remain.

1.2 DEFINITIONS

A. Clearing: Clearing operations shall consist of cutting, removing and disposing of trees, shrubs, bushes, windfalls and other vegetation within the construction limits, borrow areas, and soil stockpile areas. All brush shall be cut off within six inches of the ground surface.

B. Grubbing: Grubbing operations shall consist of removing and disposing of stumps, roots, debris deleterious materials, and other remains (such as organic and metallic materials) which if left in place would interfere with proper performance or completion of the contemplated work, would impair its subsequent use or form obstructions therein. Organic material from clearing or grubbing operations shall not be incorporated in fill or backfill.

C. Stripping: Stripping operations shall consist of removing all soil material containing sod, grass, or other vegetation and topsoil to a minimum depth of six (6) inches from all areas that will receive fill or over all trenches in field or yard areas.

1.3 MEASUREMENT AND PAYMENT

A. Measurement and payment for clearing, grubbing and stripping shall not be paid as a unit item, but considered as included in the contract unit or lump sum prices for the various items of the contract to which it relates.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 CLEARING

A. All trees, stumps, shrubs, bushes, windfalls and other vegetation (except such trees and vegetation as may be indicated or directed by ENGINEER to be left standing) shall be cut off to within six inches of the ground surface and shall be removed from the construction limits. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by such means as the circumstances require.

3.2 GRUBBING

A. All stumps, roots, debris, deleterious and other organic or metallic materials not suitable for foundations shall be removed completely from the construction limits, borrow areas

and soil stockpile areas. Unless otherwise permitted by ENGINEER, stumps shall be removed completely. If any stumps are permitted to remain, they shall be cut off not more than six inches above the ground.

3.3 STRIPPING

A. Soil material containing sod, grass, or other vegetation and topsoil shall be removed to a minimum depth of six (6) inches from all areas to receive fill from the area within lines 5 feet outside all foundation walls, over all trenches, and from beneath pavement and curb and gutter areas. The stripped material shall be deposited in such locations as are acceptable to ENGINEER. Topsoil shall be placed over designated areas to be landscaped, and over all trench areas (outside of paved areas).

B. All areas to be sodded shall have a minimum thickness of 3 inches (or thicker if required elsewhere in these documents or on the Contract Drawings) of topsoil.

3.4 DISPOSAL

A. Open burning of combustible materials will be not allowed.

B. All trees, timber, stumps, roots, debris, shrubs, bushes, and other vegetation removed during the clearing and grubbing operations shall be removed from the project site and disposed of by CONTRACTOR subject to specific regulations imposed by laws and ordinances and in a manner that will not create a public nuisance nor result in unsightly conditions. CONTRACTOR shall assume full responsibility for acceptable disposition of the material as well as for any damages resulting from his disposal operations.

- END OF SECTION -

SECTION 31 22 00
SITE GRADING

PART 1 GENERAL

1.1 SUMMARY

A. This Work consists of site grading and related activities.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 45 00 Quality Control and Materials Testing
2. Section 01 50 00 Temporary Construction Utilities & Environmental Controls
3. Section 31 23 15 Excavation and Backfill for Buried Pipelines
4. Section 31 23 23 Excavation and Backfill for Structures
5. Section 32 11 23 Untreated Base Course

1.3 REFERENCES

A. The latest edition of the following publications form a part of these Specifications to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3)
2. ASTM D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1.4 MEASUREMENT AND PAYMENT

A. Site grading shall not be paid as a separate item but shall be paid as part of the items to which it relates.

PART 2 PRODUCTS

2.1 EMBANKMENT MATERIAL

A. Embankment materials are defined as those complying with ASTM D2487, the Unified Soil Classification System (USCS) of CL, ML, SM, SC, SP or combinations of these materials.

B. Embankment material shall be free from frozen lumps, rocks larger than 6 inches in the larger dimension, roots, trash, lumber, or organic material. Suitability of material for embankment in accordance with these criteria will be as determined by ENGINEER.

C. It is not anticipated that CONTRACTOR will be required to furnish additional quantities of embankment fill material from off-site sources to supplement material available from on-site excavations. However, if required, CONTRACTOR shall not borrow materials from adjacent private or public lands without providing to OWNER written verification of such approval from the appropriate landowner or agency. CONTRACTOR shall be

responsible for all costs associated with providing additional quantities of embankment fill as may be required to complete the work described herein and as shown on the Contract Drawings.

PART 3 EXECUTION

3.1 GENERAL

A. Grading shall produce uniform grades or slopes between spot elevations or contours shown.

B. Areas of construction activity shall be left in condition of uniform grade, blending into pre-existing contours and concealing, as much as possible, evidence of construction activity by back dragging or raking to conceal tire marks. Revegetation shall not be performed until the subgrade is acceptable to OWNER.

C. Unless otherwise directed by OWNER, all excess excavated materials shall be removed from the site and disposed of by CONTRACTOR. CONTRACTOR shall restore stockpile area to pre-existing condition.

3.2 SITE PREPARATION

A. Prior to placement of embankment fill, loose or disturbed soil shall be removed and replaced with compacted structural fill, or disturbed soil shall be properly compacted.

B. Prior to placement of embankment fill, the top 6-inches, or as noted on the Contract Drawings, of the subgrade shall be scarified and compacted to 95% minimum Modified Proctor density as determined by ASTM D1557.

C. Embankment shall include the placement of materials to raise the existing grade to the established elevations indicated and the construction of driving surfaces.

D. Embankment material shall be placed in no more than 8-inch loose lifts for heavy equipment, and 4-inch loose lifts for hand operated equipment.

E. All embankment fill material shall be placed and compacted to 96% minimum Modified Proctor Density as determined by ASTM D1557. Embankment under roadways, to a minimum depth of four feet, shall be compacted to 96% minimum as determined by ASTM D1557.

F. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and recompacted to the minimum required compaction, unless recommended otherwise by the Soils Testing Agency, prior to placing any additional fill material.

G. Unless otherwise specified, CONTRACTOR shall be responsible for arranging for the placing and compacting of approved fill material in accordance with these Specifications. If the Soils Testing Agency should determine that CONTRACTOR is failing to meet the minimum requirements, CONTRACTOR shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to OWNER.

3.3 GRADING

A. The final grade of all completed areas shall be between plus and minus one-tenth (± 0.1) of a foot from the grade designated on the Contract Drawings.

- END OF SECTION -

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SECTION 31 23 15
EXCAVATION AND BACKFILL FOR BURIED PIPELINES

PART 1 GENERAL

1.1 SUMMARY

A. This item shall consist of excavating all pipeline trenches to the lines and grades indicated on the Contract Drawings or as directed by ENGINEER in the field, and the backfilling of all pipeline trenches. Excavation shall include the removal of all materials of whatever nature encountered to the depths shown on the Contract Drawings, or as modified in the Field by ENGINEER.

1.2 RELATED SECTIONS

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control & Materials Testing
3. Section 01 50 00 Temporary Construction Utilities and Environmental Controls
4. Section 31 23 19 Dewatering
5. Section 33 05 05 Ductile Iron Pipe
6. Section 33 05 11 HDPE Pressure Pipe

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referred. The publications are referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. M 145 Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
2. T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
3. T 88 Standard Method of Test for Particle Size Analysis of Soils
4. T 96 Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
5. T 180 Standard Method of Test for Moisture Density Relations of Soils Using a 10 lb. (4.54 kg) Rammer and an 18 in (457 mm) Drop
6. T 191 Standard Method of Test for Density of Soil In Place by the Sand Cone Method
7. T 205 Density of Soil In-Place by the Rubber-Balloon Method
8. T 238 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
9. T 239 Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
10. T 310 Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. C 131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
2. C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
3. D 422 Standard Test Method for Particle Size Analysis of Soils
4. D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3)
5. D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone method
6. D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3)
7. D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity -Flow Applications
8. D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
9. D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

A. Degree of Compaction: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

B. Pipe Zone: That zone in an Excavation which supports, surrounds, and extends to 12 inches above the top of the pipe barrel. Specifically, 4 inches below the bottom (where rock, hard pan, boulders, etc. are encountered), 12 inches above the top of the pipe, and 1 foot laterally beyond both sides of the pipe, unless noted otherwise on the Drawings.

C. Trench Zone Backfill: That zone in an Excavation which begins 12 inches above the top of the pipe barrel and extends to the natural surface level or the finished grade indicated on the Plans.

D. Unyielding Material: Unyielding material shall consist of rock and gravelly soils with stones greater than 12 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

E. Unstable Material: Unstable material shall consist of materials too wet to allow backfill compaction or to properly support the utility pipe, conduit, or appurtenant structures.

F. Rock: Solid mineral material which cannot be removed with equipment reasonably expected to be used in the Work without cutting, drilling or blasting. Minimum equipment size, in good running order, shall be similar to a **Komatsu 300, Caterpillar 320 or 330**, or equal.

1.5 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 - Submittal Procedures:

1. Copies of Field Density Test reports shall be submitted to ENGINEER or RPR at the beginning of each workday for the previous day's testing of subgrades, embankments and backfill Materials.

2. Copies of all Laboratory Test Reports shall be submitted to ENGINEER or RPR within 24 hours of the completion of the test.
3. Submit gradations and proctors for Pipe Zone Material and Trench Zone Backfill.
4. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

1.6 SITE CONDITIONS

A. Unsuitable Weather Limitations: CONTRACTOR shall not place, spread, or roll any fill material during unsuitable weather conditions. CONTRACTOR shall not resume operations until moisture content of material is satisfactory.

B. Weather Softened Subgrade: CONTRACTOR shall remove and replace at no additional cost to OWNER soft subgrade materials resulting from adverse weather conditions.

C. Protection of Graded Areas: CONTRACTOR shall protect all graded areas from traffic and erosion and shall keep these areas free of trash and debris. Work required to repair and reestablish grades in settled, eroded, and rutted areas shall be completed to specified tolerances at CONTRACTOR's expense.

D. Reconditioning Compacted Areas: All areas compacted to required specifications that become disturbed by subsequent construction operations or weather conditions shall be scarified, moisture conditioned, and re-compacted to the required density prior to further construction.

E. Grading: the final compacted surface of base course shall not vary more than 1/4 inch above or below design grade.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stabilization Material: Stabilization material shall consist of hard, durable particles of stone or gravel, screened or crushed to the required size and gradation. The material shall be free from vegetation matter, lumps or balls of clay, or other deleterious matter and shall conform to the following gradation when tested in accordance with AASHTO T 27 or ASTM C 136.

1. Coarse material shall be crushed or washed and fine material shall be wasted to meet the grading requirements set forth below. Note that if stabilization material is required, an 8 oz. non-woven filter fabric shall be placed between the stabilization material and the pipe zone material.
2. Coarse aggregate, retained on the No. 4 sieve, shall have a percentage of wear not greater than 40 percent when tested by the Los Angeles Test, AASHTO T-96 or ASTM C 131.

Sieve Size (Square Opening)	Percent By Weight Passing Screen
2-inch	100
1-1/2 inch	10 - 50
3/4-inch	0 - 25
No. 4	0 - 10
No. 200	0 - 3

B. Select Pipe Zone Material: Select material shall consist of 1-inch minus, well-graded native or import material, shall be free from vegetative matter, or other deleterious matter, and shall meet manufacturer's recommendations for the type of pipe installed. Select Pipe Zone Material shall be capable of meeting the compaction requirements.

C. Select Trench Backfill: Select backfill shall consist of native or imported materials (soils or bedrock which can be broken down to a compactible size). Maximum particle size for backfill shall be no greater than 4-inches. Select backfill shall be capable of meeting the compaction requirements.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated. All excavated materials not intended for reuse shall be removed from the site and disposed of by the Contractor.

B. Rock Removal

1. CONTRACTOR shall cut away Rock at excavation bottom to form level bearing.
2. All shaled layers shall be removed to provide sound and unshattered base for foundations.
3. CONTRACTOR shall remove and legally dispose of excess excavated material and debris off-site unless indicated otherwise.

4. CONTRACTOR shall correct unauthorized Rock removal at no additional cost to OWNER.

3.2 SAFETY

A. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the latest requirements of OSHA Safety and Health Standards for Construction (29 CFR 1926). CONTRACTOR is responsible for assessing safety needs to meet such requirements, arranging for proper equipment and/or construction methods, and maintaining such equipment, methods and construction practices so as to fully comply with all safety requirements.

B. CONTRACTOR is responsible for assessing needs related to confined space entry, as defined by OSHA. CONTRACTOR shall meet all such requirements, arranging for proper equipment and/or construction methods, and maintaining such equipment,

methods and construction practices so as to fully comply with all confined space safety requirements.

3.3 DEWATERING

A. Water removal shall be in accordance with Section 31 23 19 - Dewatering.

3.4 TRENCH WIDTH

A. The bottom of the trench shall have a minimum width equal to the outside diameter of the pipe plus 24-inches or as detailed on the Contract Drawings.

B. The width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed and compacted as specified. Trenches shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting, and bracing, and the handling of special units as necessary.

3.5 TRENCH PREPARATION

A. Each trench shall be excavated so that the pipe can be laid to the alignment and grade as required. The trench wall shall be so braced that the workmen may work safely and efficiently. All trenches shall be drained so the pipe laying may take place in dewatered conditions.

B. Bottom Preparation

1. Where rock, hard pan, boulders or other material which might damage the pipe are encountered, the bottom of the trench shall be over excavated 4 inches below the required grade and replaced with Stabilization Material. Otherwise, the bottom of the trench shall be over excavated 6 inches or 1/12 the outside diameter of the pipe, whichever is greater, below the required grade and replaced with Pipe Zone Backfill.
2. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 1-inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

C. Removal of Unstable Material

1. Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed by ENGINEER and replaced to the proper grade with Stabilization Material. When removal of unstable material is required due to the fault or neglect of CONTRACTOR in his performance of the work, the resulting material shall be excavated and replaced by CONTRACTOR without additional cost to OWNER.

D. The trench bottom (at the level of the base of the pipe) shall be given a final trim using a string line, laser, or another method approved by ENGINEER for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Bell holes shall be provided at each joint to permit the jointing to be made properly. The trench grade shall permit the pipe spigot to be

accurately centered in the preceding laid pipe joint, without lifting the pipe above the grade, and without exceeding the permissible joint deflection.

3.6 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.7 LAYING AND JOINING PIPE

A. Laying pipe: Provide proper facilities for lowering pipe sections into place. Dropping pipe will not be permitted. Place each section true to line and gradient in close and true contact with adjacent sections.

B. Joining pipe:

1. Use methods of joining conduit sections ensuring ends are fully entered and inner surfaces are flush and even. The equipment used to force the joints together must be adequate to overcome the gasket pressure involved. Pipe shall be installed in accordance with these specifications and the manufacturers written specifications.
2. Just prior to joining the pipes, both spigot and bell ends shall be thoroughly cleaned to remove all foreign substances which may have adhered to the bell and spigot surfaces. All dust and dirt shall be removed with a clean rag. An approved lubricant (recommended by the manufacturer), that is not injurious to the gasket, shall be applied in accordance with the manufacturer's recommendations.
3. In the event any foreign material becomes embedded in the lubricant, or the lubricant becomes contaminated by water or other substances before the joint is started, the area affected shall be re-cleaned and new lubricant applied.
4. The pipe being joined shall be carefully moved into position, line and grade checked, and, as the spigot end is started into the bell of the section previously laid, the gasket shall be checked to insure uniform entry into the bell at all points. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly. Apply firm steady pressure either by hand or by bar and block assembly, until the spigot easily slips through the gasket. Care must be taken to ensure that the spigot is not over-inserted and that previously assembled pipe joints are not disturbed.

3.8 PIPELINE TRENCH BACKFILLING AND COMPACTION

A. Pipe Zone:

1. Pipe Zone Backfill shall be placed in layers not exceeding 6 inches loose thickness

for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise approved or specified. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Each layer shall be compacted to at least 95 percent of the maximum Modified Proctor density (ASTM D-1557), unless otherwise specified.

2. Replacement of Unyielding Material: Unyielding material removed from the bottom of the trench shall be replaced with Stabilization Material placed in layers not exceeding 6 inches loose thickness.
3. Replacement of Unstable Material: Unstable material removed from the bottom of the trench or excavation shall be replaced with Stabilization Material placed in layers not exceeding 6 inches loose thickness.
4. Where the pipe grade exceeds 30%, cohesive material shall be used in lieu of pipe bedding. The cohesive material shall be moistened to within 2% of optimum moisture and compacted as noted.
5. The relative density of the compacted cohesionless material shall not be less than 60% as determined by the Bureau of Reclamation Relative Density of Cohesionless Soil Test (Designation E-12) of the "Earth Manual."

B. Trench Backfill: Trenches shall be backfilled to the grade shown with Trench Backfill material as specified.

1. Trench backfill in asphalted road shall consist of backfilling the trench from above the pipe zone up to underneath the noted recommended depth for untreated base course and asphalt or concrete of finished grade with Trench Backfill material compacted to 95 percent of maximum density (ASTM D-1557). Backfill shall be placed in layers not exceeding 6-inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise approved or specified.
2. Trench backfill in unimproved or landscaped areas shall consist of backfilling the trench from above the pipe zone to 8-inches below finished grade with Trench Backfill material compacted to 95 percent of maximum density (ASTM D-1557). Backfill from 8-inches below finished grade to finished grade shall consist of topsoil replacement in addition to replacement of all landscaped materials. Trench backfill shall be placed in layers not exceeding 8 inches loose thickness.
3. It shall be the responsibility of CONTRACTOR to be assured that the Trench Backfill material is capable of being compacted to the degree specified. It shall be CONTRACTOR’s responsibility to remove and dispose of all excess excavated material.

C. Final Backfill:

1. Unimproved and Landscaped Areas: The top 8-inches of the trench shall be filled with topsoil. Topsoil may be native material stripped prior to excavation of the trench. Backfill shall be deposited in layers of a maximum of 12-inch loose thickness and compacted to a minimum of 85 percent maximum density (ASTM D-1557). Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.
2. Roadways shall be completed with the type and thickness of materials (i.e., Untreated Road Base and Asphalt) as indicated or shown on the Contract Drawings

3.9 SPECIAL REQUIREMENTS

A. Special requirements for both excavation and backfill relating to the specific utilities from above the pipe zone to the natural surface level or the finished grade indicated on the Plans shall be placed and compacted as follows:

1. Where existing underground pipes or conduits larger than 3 inches in diameter and all sizes of sewer lines or sewer laterals cross the trench above the new work, the backfill from the bottom of the trench to 1 foot above the top of the intersecting pipe or conduit shall be pipe zone material compacted to 95 percent of maximum density (ASTM D-1557). The pipe zone material shall extend 2 feet on either side of the intersecting pipe or conduit to ensure that the material will remain in place while other backfill is placed.

B. The maximum trench length open at any given time shall not exceed 200 feet unless approved by ENGINEER and must be backfilled in a timely manner.

3.10 MAINTENANCE OF BACKFILL

A. All backfill shall be maintained in satisfactory condition, and all places showing signs of settlement shall be filled and maintained during the life of the Contract and for a period of one year following the day of final acceptance of all work performed under the Contract. When CONTRACTOR is notified by ENGINEER or OWNER that any backfill is hazardous, CONTRACTOR shall correct such hazardous condition at once. Any utility, road and/or parking surfacing damaged by such settlement shall be repaired by CONTRACTOR to the satisfaction of OWNER and ENGINEER. In addition, CONTRACTOR shall be responsible for the cost to OWNER of all claims for damage filed with the Court, actions brought against the said OWNER for, and on account of, such damage.

3.11 FINISH GRADING AND CLEANUP

A. CONTRACTOR shall grade the trench line to a smooth grade to affect a neat and workmanlike appearance of the trench line.

B. All tools, equipment and temporary structures shall be removed. All excess dirt and rubbish shall be removed from the site by CONTRACTOR.

C. CONTRACTOR shall restore the site to at least as good as original condition, including but not limited to final trench grade and restoration of affected public and private facilities whether in the public right-of-way or on private property. Any exception to this requirement must be in writing from ENGINEER for the job specific conditions.

3.12 COMPACTION TESTS

A. It shall be the responsibility of CONTRACTOR to accomplish the specified compaction for backfill, fill, and other earthwork. It shall be the responsibility of CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Backfill Materials

a. Characteristics of backfill materials shall be determined in accordance with the requirements of Section 01 45 00 - Quality Control & Materials Testing.
b. The CONTRACTOR shall demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:
   i) 50 linear feet of trench backfill.
c. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.
d. After satisfactory conclusion of the initial compaction demonstration and at any time during construction, earthwork which does not comply with the specified degree of compaction shall not exceed the previously specified quantities.
e. Compliance tests may be made by ENGINEER to verify that compaction is meeting the requirements previously specified at no cost to CONTRACTOR.
f. ENGINEER may require retesting of backfill that has settled from water penetration in the trench. CONTRACTOR shall remove the overburden above the level at which ENGI¬NEER wishes to test and shall backfill and recompact the excavation after the test is complete at no additional cost to the OWNER.
g. If compaction fails to meet the specified requirements, CONTRACTOR shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR's confirmation tests shall be performed in a manner acceptable to ENGINEER

2. Field Density Tests

a. Field density tests shall be made in accordance with ASTM D 1557.

- END OF SECTION -

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SECTION 31 23 19
DEWATERING

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section provides specifications for dewatering systems and appurtenances to be used during construction as required to remove water and continuously maintain groundwater at a level at least 1-foot below the bottom of the excavation.

B. CONTRACTOR shall obtain all necessary permits for disposal of water removed from the excavation.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Before dewatering is commenced, CONTRACTOR shall provide information to ENGINEER outlining the method, installation and details of the proposed dewatering system. CONTRACTOR shall provide ENGINEER with plans setting forth details of the proposed dewatering systems. The dewatering system plans shall be of sufficient detail to indicate sizes of pumps, piping, appurtenances, the ultimate disposal point for water, and to indicate the overall completeness and effectiveness of the proposed system.

C. CONTRACTOR shall certify to OWNER that the design and implementation of the proposed dewatering system is sufficient to complete the Work.

D. Submit a plan to monitoring settlement of adjacent structures.

1.4 QUALITY CONTROL

A. CONTRACTOR shall be responsible to control the rate and effect of dewatering to avoid all settlement and subsidence.

B. Where critical structures exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. CONTRACTOR is responsible for protecting adjacent structures from settlement. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of CONTRACTOR.

PART 2 PRODUCTS

2.1 MATERIALS

A. CONTRACTOR shall be responsible for selection of dewatering means, methods and materials.

B. Standby pumping equipment shall be maintained on the Site.

PART 3 EXECUTION

3.1 DESIGN AND IMPLEMENTATION

A. CONTRACTOR shall be responsible for complete design and implementation of the dewatering system.

B. CONTRACTOR shall be responsible for the design and implementation of any modifications that may be required to the initial design of the dewatering system (at no additional cost to OWNER) to provide a dewatering system that operates adequately to complete the Work.

C. CONTRACTOR shall furnish, install, operate and maintain all machinery, appliances, and equipment to maintain all excavations free from water during construction.

D. CONTRACTOR shall dispose of water so as to not cause damage to public or private property, or to cause a nuisance or menace to the public or violate the law.

E. CONTRACTOR shall be responsible to obtain groundwater discharge permits, if required.

F. CONTRACTOR shall install and operate the dewatering system so as to not cause damage or endanger adjacent structures or property.

G. The control of groundwater shall be such that softening of the bottom of excavations, or formation of "quick" conditions or "boils," does not occur. Dewatering systems shall be designed and operated so as to prevent removal and migration of the natural soils.

H. CONTRACTOR shall have sufficient stand-by equipment at the project site at all times to continuously maintain the dewatering program until Work necessitating dewatering is complete.

I. CONTRACTOR shall have on hand equipment and machinery in good working condition for emergencies and shall have personnel available for operation of such equipment and machinery.

J. CONTRACTOR shall control surface water to prevent entry into excavations.

- END OF SECTION -

SECTION 31 23 23
EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers excavating, backfilling, and compacting of disturbed areas for structures and roadways as directed by ENGINEER.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control and Materials Testing
3. Section 01 45 23 Testing Agency Services
4. Section 01 50 00 Temporary Construction Utilities and Environmental Controls
5. Section 31 11 00 Clearing, Grubbing and Stripping
6. Section 31 23 15 Excavation and Backfill for Buried Pipelines
7. Section 31 23 19 Dewatering

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referred. The publications are referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. M 145 Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
2. T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
3. T 88 Standard Method of Test for Particle Size Analysis of Soils
4. T 180 Standard Method of Test for Moisture Density Relations of Soils Using a 10 lb. (4.54 kg) Rammer and an 18 in (457 mm) Drop
5. T 191 Standard Method of Test for Density of Soil In Place by the Sand Cone Method
6. T 310 Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. D 422 Standard Test Method for Particle Size Analysis of Soils
2. D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3)
3. D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone method
4. D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3)

5. D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
6. D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

D. The latest Edition of the Utah Department of Transportation Standard Specification for Road and Bridge Construction.

E. The latest Edition of the American Public Works Association (APWA) and Associated General Contractors of America Standard Plans and Standard Specifications.

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 Submittal Procedures:

1. Submit gradations and proctors for structural fill materials and backfill materials.

PART 2 PRODUCTS

2.1 WALL BACKFILL MATERIAL

A. Wall backfill material shall consist of native or import fill material meeting soils classifications A-1, A-2 or A-3 of AASHTO M 145, with a maximum particle size no greater than 6 inches in any dimension and shall be capable of meeting the compaction requirements.

1. Wall backfill material shall be free from frozen lumps, rocks larger than 6 inches in the largest dimension, roots, trash, lumber and organic material.

2.2 STRUCTURAL FILL

A. Structural fill material, if required, shall meet the following requirements.

1. Material shall be non-expansive granular soil with less than 35 percent passing the No. 200 sieve, with a liquid limit less than 30, and free from rocks larger than 4 inches in the largest dimension, frozen lumps, roots, trash, lumber and organic material. The natural soils may be used as structural fill where it meets the above stated criteria.

2.3 FLOOR SLAB FILL (Upper 4 inches)

A. Material shall be non-expansive granular soil with less than 5 percent passing the No. 200 sieve, and free from rocks larger than 2 inches in the largest dimension, frozen lumps, roots, trash, lumber and organic material. The natural soils may be used as fill for the first 4 inches directly under the slab where it meets the above stated criteria.

2.4 FLOOR SLAB

A. Material shall be non-expansive granular soil with less than 50 percent passing the No. 200 sieve, with a liquid limit less than 30, and free from rocks larger than 6 inches in the largest dimension, frozen lumps, roots, trash, lumber and organic material. The natural

soils may be used as fill below the first 4 inches under the slab where it meets the above stated criteria.

2.5 3/4" WASHED ROCK

A. 3/4" Washed Rock shall consist of hard, durable particles of stone or gravel, screened or crushed, to the required size and gradation. The material shall be free from vegetation matter, lumps or balls of clay, or other deleterious matter and shall conform to the following gradation when tested in accordance with AASHTO T 27 or ASTM C 136.

Sieve Size (Square Opening)	Percent By Weight Passing Screen
3/4-inch	100
3/8 inch	78-92
No. 4	0 - 50
No. 8	0 - 5
No. 200	0 - 3

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated. Excavated material not required or not satisfactory for backfill shall be removed from the site.

B. Excavations shall be braced and supported as needed to prevent the ground adjacent to the excavation from sliding or settling. Slides shall be promptly removed and corrected by CONTRACTOR.

3.2 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill and compact to density equal to or greater than requirements for subsequent fill material.

C. Scarify subgrade surface to depth of 6 inches.

3.3 DEWATERING

A. Water removal shall be in accordance with Section 31 23 19 - Dewatering.

3.4 BACKFILL

A. Backfill material shall not be placed against concrete structures that have not been properly cured. No backfill material shall be placed until concrete has cured for a minimum of 7 days or until the compressible strength is 3,400 psi, whichever is greater.

B. Backfill material shall be placed in no more than 6-inch loose lifts for compaction by

hand operated machine compactors, and 8 inches loose lifts for other than hand operated machines.

C. Structural fill placed beneath foundations, footings or the floor slab shall be placed and compacted to at least 96% of maximum dry density at a moisture content within 2 percent of optimum moisture content in accordance with ASTM D 1557.

D. Backfill material shall be placed and compacted to at least 95 percent of maximum dry density at a moisture content within 2 percent of optimum moisture content in accordance with ASTM D-1557.

E. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and re-compacted to the minimum required compaction prior to placing any additional fill material.

F. CONTRACTOR shall be responsible for arranging for the placing and compacting of approved fill material in accordance with these Specifications. If it is determined that CONTRACTOR is failing to meet the minimum requirements, CONTRACTOR shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to OWNER.

G. Sufficient personnel, equipment, sumps or other means should be provided to maintain the site in an acceptable dry condition for the duration of this contract.

H. Excavations shall be so braced and supported as needed to prevent the ground, adjacent to the excavation, from sliding or settling. Localized slides or settlements shall be promptly removed and corrected by CONTRACTOR.

3.5 FINISHED GRADE

A. The finished subgrade and grade of the fill shall not vary more than 0.05 feet from the established grades and cross sections shown on the Contract Drawings.

3.6 COMPACTION TESTS

A. Compaction testing shall be the provided and paid for in accordance with Section 01 45 00 – Quality Control and Materials Testing.

B. It shall be the responsibility of CONTRACTOR to accomplish the specified compaction for backfill, structural fill, Untreated Base Course and other earthwork. It shall be the responsibility of CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Backfill Materials

    a. Characteristics of backfill materials shall be determined in accordance with the requirements of Section 01 45 00.
    b. Contractor shall demonstrate the adequacy of compaction equipment and

procedures before exceeding any of the following amounts of earthwork quantities:

1) One (1) test per 1.0 feet of backfill thickness placed per structure.

c. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.
d. After satisfactory conclusion of the initial compaction demonstration and at any time during construction, earthwork which does not comply with the specified degree of compaction shall not exceed the previously specified quantities.
e. Quality Control tests may be made by ENGINEER to verify that compaction is meeting the requirements previously specified at no cost to CONTRACTOR. If ENGINEER requires retesting of backfill, CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete at no additional cost to OWNER.
f. If compaction fails to meet the specified requirements, CONTRACTOR shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid in accordance with Section 01 45 23 – Testing Agency Services. The confirmation tests shall be performed in a manner acceptable to ENGINEER. Frequency of confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

2. Field Density Tests

a. Tests shall be performed in sufficient numbers to meet the requirements of Section 01 45 00 and to ensure that the specified density is being obtained.

C. Field density tests shall be made in accordance with ASTM D1557 and ASTM D6938.

- END OF SECTION -

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SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers furnishing and placing the loose riprap materials in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on the drawings and/or as directed by the ENGINEER.

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text to by basic designation only.

B. American Society for Testing and Materials (ASTM)

1. ASTM C-127 Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
2. ASTM C-535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Testing certificates shall be submitted prior to acceptance of the rock source to verify the conformity for abrasion resistance or compressive strength to the requirements of this Section.

1.5 STORAGE OF MATERIALS

A. Materials shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials.

PART 2 PRODUCTS

2.1 LOOSE RIPRAP

A. Riprap shall consist of quarry stone which is sound and durable against disintegration under conditions to be met in handling and placing, and is hard and tenacious and otherwise of suitable quality to ensure permanency in the specified kind of work.

B. Riprap sources shall be approved by the ENGINEER prior to use. Concrete masonry or concrete pavement may not be used for riprap. Riprap shall be well graded with additional gradation requirements for riprap as follows:

LOOSE RIPRAP GRADATIONS

Riprap Designation	% Smaller Than Given Size By Weight	(Inches)	D_{50}** (Inches)
RIPRAP D50 = 12"	70-100	21	
	50-70	18	12
	35-50	12	
	2-10	4	

** D_{50} = Nominal particle size

C. All stone shall be angular (no rounded rock will be permitted), each piece having its greatest dimensions not greater than three times its least dimensions. All stone shall conform to the following test requirements of the American Society for Testing and Materials Standards:

	Requirements	**ASTM Standard**
Specific Gravity (min)	2.6	C 127
Los Angeles Abrasion, (max %)	40	C 535

D. The Contractor shall be responsible for obtaining (by selective mining, crushing, screening, or some other method) loose riprap that will meet the specified material requirements.

PART 3 EXECUTION

3.1 LOOSE RIPRAP

A. Prior to placement of loose riprap, the subgrade shall be graded to the lines and grades shown on the drawings.

B. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and objectionable material.

C. Where filter fabric is placed under the riprap, the fabric shall be overlapped a minimum of 2-feet at all joints. Upstream sheets shall overlap downstream sheets. The fabric shall

be anchored using trenches or aprons at the crest or toe of the slope. Fabric exposed to sunlight longer than 7 days shall be removed and replaced.

D. Riprap shall generally be placed starting at the lowest elevations and working upward. Riprap shall be placed to the minimum thickness designated on the drawings and shall be positioned in such a manner that will provide uniform distribution of the various sizes of stone and produce a well-keyed mass of rock with the least practical amount of void space. The surface shall be leveled as necessary, to produce a reasonably uniform appearance and the required thickness.

E. Where riprap is placed over a filter fabric, the riprap shall be placed so as to avoid damage to the fabric.

- END OF SECTION -

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SECTION 32 11 23
ROAD BASE - UNTREATED BASE COURSE

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work consists of the placement of Sub-Base and Untreated Base Course (UBC) material at designated roadways and all driving surfaces as indicated on the Drawings.

1.2 RELATED SECTIONS

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control and Materials Testing

1.3 REFERENCES

A. The latest edition of the following publication forms a part of this Specification to the extent referenced. The publication is referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. AASHTO T 88 Standard Method of Test for Particle Size Analysis of Soils
2. AASHTO T 180 Standard Method of Test for Moisture Density Relations of Soils Using a 10 lb. (4.54 kg) Rammer and an 18 in (457 mm) Drop
3. AASHTO T 191 Standard Method of Test for Density of Soil In-Place by the Sand Cone Method
4. AASHTO T 310 Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods. (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 422 Standard Method for Particle Size Analysis of Soils
2. ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3)
3. ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone method
4. ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lnf/ft3)
5. ASTM D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
6. ASTM D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

D. The latest edition of the Utah Department of Transportation Standard Specification for Road and Bridge Construction (UDOT).

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Untreated Base Course (State approved 1-1/2" gradation, APWA Grade 1 or Grade 3/4).

1.5 MEASUREMENT AND PAYMENT

A. Road Base shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 MATERIALS

A. Untreated Base Course: Untreated Base Course Materials shall meet the APWA Specifications for Grade 1 or Grade 3/4 as shown in Table 32 11 23-1.

TABLE 32 11 23-1

SIEVE SIZE	MASTER GRADING BAND LIMITS (PERCENT PASSING)	GRADE 1 GRADATION (PERCENT PASSING)	GRADE 3/4 GRADATION (PERCENT PASSING)
1 1/2 inch	100	-	-
1 inch	90-100	100	-
3/4 inch	70-85	-	100
1/2 inch	65-80	79 - 91	-
3/8 inch	55-75	-	78 -92
No. 4	40-65	49 - 61	55 - 67
No. 16	25-40	27 - 35	28 - 38
No. 200	7-11	7 - 11	7 - 11

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Prior to placement of untreated base course materials, the foundation area to receive untreated base course materials shall be scarified to a minimum depth of 8-inches and recompacted to 95% minimum laboratory density as determined by ASTM D1557.

3.2 UNTREATED BASE COURSE MATERIAL PLACEMENT

A. No Untreated Base Course material shall be placed on sub-grade materials until the sub-grade has been checked and accepted by ENGINEER.

B. Road base material placed on driving surfaces shall be compacted to a minimum

density of 96% in accordance with ASTM D1557 to provide a uniform graded smooth surface.

C. Untreated Base Course material shall be placed to a minimum thickness eight (8) inches or as shown on the Contract Drawings.

3.3 FIELD QUALITY CONTROL

A. CONTRACTOR shall be responsible for directing proper placement of all road base materials. CONTRACTOR shall be responsible for the stability of the road base materials during placement and shall replace any portions which have become displaced due to careless or negligent work on the part of CONTRACTOR, or to damage resulting from natural causes, such as storms.

B. Whenever the work areas to receive Sub-Base and/or Untreated Base Course material are covered with snow, the snow must be removed prior to placing the road base and/or Untreated Base Course and deposited outside the immediate construction areas at CONTRACTOR's expense.

- END OF SECTION -

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SECTION 32 31 13
GALVANIZED CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the furnishing of labor, materials and appurtenances necessary for installation of the galvanized chain link fence system defined herein. The manufacturer shall provide a total fence system including all components, panels, posts, gates, and hardware required.

1.2 RELATED WORK

A. Related Work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 30 00 Cast-in-Place Concrete

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specifications to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
2. ASTM A 392 Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
3. ASTM A 780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
4. ASTM A 824 Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link
5. ASTM F 552 Standard Terminology Relating to Chain Link Fencing
6. ASTM F 567 Standard Practice for Installation of Chain Link Fence
7. ASTM F 626 Standard Specification for Fence Fittings
8. ASTM F 900 Standard Specification for Industrial and Commercial Swing Gates
9. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

1.4 MEASUREMENT AND PAYMENT

A. Full compensation for chain link fences and gates shall be considered at the contract unit bid prices for each lineal foot of chain link fences and gates installed and accepted.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop drawings: Site plan showing layout of fence location with dimensions, location of gates and opening size, cleared area, elevation of fence, gates, footings and details of attachments.

C. Certifications: Manufacturers material certifications in compliance with the current ASTM specifications.

D. Domestic certifications: Material certifications, made in U.S.A., Buy American Act or Buy America when required.

E. Material samples: When required, provide representative samples of chain link fabric, framework and fittings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company headquartered in the United States having U.S. manufacturing facility/facilities specializing in manufacturing chain link fence products with at least 5 years' experience.

B. Fence contractor: Company with demonstrated successful experience installing similar projects and products in accordance with ASTM F 567 and have at least 5 years' experience.

C. Tolerances: Current published edition of ASTM specifications tolerances apply. ASTM specification tolerances supersede any conflicting tolerance.

1.8 WARRANTY

A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wheatland Tube Co.,

B. Master Halco, Inc.,

C. Southwestern Wire, Inc.,

D. Or approved equal

2.2 GENERAL

A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.

B. Fence fabric height shall be 6 feet unless otherwise indicated.

C. Fencing materials shall be galvanized after fabrication.

D. Fencing shall be topped with 3 lines of barbed wire on single, 45 degree supporting arms, sloped outward.

2.3 STEEL FABRIC

A. Fence fabric shall be 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

B. Fabric shall be hot-dip galvanized per ASTM A 392, Class 2, 2.0 oz/ft² before weaving.

2.4 FRAMING AND ACCESSORIES

A. **Round steel pipe and rail:** Schedule 40 standard weight pipe, in accordance with ASTM F1083, 2.0 oz/ ft² hot dip galvanized zinc exterior and 2.0 oz/ft² hot dip galvanized zinc interior coating. Intermediate Strength Grade: Minimum yield strength 50,000 psi.

1. Line post shall be 2-3/8" outside diameter, 2.0 oz/ft² zinc coating.
2. End, Corner, Pull post 2-7/8" outside diameter, 2.0 oz/ft² zinc coating.
3. Top, brace, bottom and intermediate rails, 1.660" outside diameter, 2.0 oz/ft² zinc coating.

B. **Tension Wire:** Tension wire shall be located at the bottom of the fabric and shall consist of 7 gauge marcelled wire complying with ASTM A 824 and shall match the coating of the chain link fabric. Tension wire shall be interlaced with the fabric or attached to the fabric with wire ties at a spacing of no more than 18 inches apart.

C. **Barbed Wire Support Arms:** Support arms shall be manufacturer's standard fabrication with finish to match fence framework. Support arms shall be single 45 degree arm type and shall be capable of withstanding 250 pounds of downward pull.

D. **Barbed Wire:** Metallic coated steel barbed wire shall comply with ASTM A 121, Design Number 12-4-5-14R, double 12-1/2 gauge twisted strand wire, with 4 point 14 gauge round barbs spaced 5 inches on center. Match coating of the chain link fabric.

E. **Tension and Brace Bands:** Galvanized pressed steel complying with ASTM F626, minimum steel thickness of 12 gauge (0.105 in.), minimum width of 3/4 inch and minimum zinc coating of 1.20 oz/ft². Secure bands with 5/16 inch galvanized steel carriage bolts.

F. **Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves:** In compliance to ASTM F626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft².

G. **Truss Rod Assembly:** In compliance with ASTM F626, 3/8 inch diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft², assembly capable of withstanding a tension of 2,000 lbs.

H. **Tension Bars:** Tension bars shall be in accordance with ASTM F626 and shall be galvanized steel one-piece length 2 inch less than the fabric height. Minimum zinc coating 1.2 oz. /ft². Bars for 2 inch mesh shall have a minimum cross section of 3/16 inch by 3/4 inch.

I. **Tie Wire and Hog Rings**: Galvanized minimum zinc coating 1.20 oz/ft², 9 gauge (0.148") steel wire in compliance with ASTM F626.

2.5 SWING GATES

A. **Swing Gates:** Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.900 inch outside diameter, ASTM F 1083 schedule 40 galvanized steel pipe. Frame members spaced no greater than 8 ft. apart vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A 780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match gate fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe. The gatepost diameter from table 2.5.B.

B. Gateposts: Schedule 40 pipe in compliance with ASTM F1083.

Gate fabric height up to and including 6 ft.		
Gate leaf width	**Post Outside Diameter**	**Weight**
up to 4 ft.	2.375 in.	3.65 lb/ft
over 4 ft. to 10 ft.	2.875 in.	5.79 lb/ft
over 10 ft. to 18 ft.	4.000 in.	9.11 lb/ft
Gate fabric height over 6 ft. to 12 ft.		
Gate leaf width		
up to 6 ft.	2.875 in.	5.79 lb/ft
over 6 ft. to 12 ft.	4.000 in.	9.11 lb/ft
over 12 ft. to 18 ft.	6.625 in.	18.97 lb/ft
over 18 ft. to 24 ft.	8.625 in.	28.58 lb/ft

2.6 CONCRETE

A. Concrete for post footings shall have a 28-day compressive strength of 2,500 psi in accordance with Section 03 30 00 – Cast-in-Place Concrete.

PART 3 EXECUTION

3.1 FRAMEWORK INSTALLATION

A. Posts: Posts shall be set plumb in concrete footings in accordance with ASTM F567. Minimum footing depth, 24 inch plus an additional 3 inch depth for each 1 ft. increase in the fence height over 4 ft. or as indicated on the contract drawings whichever is greater. The minimum footing diameter shall be four times the largest cross section of the post up to a 4.00" dimension and three times the largest cross section of post greater than a 4.00" dimension or as indicated on the contract drawings, whichever is

greater. Top of concrete footing to be at grade and crowned to shed water away from the post. Line posts installed at intervals not exceeding 10 ft. on center.

B. Top rail: When specified, install 21 ft. lengths of rail continuous thru the line post or barb arm loop top. Splice rail using top rail sleeves minimum 6 inches long. Rail shall be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail shall be field cut and secured to the line posts using boulevard clamps or brace band with rail end. Fences 12 feet high or higher require mid rail.

C. Terminal posts: End, corner, pull and gate posts shall be braced and trussed for fence 6 ft. and higher and for fences 5 ft. in height not having a top rail. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.

D. Tension wire: Shall be installed 4 inches up from the bottom of the fabric. Fences without top rail shall have a tension wire installed 4 inches down from the top of the fabric. Tension wire to be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to each line post with a tie wire. Install the top tension wire through the barb arm loop for fences having barbed wire and no top rail.

3.2 CHAIN LINK FABRIC INSTALLATION

A. Chain Link Fabric: Install fabric to outside of the framework. Attach fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and 5/16 inch carriage bolts spaced no greater than 12 inches on center. Chain link fabric shall be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches on center and to horizontal rail spaced no greater than18 inches on center. Secure fabric to the tension wire with hog rings spaced no greater than 18 inches on center.

1. Tie wire shall be wrapped 360 degrees around the post or rail and the two ends twisted together three full turns. Excess wire shall be cut off and bent over to prevent injury. The installed fabric shall have a ground clearance on no more than 2 inches.

3.3 BARBED WIRE INSTALLATION

A. Barbed Wire: Stretched taut between terminal posts and secured in the slots provided on the line post barb arms. Attach each strand of barbed wire to the terminal post using a brace band.

3.4 GATE INSTALLATION

A. Swing Gates: Installation of swing gates and gateposts in compliance with ASTM F 567. Direction of swing shall be inward. Gates shall be plumb in the closed position having a bottom clearance of 3 inch, grade permitting. Hinge and latch offset opening space shall be no greater than 3 inches in the closed position. Double gate drop bar receivers shall be set in a concrete footing minimum 6 inch diameter 24 inch deep. Gate leaf holdbacks shall be installed for all double gates.

3.5 GROUNDING

A. Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150-feet on each side of the crossing.

B. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4-inch by 10-foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below grade. Where driving is impractical, electrodes shall be buried a minimum of 12-inches deep and radially from the fence. Top of electrode shall be not less than 2 feet or more than 8 feet from the fence.

C. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps so as to create electrical continuity between the fence posts, fence fabric, and ground rods. After installation, the total resistance of fence to ground shall not be less than 25 ohms.

D. Fence grounding is not the responsibility of the fence installer or manufacturer. A licensed electrical contractor shall install grounding when required.

3.6 CLEAN UP

A. Clean Up: The area of the fence line shall be left neat and free of any debris caused by the installation of the fence.

- END OF SECTION -

SECTION 33 05 05
DUCTILE IRON PIPE

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all pipe, fittings, closure pieces, supports, bolts, nuts, gaskets, jointing material, polyethylene wrap, marker tape, tracer wire, and appurtenances as shown and specified, and as required for a complete and workable piping system.

1.2 RELATED WORK

A. Related work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 50 30 Protection of Existing Utilities
3. Section 31 23 15 Excavation and Backfill for Pipelines
4. Section 33 12 00 Mechanical Appurtenances
5. Section 33 13 00 Pipeline Testing and Disinfection

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ASTM D 2041 Cast-Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250

C. AMERICAN STANDARDS FOR TESTING AND MATERIAL (ASTM)

1. ASTM A 193 Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
2. ASTM A 194 Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
3. ASTM A 283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
4. ASTM A 536 Standard Specification for Ductile Iron Castings

D. American Society of Mechanical Engineers (ASME)

1. ASME B1.1 Unified Inch Screw Threads, (UN And UNR Thread Form)
2. ASME B18.2.1 Square, Hex, Heavy Hex, And Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, And Lag Screws (Inch Series)
3. ASME B18.2.2 Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, And Coupling Nuts (Inch Series)

E. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 104 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
2. AWWA C 105 Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
3. AWWA C 110 Standards for Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48-inch, for Water
4. AWWA C 111 Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
5. AWWA C 115 Standard for Flanged Ductile-Iron Pipe with Ductile Iron or Gray-Iron Threaded Flanges
6. AWWA C 150 Standard for the Thickness Design of Ductile-Iron Pipe
7. AWWA C 151 Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water
8. AWWA C 153 Standard for Ductile-Iron Compact Fittings, 3-inch Through 64-inch for Water
9. AWWA C 219 Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe
10. AWWA C 600 Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances
11. AWWA C 606 Standard for Grooved and Shouldered Joints
12. AWWA C 651 Standard for Disinfecting Water Mains
13. AWWA M 11 Steel Pipe – A Guide for Design and Installation

1.4 SUBMITTALS

A. Submit catalog information on all pipe, fittings, valves, couplings, gaskets, tapes, bolts and nuts, wraps, safety tapes, and tracer wires as shown on the Drawings. Information shall indicate manufacture specification compliance and dimensional data.

B. Submit shop drawings on all fabricated piping and pipe supports.

C. Submit bolting patterns, procedures, and bolting equipment data, and calculations for target torque calculations.

D. Certified affidavit of compliance for pipe and fittings or other materials furnished under this Section and as specified in the referenced standards.

1.5 QUALITY ASSURANCE

A. Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe shall conform to the requirements of the AWWA C151 and AWWA C150 and pipe must be certified for potable water use by the National Sanitation Foundation (NSF/ANSI 61) and must bear the logo "NSF-pw" or "NSF-61" indicating such certification. Pipe thickness rating shall be minimum Class 53 for pipe larger than 12" diameter, and Class 350 for pipe 12" diameter and smaller, unless otherwise noted on the drawings.

The pipe shall be provided with rubber gaskets, specials, and fittings as required. Nominal pipe laying lengths shall be 20-feet.

B. Buried Ductile Iron Pipe shall be encased with 8 mil (minimum), Group 2, Class C black polyethylene, conforming to the requirements of AWWA C105. All seams in the polyethylene encasement shall be taped with a minimum 12 mil adhesive tape, **Polyken #900**, **3M Scotchrap 51,** or approved equal, to completely seal the seam.

2.2 FITTINGS

A. MJ and Push-on fittings shall conform to the (AWWA C110 or C153), be NSF certified to ANSI/NSF 61 and shall be for a minimum rated working pressure of 150 psi.

B. Flanges shall conform to AWWA C110 AWWA C111, and ANSI B16.1, Class 125 and shall have either raised or plain faces, and shall have a minimum working pressure rating of 250 psi. For pipe sizes 24-inch and smaller, flanged joints may be rated for a maximum of 350 psi with the use of specially designed gaskets.

C. All buried fittings shall be completely coated with food grade grease, **Chevron FM Grease**, or approved equal, and shall be completely encased with 8 mil (minimum), Group 2, Class C polyethylene, conforming to AWWA C105 and color to match the pipe wrap. All seams in the polyethylene encasement shall be taped with a minimum 12 mil adhesive tape, **Polyken #900**, **3M Scotchrap 51,** or approved equal, to completely seal the seam.

2.3 DUCTILE IRON PIPE JOINTS

A. Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, or restrained joints as required.

1. Mechanical and push-on joints shall conform to the requirements of AWWA C111.
2. Flanged joints shall conform to the requirements of AWWA C115.
3. Restrained joints shall conform to the requirements of AWWA C151. Restrained joints shall **be Flex-Ring, Field Flex-Ring, or Lok-Ring by American Ductile Iron Pipe, Field Lok, TR-Flex by U.S. Pipe**, or approved equal.
4. Joint restraining devices that impart point loads and/or wedging action on the pipe wall as a means of joint restraint shall not be allowed unless there are no other options available. CONTRACTOR may propose such devices by providing a formal substitution request indicating the locations the devices are to be used and that the devices is rated at least for the class of pipe being supplied. The devices shall be **MegaLug Model 1100 by EBAA Iron**, or approved equal.

2.4 SOLID SLEEVE-TYPE COUPLINGS

A. Solid sleeve-type couplings shall be provided where shown on the Drawings. Coupling shall be of ductile iron and shall be of the size to fit the pipe and fittings shown. Coupling shall be pressure rated 250 psi and comply with AWWA C110. Restraints shall be provided where indicated on the Drawings.

2.5 BOLTED SLEEVE-TYPE COUPLINGS

A. Sleeve-type couplings shall be provided where shown on the Drawings. Couplings shall be of ductile iron, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. Coating shall be fusion bonded epoxy. Couplings shall be pressure rated for 250 psi and comply with AWWA C219. Couplings shall be **Style 501 or FC1 by EJ Prescott, Style 501 by Romac**, or approved equal.

2.6 RESTRAINED BOLTED SLEEVE-TYPE COUPLINGS

A. Restrained bolted sleeve-type couplings shall be provided where shown on the Drawings. Couplings shall be of ductile iron or ASTM A283 Grade C steel, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. Coating shall be fusion bond epoxy. Couplings shall be the rated for 250 psi and comply with AWWA C219. Sleeve length shall be 7 inches for pipe diameters 4-inch through 12-inch and 10 inches for pipe diameters 14-inch and larger. Restraint gland shall be ductile iron meeting the requirements of ASTM A 536. Couplings shall be **Series 470 by Smith-Blair, Style 400RG by Romac, Series 3800 by EBAA Iron, Inc.**, or approved equal.

2.7 FLANGE COUPLING ADAPTER (DISMANTLING JOINT)

A. Provide flanged coupling adapters (dismantling joint) were shown on the Drawings. CONTRACTOR will not be allowed to substitute any other type of flanged coupling adapter unless approved by ENGINEER. The coupling shall be rated as indicated on the Drawings.

B. Flanged coupling adapter bodies shall be fabricated from steel, ASTM A512 or A 513 or Ductile Iron ASTM A536, without pipe stop. The body shall not be less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The follower ring shall be fabricated from steel, ASTM A576 or A36.

C. For flanged coupling adapters installed in piping systems rated for positive pressure, the coupling shall be restrained with harness bolts or tie rods. Other means of restraining the coupling such as set screws will not be accepted. Harnesses shall be designed in accordance with AWWA Manual 11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

D. Gaskets shall be composed of a rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions.

E. Flanged coupling adapters (dismantling joints) shall be **Model 975 by Smith-Blair, Model 309 by JCM, Model DJ400 by Romac**, or approved equal.

2.8 ROMAC ALPHA RESTRAINED FLANGED COUPLING

A. Flanged coupling adapter shall be restrained type capable of joining flanged joint to a DIP plain end and shall have bodies fabricated from Ductile Iron ASTM A536.

B. Restraint shall be mechanical loading type. Coating shall be fusion bonded epoxy.

C. Flanged coupling adapters shall be **Type ALPHA by Romac,** or approved equal.

2.9 GASKETS

A. Except as otherwise provided, gaskets for flanged joints shall be 1/8-inch thick rubber fabric. Class 250 or less flange gaskets shall be **Flange-Tyte by U.S. Pipe**, higher pressure joint gaskets shall be **Garlock BLUE-GARD Style 3000**, or approved equal. Wherever blind flanges are shown, the gaskets shall consist of 1/8-inch thick cloth-inserted rubber sheet which shall cover the entire inside surface of the blind flange and shall be cemented to the surface of the blind flange.

B. All buried fittings using steel bolts shall be coated with no-oxide wax and wrapped with polyethylene or as otherwise approved by ENGINEER.

2.10 BOLTS AND NUTS

A. Bolts and nuts shall be rated for the system working pressure with a minimum safety factor of three. Bolts and nuts buried, submerged, and inside vaults shall be Type 304 stainless steel. Bolts and nuts above grade, exposed or inside structures, shall be zinc coated steel. Bolts and nuts in exposed to wastewater or in corrosive environments shall be Type 304 stainless steel.

B. All flange bolt lengths shall be selected by CONTRACTOR such that three full threads, as a minimum, protrude from the hex nut and washer after assembly.

C. Flange bolts shall have ASME B1.1, Class 2A threads, and be manufactured of ASTM A 193, Grade B7 steel. Bolts shall conform to ASME B18.2.1.

D. Flange nuts shall have Class 2A fit, and be manufactured of ASTM A 194, Grade 2H steel, having square or hex heavy dimensions in accordance with ASME B18.2.2.

E. Connection T-bolts for mechanical joint (MJ) fittings shall be Cor-Ten high strength, low alloy steel conforming to AWWA C111.

2.11 CEMENT MORTAR LINING

A. Ductile iron pipe and fittings shall be lined with cement mortar in accordance with the requirements of the AWWA C104 except that the lining thickness shall be not less than 1/8 of an inch. The pipe interior surfaces shall be smooth and free from factures, excessive crazing, and roughness.

2.12 SAFETY TAPE

A. Safety tape shall be a minimum of 3-inch wide by 5.0 mil overall thickness, with no less than a 0.35 gauge solid aluminum foil core. It shall be Safety Blue in color per American Public Works Association (APWA) National Color Code and shall be clearly labeled with

the words “CAUTION WATER LINE BELOW” or similar wording approved by ENGINEER. Safety tape shall be **MagnaTec by Empire Level Mfg Corp**, or approved equal.

2.13 TRACER WIRE

A. All piping (including service lines) shall be installed with 12 gauge solid copper THHN, #14 UF-G direct bury blue tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe on the top of the pipe and be held in place with poly tape at all pipe joints and at 5 foot intervals.
2. Sections of wire shall be spliced together using approved splice caps and waterproof seals. Twisting the wires together is not acceptable.

2.14 PIPE COATINGS

A. All exposed piping, valves, and fittings including inside vaults and buildings shall be painted as specified in Section 09 90 00 – Painting and Finishes. Exposed piping, valves and fittings to be painted shall be primed by the manufacturer in preparation for painting. CONTRACTOR shall provide verification from the finish coating supplier that the field applied coatings are compatible with the manufacturer’s prime coat. Pipe to be painted shall not have asphalt emulsion coating. The exterior of buried pipe and fittings shall be an asphaltic coating approximately one-mil thick.

PART 3 EXECUTION

3.1 INSTALLATION

A. Excavation and backfill of trenches and for appurtenances shall be in accordance with Section 31 23 15 - Excavation and Backfill for Buried Pipelines.

B. Ductile iron fittings shall be installed in accordance with the ANSI/AWWA C600. Inspect each pipe and fitting prior to installation to verify there is no damage and clean each pipe and fitting prior to installation.

C. Pipe shall be laid directly on the bedding material. Bell holes shall be formed at the ends of the pipe to prevent point loading.

D. No pipe shall be installed on a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation before backfilling occurs.

E. Immediately before joining the pipe, the bell end of the pipe shall be thoroughly cleaned. The spigot end of the pipe and the inside surface of the gasket shall be cleaned and lubricated. The lubricant shall be non-toxic, shall not support bacteria growth, shall not be harmful to the gasket material, and shall be compliant with NSF/ANSI 61 requirements. The lubricant shall not impart a taste or odor to the water in the pipe. Tilting of the pipe to insert the spigot into the bell will not be permitted.

F. Buried Ductile Iron pipe shall be polyethylene encased in accordance with the requirements of AWWA C105 Method A. Remove all lumps of clay, mud, cinders, etc. on the pipe surface before installation of the encasement. During installation, soil or

embedment material shall not be trapped between the pipe and the polyethylene. Cut polyethylene tube to a length at least 2 feet longer than the pipe section. Wrap shall overlap the adjacent pipe joint at least 1 foot. After assembling the pipe joint, overlap the joint with the polyethylene tube and secure to the pipe with adhesive tape completely around the seam. Overlap the joint on the previous pipe with the polyethylene tube and secure to the existing wrap with adhesive tape and completely seal the seam. Take up the slack width at the top of the pipe to make a snug but not tight fit along the barrel of the pipe and secure with poly tape at 5 foot intervals. For installations below the water table or wet areas, circumferential wraps of tape should be placed at 2 foot intervals along the barrel of the pipe prior to lowering the pipe into the trench.

G. All buried Ductile Iron fittings and valves shall be completely coated with food grade grease, **Chevron FM Grease**, or approved equal, and shall be encased with polyethylene wrap and installed in conformance with AWWA C105 standards. All seams in the polyethylene encasement shall be taped with **Polyken #900, 3M Scotchrap 51,** adhesive tape, or approved equal, to completely seal the seam.

H. Repair punctures to the polyethylene wrap with adhesive tape. Repair cuts, tears, or damage to the polyethylene wrap with a tube cut open, wrapped around the pipe to cover the damaged area, and secure in place with **Polyken #900, 3M Scotchrap 51,** adhesive tape, or approved equal, to completely seal the seam.

I. Provide openings for branches, service taps, blowoffs, air valves, and similar appurtenances by cutting an “X” in the polyethylene and temporarily folding back the film. After the appurtenance is installed, tape the slack securely to the appurtenance, and repair the cut and any other damaged areas.

J. To make a direct tap, apply two or three wraps of adhesive tape completely around the polyethylene encased pipe to cover the area where the tapping machine and chain will be mounted. Install the corporation stop directly through the tape and polyethylene encasement. After the direct tap is completed, inspect for damage and repair if needed.

K. Where polyethylene wrapped pipe joins an adjacent pipe that is not wrapped, extend the polyethylene wrap to cover the adjacent pipe for a distance of 3 feet. Secure the end with adhesive tape completely around the seam. Service lines with dissimilar metals shall be wrapped with polyethylene or approved dielectric tape for a minimum clear distance of 3 feet away from the ductile iron pipe.

L. Valves shall be handled in a manner to prevent damage to any part of the valve. CONTRACTOR shall adjust stem packing and operate each valve prior to installation to insure proper operation. Valves shall be installed so that the valve stems are plumb and, in the location, indicated on the drawings.

M. The pipe shall be plugged at the end of each work day or period of suspension.

N. Safety tracer tape shall be installed 12-inches above the pipe along the entire length of pipeline.

O. Tracer wire shall be brought up at valve boxes and fire hydrants as shown on the Drawings. Tracer wire does not need to be brought up at shut-off valves for fire hydrants. When splicing a wire use a greased filled or approved connector. All splices should occur

within a valve box. Wire is to be continuous underground. Underground splices may only be used by specific permission of the OWNER and must be inspected before backfill.

3.2 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to ensure that sand, rocks, or other foreign material do not remain in any of the pipeline. If possible, the flushing shall be made with an open pipe end.

B. CONTRACTOR shall provide to ENGINEER a proposed schedule and method of flushing for review before the flushing starts.

3.3 BOLTING PROCEDURES FOR FLANGED JOINTS

A. Flange joints shall be assembled per the gasket manufacturer's instructions and as specified herein. Utilize calibrated bolting equipment capable of applying a measured torque to flange bolts during joining. Bolting patterns, procedures, and bolting equipment data shall be submitted prior to pipe fitting and bolting.

B. Gaskets, bolts, and anti-seize lubricant used in the bolting procedure shall be selected from those specified herein. Submit target torque calculations for each application. Calculations shall identify specific gasket (manufacturer, model, size, configuration, material), bolts (size and material), and anti-seize lubricant. The calculations shall document and take into consideration the pipe service, working and test pressures, pipe diameter, gasket data sheet, bolt material, gasket supplier-recommended assembly stress, and gasket-supplier recommended bolt stress. Calculations shall be stamped by a professional engineer. Target torque calculations shall be used in the assembly of bolted joints.

C. Flange bolts, nuts, and washers shall be visually inspected and cleaned prior to bolting. Lubricate bolts and nuts; if hardened washers are not used, lubricate the flange surface around the bolt holes. This lubricant must be removed by cleaning solvent prior to applying a coating system. Hand-tighten all nuts and bolts then tighten them to 10 to 20 percent of the target torque. The initial torque shall not exceed 20 percent of the target torque. The bolts shall be tightened according to the pattern included in AWWA Manual M11, Figure 12-3.

D. For flanges having 4 to 8 bolts there shall be three rounds of tightening, after hand tightening, to 30 percent, 60 percent and then 100 percent of the target torque. For flanges having 12 or more bolts there shall be four rounds of tightening, after hand tightening, to 20 percent, 40 percent, 80 percent and 100 percent of the target torque. At 100 percent of target torque the flange gap shall be measured at every other bolt to confirm uniformity. The bolts shall be re-tightened to the target torque 24 hours after completion of the initial bolting sequence.

3.4 TRACER WIRE TESTING

A. Tracer wire shall be installed where indicated above or shown on the Contract Drawings on the pipe along the entire length of pipeline.

B. Upon completion of the pipe installation, CONTRACTOR shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.

1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of OWNER and/or ENGINEER.
2. If the wire is broken, CONTRACTOR shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.5 TESTING OF PIPELINE

A. CONTRACTOR shall provide additional temporary blow-off valves and fittings as required to flush and disinfect new pipelines. Temporary blow-off valves and fittings shall be removed prior to placing pipeline into service.

B. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for pressure testing of the pipeline.

C. Testing Procedure

1. Pipe shall be tested at a static pressure of 40 psi for 2 hours and in accordance with the AWWA C600 standards. Pipe shall be tested in segments such that the test pressure at the low point of the segment shall be 60 psi, and the minimum pressure at the high point in the segment shall be 40 psi.
2. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the excessive leakage, shall take corrective measures necessary to repair the leaks, and shall repeat the pipeline test, all at no additional cost to OWNER.
3. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that ENGINEER may be present during the test.

D. Pressure and Leak Test

1. CONTRACTOR shall test all piping either in sections or as a unit. The test shall be made by placing temporary bulkheads as needed in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during the filling. Bulkheads, valves, and connections shall be examined for leaks. If any leaks are found, corrective measures satisfactory to ENGINEER shall be taken. The test shall consist of holding a minimum pressure as shown on the Drawings in the section being tested for a minimum period of two hours using either pneumatic or hydraulic means to maintain the pressure. Suitable means shall be provided by CONTRACTOR for determining the quantity of water lost by leakage under the test pressure. The testing allowance is defined as the quantity of water that must be applied to the pipe section being tested to maintain a pressure within 5 psi of the specified hydrostatic test pressure. The maximum allowable leakage shall be defined as follows:

$$L = SD(P)1/2/148,000$$

L = Testing allowance (makeup water) in gallons per hour of test
S = Length of pipe in feet

D = Nominal diameter of pipe in inches
P = Average Test Pressure in pounds per square inch (gauge)

3.6 DISINFECTING

A. Disinfection shall be in accordance with Section 33 13 00 – Pipeline Testing and Disinfection.

3.7 PAINTING

A. All exposed piping including inside vaults shall be painted as specified in Section 09 90 00 – Painting and Finishes.

- END OF SECTION -

SECTION 33 05 11
HDPE PRESSURE PIPE (AWWA C906)

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers furnishing and installation of the high density polyethylene (HDPE) pipeline as shown on the Contract Drawings and specified herein.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittals
2. Section 31 23 15 Excavation and Backfill of Buried Pipelines
3. Section 33 13 00 Pipeline Disinfection

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

1. ASTM D 1248 Standard Specifications for Polyethylene Plastics Extrusion Materials for Wire and Cable
2. ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
3. ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
4. ASTM D 2837 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
5. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
6. ASTM D 3350 Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
7. ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
8. ASTM F 1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing

C. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2"-inch through 3-inch, for Water Service.
2. AWWA C 906 Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution and Transmission.
3. AWWA M 55 PE Pipe – Design and Installation

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. The following shall be submitted:

1. Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.
2. A plan for pipe joining and installation. The plan must be reviewed and approved by ENGINEER prior to pipe installation.

1.5 QUALITY ASSURANCE

A. Pipe shall be subject to inspection at the place of manufacture. Notify ENGINEER not less than 14 days prior to the start of any phase of the pipe manufacture. During manufacture the ENGINEER shall be given access to all areas of the process and shall be permitted to make inspections necessary to confirm compliance with the Specifications.

B. Materials used in the manufacture of the pipe shall be tested in accordance with this Section and the referenced standards. CONTRACTOR shall perform said material tests. ENGINEER shall have the right to witness testing provided that CONTRACTOR's schedule is not delayed for convenience of ENGINEER.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe up to 3-inch nominal diameter shall meet the requirements of AWWA C901. Pipe 4-inch through 63-inch nominal diameter shall meet the requirements of AWWA C906.

B. The high density polyethylene pipe shall be as manufactured by **JM Eagle, WL Plastics Corp.**, or approved equal, and shall have a minimum pressure rating as noted on the Contract Drawings. The HDPE pipe shall have designation of PE 4710 (IPS size), made from prime virgin resin with a minimum cell classification of PE 445574C or higher in accordance with ASTM F-714 and D 3350. The resin shall be listed by the Plastic Pipe Institute (PPI) in its pipe-grade registry Technical Report (TR) 4, "Listing of HDB/HDS/SDB/PDB/MRS for Thermoplastic Piping Materials or Pipe".

C. The manufacturer shall comply with NSF Standard 14 and NSF 61 by certifying in writing to the design engineer and making the pipe with the NSF logo in the print line. The manufacturer shall comply with AWWA Standard C901 or C906 by certifying to the design engineer and marking the pipe with the appropriate AWWA standard in the print line.

D. Pipe shall be marked per AWWA C901 or C906 and NSF. Pipe markings shall include nominal size, OD base, dimension ratio, pressure class, manufacturer's name, manufacturer's production code including day, month, and year extruded, and manufacturer's plant and extrusion line.

E. Fittings shall be pressure rated to match the system piping to which they are joined. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall

meet the outside diameter and minimum wall thickness specifications of AWWA C901 or AWWA C906 for the same size of pipe.

2.2 TRACER WIRE

A. All direct bury piping (including service lines) shall be installed with 12 gauge solid copper THHN tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe on the top of the pipe and be held in place with ties or hitches spaced not more than 12-feet apart.
2. Sections of wire shall be spliced together using approved splice caps and waterproof seals or solder. Twisting the wires together is not acceptable.

2.3 SAFETY TAPE

A. Safety tape shall be a minimum of 3-inch wide by 5.0 mil overall thickness, with no less than a 0.35 gauge solid aluminum foil core. It shall be Safety Blue in color per American Public Works Association (APWA) National Color Code and shall be clearly labeled with the words “CAUTION WATER LINE BELOW” or similar wording approved by ENGINEER. Safety tape shall be **MagnaTec by Empire Level Mfg Corp**, or approved equal.

PART 3 EXECUTION

3.1 STORAGE AND HANDLING

A. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. Sections of pipe with deep cuts or gouges shall be removed and ends of pipes rejoined. Handling of the joined pipe shall be in such a manner that the pipe is not damaged by dragging over sharp or cutting objects.

B. Lifting of joined pipe sections shall preclude concentration of bending stresses at joints and shall be done in a manner which evenly distributes lifting stresses along the full length of the pipe.

C. Pipe shall be stored in a shaded area or covered to avoid temperature extremes which may cause the pipe to bow or warp.

3.2 EXCAVATION AND BACKFILL

A. Excavation and backfill of trenches and for appurtenances and backfilling for high density polyethylene pipe shall be in accordance with Section 31 23 15 Excavation and Backfill for Buried Pipelines.

3.3 INSTALLATION

A. High density polyethylene pipe shall be installed according to the requirements of ASTM D 2321, AWWA M 55, and the manufacturer's requirements. Wherever the aforementioned requirements are in conflict, the more stringent requirement shall apply.

B. Sections of pipe shall be joined into continuous lengths by the butt fusion method and shall be performed in strict conformance with the pipe manufacturer's recommendations

using approved equipment. Sections of pipe shall be as long as practical to minimize the number of joints.

C. High density polyethylene pipe shall be installed, backfilled, and allowed to acclimatize to the typical soil temperatures prior to connection to other piping systems.

3.4 TRACER WIRE TESTING

A. Safety tracer wire shall be installed above pipe as required by the Contract Drawings. Tracer wire shall also be installed as required by the Contract Drawings.

B. Upon completion of the pipe installation, CONTRACTOR shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.

1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of OWNER or ENGINEER.
2. If the wire is broken, CONTRACTOR shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.5 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to ensure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible, the flushing shall be made with an open pipe end.

B. CONTRACTOR shall provide to ENGINEER a proposed schedule and method of flushing for review before the flushing starts.

3.6 PRESSURE AND LEAK TEST

A. The system design pressure shall be 40 psi for the new pipeline.

B. Testing prior to pipe installation outside of the trench.

1. CONTRACTOR shall test all piping either in sections or as a unit. The test shall be made by placing temporary bulkheads as needed in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during the filling. After the piping or section thereof has been filled, subject the pipe to a hydrostatic test pressure that equal to 1.5 times the system design pressure for a maximum of three hours. During this time, add water periodically to maintain the test pressure; this compensates for the initial stretching of the pipe. The line-pressure tightness is determined by visual observation; therefore, it is not necessary to measure the make-up water. Examine every fused joint; any leakage must be repaired and then retested.
2. CONTRACTOR shall be responsible to ensure that appropriate safety precautions are observed during the hydrostatic testing above ground.

C. Testing in the trench. Fill the pipeline with water after it has been laid; bleed off any trapped air. Subject the lowest element in the system to a test pressure that is 1.5 times the design pressure, and check for any leakage. When, in the opinion of the engineer, local conditions require that the trenches be backfilled immediately after the pipe has

been laid, apply the pressure test after backfilling has been completed but not sooner than a time which will allow sufficient curing of any concrete that may have been used.

1. The test procedures consist of two steps: the initial expansion and the test phase. When test pressure is applied to a water-filled pipe, the pipe expands. During the initial expansion of the pipe under test, sufficient make-up water must be added to the system at hourly intervals for three hours to maintain the test pressure. After about four hours, initial expansion should be complete and the actual test can start.
2. When the test is to begin, the pipe is full of water and is subjected to a constant test pressure of 1.5 times the system design pressure. The test phase should not exceed three hours, after which time any water deficiency must be replaced and measured. Add and measure the amount of make-up water required to return the test pressure and compare this to the maximum allowance in Table 33 05 11-1 below.

TABLE 33 05 11-1
ALLOWANCE FOR EXPANSION UNDER TEST PRESSURE

Nominal Pipe Size	U.S. Gal/100 ft of Pipe			Nominal Pipe Size	U.S. Gal/100 ft of Pipe		
	1-Hour	2-Hour	3-Hour		1-Hour	2-Hour	3-Hour
2	0.08	0.12	0.15	20	2.80	5.50	8.00
3	0.10	0.15	0.25	22	3.50	7.00	10.50
4	0.13	0.25	0.40	24	4.50	8.90	13.30
5	0.21	0.41	0.63	28	5.50	11.10	16.80
6	0.30	0.60	0.90	30	6.20	12.60	19.10
8	0.50	1.00	1.50	32	7.00	14.30	21.50
10	0.75	1.30	2.10	36	9.00	18.00	27.00
12	1.10	2.30	3.40	42	12.00	24.00	36.00
14	1.40	2.80	4.20	48	15.00	27.00	43.00
16	1.70	3.30	5.00	54	18.00	30.00	50.00
18	2.20	4.30	6.50				

From PPI Technical Report TR-31 by the Plastic Pipe Institute.

D. An alternate leakage test consists of maintaining the test pressure over a period of four hours, and then dropping the pressure by 10 psi. If the pressure then remains within 5% of the target value for one hour, this indicates there is no leakage in the system.

E. Under no circumstances shall the total time under test exceed eight hours at 1.5 times the system pressure rating. If the test is not complete within this time limit (due to leakage, equipment failure, etc.), the test section shall be permitted to “relax” for eight-hours prior to the next test sequence.

3.7 DISINFECTING

A. Disinfection shall be in accordance with Section 33 13 00- Pipeline Testing and Disinfection.

- END OF SECTION -

SECTION 33 08 30
GRAVITY PIPELINE TESTING

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall test sanitary system, overflow, storm drain, and other gravity drains in accordance these specifications and with the Contract Documents.

B. CONTRACTOR shall be responsible for obtaining permits for discharging excess testing water and dechlorination of such water, if required.

1.2 RELATED SECTIONS

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 33 05 02 Reinforced Concrete Pipe

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM C 828 Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines
2. ASTM C 969 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
3. ASTM C 1103 Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
4. ASTM D 3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
5. ASTM F 1417 Standard Test Method for Installation of Plastic Gravity Sewer Line Using Low Pressure Air

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Furnish a written testing plan and schedule, including water source and methods for conveyance to the project, sequence, control, and disposal.

C. Where deflection testing of flexible pipe is required, submit a method for mandrel testing or other measurement, as applicable to pipe size.

1.5 PERFORMANCE REQUIREMENTS

A. Gravity flow sanitary sewers are required to have a straight alignment and uniform grade between manholes.

B. Flexible pipe, including “semi-rigid” pipe, is required to show no more than 5 percent deflection. Test pipe no sooner than 30 days after backfilling of a line segment but prior to final acceptance using a standard mandrel to verify that installed pipe is within specified deflection tolerances.

C. Maximum allowable leakage for infiltration and exfiltration:

1. The total infiltration or exfiltration shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours at a minimum test head of 2 feet above the crown of the pipe at the upstream manhole or 2 feet above the groundwater elevation, whichever is greater.

D. Time allowed for pressure loss from 3.5 psig to 2.5 psig shall be per Table 33 08 30 – 2 at the end of this section.

PART 2 MATERIALS

2.1 DEFLECTION MANDREL

A. Design: CONTRACTOR shall construct a mandrel of steel or rigid plastic which can withstand a force of 200 psi without deforming. The mandrel shall have 9 or more "runners" or legs, as long as the number is an odd number. The mandrel barrel length shall be at least 75 percent of the pipe inside diameter.

B. Sizing: The rigid mandrel shall have an outside diameter (O.D.) equal to 95 percent of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe. Dimensions shall be per appropriate standard. Statistical or other “tolerance package” shall not be considered in mandrel sizing.

2.2 VIDEO EQUIPMENT

A. Use color video equipment. Prepare three copies of the video in DVD format and deliver two copies to OWNER and one copy to ENGINEER. Record the project name, contractors name, date recorded, and locations of the video on the DVD.

B. Produce a DVD using a pan-and-tilt radial-viewing pipe inspection camera that pans 275 degrees and rotates 360 degrees. Use a camera with an accurate footage counter which displays on the monitor the exact distance of the camera from the centerline of the starting manhole. Use a camera with camera height adjustment so that the camera lens is always centered at one-half the inside diameter, or higher, in the pipe being videoed. Provide a lighting system that allows the features and condition of the pipe to be clearly seen. A reflector in front of the camera may be required to enhance lighting in dark or large diameter pipe.

PART 3 EXECUTION

3.1 GENERAL

A. Gravity pipes shall be tested for exfiltration or infiltration and deflection as indicated. Manholes and pipe shall be backfilled prior to testing. The maximum length of pipe

tested shall be the 4 reaches between 5 manholes. Leakage tests shall be completed and approved prior to placing of permanent resurfacing of pavement. When leakage or infiltration exceeds the allowed amount, CONTRACTOR shall locate the leaks and make the necessary repairs or replacements to reduce the leakage or infiltration to the allowable limits. Individually detectable leaks shall be repaired, regardless of whether the test results are acceptable or not.

B. CONTRACTOR shall assume all responsibility to obtain the necessary water for testing of the gravity pipes.

C. No materials shall be used which could damage the pipeline.

D. Air test gauges shall be laboratory-calibrated test gauges, and if required by ENGINEER, shall be recalibrated by a certified laboratory prior to the leakage test. Air test gauges shall have a size and pressure range appropriate for the pipe being tested.

E. Testing shall be performed in the presence of OWNER and/or ENGINEER.

F. Remove debris, sediment, and other material from installed pipe prior to testing. Do not discharge or flush sand, gravel, concrete, debris, or other foreign material into any existing pipeline system. Flushing with clean water only will be allowed but with minimal flows to eliminate exceeding capacities of the existing gravity systems.

3.2 TESTING SCHEDULE

A. Leakage Tests

1. Perform leakage tests as determined from the Table 33 08 30 - 1 below:

TABLE 33 08 30 - 1				
	Criterion 1 Slope Between Manholes		**Criterion 2 Difference in Water Levels**	
Pipe Size	Manhole Delta H (feet)		Test Water vs Ground Water Delta H (feet)	
	Less than or equal to 10 ft	Greater than 10 ft	Greater than or equal to 4 ft	Less than 4 ft
Less than or equal to 24 inches	See Criterion 2	Infiltration or Air (See Note 1)	Exfiltration	Infiltration or Air
Greater than 24 inches	See Criterion 2	See Criterion 2	Exfiltration	Infiltration

Notes:
1) If groundwater is present and at least 1 foot above the top of the pipe, perform an infiltration test. If groundwater is not present, perform an air test.
2) Definitions:
   a) Manhole Delta H is the invert elevation difference between two adjacent manholes.
   b) Test Water vs Groundwater Delta H is the required elevation of water surface for testing minus the average elevation of groundwater adjacent to the pipe to be tested.

3.3 AIR PRESSURE TEST

A. Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter.

B. Lines 36-inch average inside diameter and larger shall be “joint” tested at each joint. The minimum allowable for the pressure drop from 3.5 psig to 2.5 psig during a joint test shall be 10 seconds, regardless of pipe size. Joint test shall be conducted as follows:

1. Each joint shall be tested successfully.
2. Joint tester shall be set over joint to be tested so that the two inflation tubes straddle the joint.
3. Inflate tubes to 25 psig to seal off joint to be tested.
4. Apply air pressure into void between inflation tubes until pressure reaches 4 psig.
5. After pressure has stabilized, bleed air pressure back to 3.5 psig.
6. Record time required for pressure to drop from 3.5 psig to 2.5 psig.
7. If the time in seconds for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than 10 seconds, the joint shall be presumed to be free from defect. When the time is less than 10 seconds pipe breakage, joint leakage, or leaking testing seals are indicated and an inspection must be made to determine the cause. CONTRACTOR shall affect such repairs as may be required to accomplish a successful air joint test.

C. For pipe sections less than 36-inch average inside diameter:

1. Determine the groundwater level.
2. Plug both ends of the pipe. For concrete pipe, flood pipe and allow 2 hours to saturate concrete. Then drain and plug pipe.

3. After a manhole to manhole section of pipe has been sliplined and prior to any services lines being connected to new liner, plug liner at each manhole with pneumatic plugs.
4. Pressurize pipe to 4.0 psig. Increase pressure 1.0 psi for each 2.3 feet of ground water over highest point in the system. Allow pressure to stabilize for 2 to 4 minutes. Adjust pressure to start at 3.5 psig (plus adjustment for ground water table). See Table 33 08 30 - 2 at the end of this Section.
5. To determine air loss, measure the time interval for pressure to drop to 2.5 psig. The time must exceed that listed in the Table 33 08 30 - 2 at the end of this Section for pipe diameter and length. For sliplining, use diameter of carrier pipe.

D. The test of the pipe and service laterals shall be conducted in the presence of ENGINEER. Testing of pipe, regardless of the pipe material, shall be performed in accordance with ASTM C 828, C 1103, or ASTM F 1417, as applicable.

E. Any section of pipe which fails to meet requirements shall be repaired and retested.

3.4 EXFILTRATION TEST

A. Exfiltration testing shall be completed in accordance with ASTM C 969 and as modified below. Testing shall be conducted in the presence of ENGINEER and/or OWNER.

B. Each section of gravity lines shall be tested between successive manholes by closing the lower end and the inlet gravity lines of the upper manhole with stoppers or inflatable plugs. The pipe and manhole shall be filled with water to a point 4-feet above the centerline of the gravity line at the center of the upper manhole; or if ground water is present, 4-feet above the average adjacent ground water level, whichever is higher.

C. Water shall remain in the pipe for at least one hour or until the water level stabilizes, whichever is longer, before the test begins. The minimum test duration shall be 4 hours.

D. Unless indicated otherwise, CONTRACTOR shall measure exfiltration. Measure the amount of water added to the upstream manhole to maintain the water level at the elevation set above. Compare the amount added to the allowable leakage calculated below, and if the amount added is equal to or less than the allowable amount, the tested section of the pipe has passed.

E. The allowable leakage will be computed by the formula:

$$E = 0.000012\ LD\ (H)^{1/2}$$

Where:

E = Allowable leakage in gallons per minute of gravity line tested.
L = Length of gravity line and house connections tested, in feet.
D = Internal diameter of the pipe, in inches.
H = Elevation difference in feet between the water surface in the upper manhole and the centerline of the pipe at the lower manhole; or if ground water is present above the centerline of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the ground water at the lower manhole.

3.5 INFILTRATION TEST

A. Infiltration testing shall be completed in accordance with ASTM C 969 and as modified below. Testing shall be conducted in the presence of ENGINEER and/or OWNER.

B. Groundwater elevation must be not less than 2 feet above the highest point of pipe or service lead (house service).

1. Determine groundwater elevation
2. Plug incoming pipes in upstream manhole.
3. Insert calibrated 90° V-notch weir in pipe on downstream manhole.
4. Allow water to rise and flow over weir until it stabilizes.
5. Take five readings of accumulated volume over a period of 2 hours and use average for infiltration. The average must not exceed that calculated using the equation in paragraph 3.4.D above.

3.6 DELFECTION TEST

A. Mandrel Test

1. CONTRACTOR shall test all flexible and semi-rigid pipe 30-inches and smaller for deflection, joint displacement, and other obstructions by passing the mandrel through the pipe not less than 30 days after completion of the trench backfill, but prior to permanent pavement resurfacing.
2. Testing shall confirm the pipe has no more than 5 percent deflection. Mandrel testing shall conform to ASTM D 3034. Pull the approved mandrel by hand through sewer sections.
3. Pipe with diameter less than the mandrel will be considered defective and CONTRACTOR shall replace it.

B. Flexible or semi-rigid pipe larger than 30-inches shall have deflections measured by a rigid metal bar, a rigid frame, or other method approved by ENGINEER.

1. The average inside diameter shall be measured before the pipe is installed and backfilled.
2. Deflection is defined as the difference between vertical inside diameter in the pipe before and after installation and backfilling.

3.7 MANHOLE TEST

A. Manholes shall be hydrostatically tested for leakage prior to backfilling. Prior to testing, manholes shall be visually inspected for obvious defects. Leaks or cracks shall be repaired to the satisfaction of ENGINEER.

B. All pipes entering the manhole shall be sealed at a point outside the manhole walls to include testing of the pipe to manhole joints. The manhole shall be filled with water to a level 2-inches below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least one hour to allow the water level to stabilize, the manhole shall be refilled and the water level shall be marked. The water level shall again be checked after 4 hours. The maximum leakage shall be 0.025 gallons per foot of manhole diameter per foot of manhole depth per hour. The exterior of the manhole shall be inspected during this period for visible evidence of leakage. Visible moisture,

sweating, or beads of water on the exterior of the manhole shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of ENGINEER regardless of the volume of water lost.

3.8 VIDEO INSPECTION

A. Immediately after cleaning and testing, video the gravity pipeline to document the condition of the line. Notify ENGINEER 24 hours in advance of any video inspection so that ENGINEER or RESIDENT PROJECT REPRESENTATIVE may observe inspection operations.

B. Survey video inspection DVDs shall be continuous for pipe segments between manholes. Do not leave gaps in the videotaping of a segment between manholes and do not show a single segment on more than one DVD.

C. Do not pull or propel the video camera through the line at a speed greater than 30 feet per minute.

3.9 ALIGNMENT AND GRADE TEST

A. Line and grade of pipe may not vary more than 1/2 inch in 10 feet and not more than 1 inch variance from true line at any location.

B. Grade of pipe may not vary more than 1/4 inch in 10 feet for all design grades less than or equal to 1 percent and not more the 1/2 inch total variance from true grade at any location. Also, grade of pipe may not vary more than 1/2 inch in 10 feet for all design grades greater than 1 percent and not more than 1 inch total variance from true grade at any location. These tolerances shall be acceptable provided that such variation does not result in a level or reverse sloping invert.

C. The variation in the invert elevation between adjoining ends of pipe due to eccentricity of joining surface and pipe interior surfaces shall not exceed 1/64 inch per inch of pipe diameter, or 1/4 inch maximum.

TABLE 33 08 30 – 2 (1.0 psi Pressure Drop)

Pipe Diameter (inch)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec/ft)	Specification Time for Length (L) Shown (min:sec)								
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14
30	28:20	80	21.3690	35:37	53:25	71:14	89:02	106:51	124:39	142:28	160:16	178:05
36	34:00	66	30.768	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46	256:24
42	39:48	57	41.883	69:48	104:42	139:37	174:30	209:24	244:19	279:13	314:07	349:02
48	45:34	50	54.705	91:10	136:45	182:21	227:55	273:31	319:06	364:42	410:17	455:53
54	51:02	44	69.236	115:24	173:05	230:47	288:29	346:11	403:53	461:34	519:16	576:58
60	56:40	40	85.476	142:28	213:41	284:55	356:09	427:23	498:37	569:50	641:04	712:18

- END OF SECTION -

SECTION 33 12 00
MECHANICAL APPURTENANCES

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall furnish and install all valves, and equipment, complete and operable in accordance with the Specifications.

B. Where 2 or more valves or equipment of the same type and size are required, the valves shall be furnished by the same manufacturer.

C. CONTRACTOR shall verify that flanges on pipe match the bolt hole pattern of the flanges on the mechanical appurtenances.

D. All appurtenances shall be NSF 61 certified if used in potable water systems.

E. Unless noted otherwise below or on the Contract Drawings, all system components shall be rated for the maximum system pressure or higher.

1.2 RELATED WORK

A. Related work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control & Materials Testing
3. Section 01 50 00 Temporary Construction Utilities and Environmental Controls
4. Section 31 23 15 Excavation and Backfill for Buried Pipelines
5. Section 31 23 23 Excavation and Backfill for Structures
6. Section 33 05 05 Ductile Iron Pipe
7. Section 33 05 11 HDPE Pressure Pipe (AWWA C906)

1.3 REFERENCES

A. The latest edition of the following publications form a part of these specifications to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. A 126 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
2. A 216 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
3. B 584 Standard Specification for Copper Alloy Sand Castings for General Applications

C. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. C 504 Rubber-Seated Butterfly Valves, 3-inch through 72-inch
2. C509 Resilient-Seated Gate Valves for Water Supply Service

3. C512 Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
4. C 515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
5. C 518 Dual-Disc Swing-Check Valves for Waterworks Service
6. C 550 Protective Interior Coatings for Valves and Hydrants

D. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. B 16.1 Gray Iron Pipe Flanges and Flanged Fittings
2. B 16.34 Valves – Flanged, Threaded, and Welding End

E. NSF INTERNATIONAL (NSF)

1. NSF/ANSI 61 Drinking Water System Components - Health Effects

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit catalog cut sheets on all mechanical appurtenances including fittings, valves, or other items shown on the Contract Drawings referencing each item by mark number. Information shall indicate manufacturer specification compliance, Cv factor, pressure rating, and dimensional data.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Gate valves shall conform to the requirements of AWWA C-509 or C-515. Valves shall be of the resilient-seat type with non-rising stem (NRS), opening to the left, and provided with a 2-inch square operating nut for buried valves or hand wheel for valves located in structures. Buried valves shall be of flange or mechanical joint design to match pipe joint system.

B. Valves, valve-operating units, stem extensions and other accessories shall be installed by CONTRACTOR where shown, or where required in the opinion of ENGINEER, to provide for convenience in operation. Where buried valves are indicated, CONTRACTOR shall furnish and install valve boxes to 3-inches above grade in unimproved areas or at grade with concrete collar in improved areas. All valves and gates shall be new and of current manufacture.

C. The valve shall have a two part thermosetting or fusion bonded epoxy protective coating (10 mil minimum inside and out) system that is non-toxic and imparts no taste to water. The epoxy shall be applied in accordance with AWWA C550 and be ANSI/NSF 61 certified.

D. The flanges of valves may be raised or plain faced. Flanges of valves shall be faced and drilled to 125-lb American Standard template. Provide ASME Class 250 flanges for valves located on the high pressure discharge side piping.

E. All valves shall be furnished with pressure classes equal to or better than the pressure class of the pipe with which the valves are to be used. Unless otherwise specified, each

valve body shall be tested under a test pressure equal to twice its design water-working pressure.

F. Valves shall be manufactured by **Mueller Co., Clow Valve Co., American Flow Control, Kennedy Valve Co., American AVK Company (high pressure)**, or approved equal.

2.2 BUTTERFLY VALVES

A. Butterfly valves shall conform to the following requirements:

1. Butterfly valves shall have a double offset disc design to reduce torque and seat wear, known as a double eccentric type. Valves shall be AWWA C504 Standard Class 150B.
2. The valves shall have a heavy-duty ductile iron body conforming to ASTM A 536 65-45-12 with flanges fully faced and drilled per ANSI B16.1 Class 150B. Maximum flow velocity shall be less than 16 fps for cold water service.
3. Disc body shall conform to ASTM A536 65-45-12 or 60-40-18 and shall be pinned used 2205 Duplex stainless steel pin. Disc seat shall be elastomeric and shall be secured to the disc with Type 316 stainless steel hardware. Disc seat shall be EPDM unless manufacturer recommends alternative which demonstrates better resistance to abrasion.
4. Body seat shall be 316L stainless steel and shall be applied through a high alloy weld double overlay process with a minimum thickness of 5mm.
5. The valve shall have a hand wheel operator and shall be geared to close slowly. Position indicator shall be provided with valve.
6. The valve shall a fusion bonded epoxy protective coating inside and outside with a minimum DFT of no less than 14 mils. Coating shall meet AWWA C550 and shall be non-toxic and impart no taste to water.

B. Where shown on the Drawings the valves shall be electrically actuated. See Section 40 92 57 Electric Motor Actuators.

C. The valve shall be manufactured by **Av-Tek, VAG, AVK**, or approved equal.

2.3 BALL VALVES

A. Valves shall be rated for the working pressure of the system. Valves for use in potable water systems shall be NSF 61 certified.

B. Segmented Ball Valves shall be v-ported ball quarter turn valves. Valves shall be Neles R-Series Segment Valve, flanged RE, with low flow Q trim for cavitation/noise abatement as manufactured by Metso Automation. Flanges and body shall be ASME 150 rated. Valves shall be connected to a 3 phase electric motor operator.

C. Brass Ball Valves shall be full port opening brass body, hard chrome plated brass ball and have adjustable stem packing gland. Seat and seals shall be PTFE. Handle shall be heavy duty, zinc-plated steel with vinyl insulator. They shall be **Apollo 64 Series**, or approved equal.

2.4 VALVE BOXES AND LIDS

A. All buried valves shall be installed complete with 6-inch diameter slide type, two-piece cast iron valve box. Manufacturer be **Tyler 562 Series**, or approved equal. The valve box lid shall be designated “WATER” unless noted otherwise on the Contract Drawings.

B. Concrete Collars shall be 10" thick x 2'- 6" in diameter centered on the valve box. They shall have two circumscribing #4 bars, one at three inches from the outside edge and a second bar nine inches from the outside edge each centered in the concrete. Concrete shall be 3000 psi.

2.5 CHECK VALVES

A. The globe style check valves shall be **APCO Globe Style Series 600 Silent Check Valves**, or approved equal, and shall be rated at 150 psi.

B. The 1-inch and 2-inch brass check valves shall be **Watts CVY Series**, or approved equal, with rating 125 WSP/200 WOG.

C. The 1-inch PVC check valves shall be **Spears Industrial Ball Check Valve Model 4521**, or approved equal, with a pressure rating of 235 psi.

2.6 SWING CHECK VALVES

A. Provide 250 psi rated, ASME Class 125 flanged AWWA C508 compliant, ductile iron body, swing check valves with domed access cover and vent port cable of accepting air cushion, lever and weight within removable perforated metal safety guard.

B. Provide lever and weight adjustable (to 30 deg below horiz) with air cushion assembly; one piece stainless steel disc, 2 pivot pins, convex removable stainless steel disc with removable BNA-N molded O-ring seal surface, drip tight shut off at all pressures, V type shaft packing, pre-wired limit switch to indicate open-closed position, FBE lined and coated. Submit proof of testing with zero leakage.

C. Provide Valmatic Series 7800 Swing Check Valve, or Engineer approved equal.

2.7 HOSE BIBBS and SAMPLING TAPS

A. Hose bibbs shall be as-manufactured by Watts, or approved equal, and shall include an integral vacuum breaker or built-in backflow protection devices and cast iron wheel handle. Sampling Taps shall be smooth nose type. Valves shall be stainless steel.

2.8 COMBINATION AIR/VACUUM VALVES

A. Combination Air/Vacuum valves shall be single body, double orifice valves conforming to the requirements of AWWA C 512. Valve float shall be stainless steel. Valves shall be the size indicated on the drawings and shall be **Series 1504 by APCO (DeZURIK)**, or approved equal.

2.9 AIR RELEASE VALVES

A. Air release valves shall be provided where shown. Valve body shall be ductile iron and float shall be stainless steel and shall conform to the requirements of AWWA C 512. Air

release valves on the discharge piping shall be designed for a working pressure of 350 psi. Valves shall be the size indicated on the drawings and shall be **Series 200 by APCO (DeZURIK)**, or approved equal.

2.10 AIR VALVE FOR DEEP VERTICAL TURBINE SERVICE

A. Provide AWWA C512 compliant air valve for deep well vertical turbine pump rated to 150 psi min **Valmatic 102 ST**, well service air valves, or Engineer approved equal.

B. Provide valve with the following functions:

1. Provides regulated exhausting of large volumes of air during pump startup and filling
2. Admits large volumes of air during shut down and draining of well
3. Provides air related surge protection
4. Protects against column separation
5. Maintains pipeline efficiency
6. Provides protection against damage to pipe joints, gaskets, packing

2.11 PUMP CONTROL VAVLE

A. The pump control valve shall be a deep well pump control valve pilot operated valve designed to eliminate pipe surges caused by the starting and stopping of vertical turbine pumps. A four-way solenoid pilot valve controls the valve operation. It shall contain a resilient, synthetic rubber disc.

B. The pump control valve shall be manufactured by Cal-Val Co., Model 61-02, for installation at the location shown on the drawings. The valve shall be full port globe style and shall include the required pilot, dual position indicator switches (one for open and one for closed), and solenoid system assemblies. The pressure class shall be 150 lb, rated for 250 psi working pressure, and the valve shall include opening and closing speed adjustments, stainless steel trim, stainless steel tubing, and “Y” strainers. The solenoid shall operate on 120 volts AC.

C. A direct factory representative shall provide start-up assistance, inspection and adjustments. The representative shall provide 2 to 4 hours of assistance for each valve installed on the project.

2.12 TAPPING SLEVE

A. Tapping sleeve shall be stainless steel split-sleeve type with flanged outlet, bolts, follower rings and gaskets on each end of sleeve suitable for maximum working pressure of 150 psi and shall be **JMC Industries Model #432, Ford Meter Box Company, Smith-Blair, Romac Industries Model SST,** or approved equal. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets shall be as recommended by manufacturer of the sleeve.

B. Flange shall be ductile iron meeting ASTM A536 grade 65-45-12.

C. Sidebars and lugs shall be 304 stainless steel, heavy gauge.

D. Test ports and test plugs shall be 304 stainless steel. Test ports shall be ¾ inch FNPT. Test plugs shall be coated to prevent galling.

E. Bolts and nuts shall be 304 stainless steel. Nuts shall be coated to prevent galling.

F. Gaskets shall be SBR and shall provide seal around the full circumference of the pipe.

G. Tapping valves shall conform to Section 33 12 00 2.1 – Gate Valves. Tapping valves shall be designed for a minimum working pressure of 150 psi, and have a clear waterway equal to the full nominal diameter of the valve.

H. Tapping sleeves and tapping valves shall be installed in accordance with the manufacturer's recommendations.

I. Tapping sleeves shall be disinfected by flushing the exterior of the pipe with potable water after removal of the existing coating. Swab exterior of the pipe with a 1 percent sodium hypochlorite solution. Disinfection shall be performed per AWWA C651, Section 4.8. After completion of tapping and line stopping, swab the interior of the pipe, valves, and faces of flanges to be connected to bypass piping with a 1 percent sodium hypochlorite solution.

2.13 FLOW METER

A. See Section 40 91 23 – Miscellaneous Properties Measurement Devices.

2.14 PRESSURE TRANSMITTERS

A. See Section 40 91 23 – Miscellaneous Properties Measurement Devices.

PART 3 EXECUTION

3.1 INSTALLATION

A. Valves, valve-operating units, stem extensions and other accessories shall be installed by CONTRACTOR where shown, or where required in the opinion of ENGINEER, to provide for convenience in operation. Where buried valves are indicated, CONTRACTOR shall furnish and install valve boxes at grade with concrete collars. All valves and boxes shall be new and recently manufactured.

B. Install mechanical appurtenances as indicated on the plans and in accordance with the manufacturer's written instructions.

- END OF SECTION -

SECTION 33 12 30
DEEP WELL PUMP AND PUMP MOTOR

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish, deliver and install an oil lubricated surface discharge deep well turbine pump into the well casing to depths as shown on the drawings.

1.2 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at time of award of the Contract:

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
2. ANSI/HI 9.6.4 Rotodynamic Pumps for Vibration Measurements and Allowable Values

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Structural Steel
2. ASTM A 48 Gray Iron Castings
3. ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
4. ASTM A 108 Steel Bars, Carbon, Cold Finished, Standard Quality
5. ASTM A 269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
6. ASTM A 536 Standard Specification for Ductile Iron Castings
7. ASTM A 582 Standard Specification for Free-Machining Stainless Steel Bars
8. ASTM B 584 Standard Specification for Copper Alloy Sand Castings for General Applications

D. AMERICAN WATER WORKS ASSOCIATION

1. AWWA C 651 Standard for Disinfecting Water Mains
2. AWWA C 654 Standard for Disinfecting of Wells
3. AWWA E 103 Standard Specifications for Horizontal and Vertical Turbine Line-Shaft Pumps

E. NATIONAL SANITATION FOUNDATION

1. NSF/ANSI 60 Drinking Water Treatment Chemicals
2. NSF/ANSI 61 Drinking Water System Components – Health Components
3. NSF/ANSI 372 Drinking Water System Components – Lead Content

1.3 SUBMITTALS

A. CONTRACTOR shall submit for review to ENGINEER, sufficient literature, detailed specifications, and drawings to show dimensions, make, style, speed, size, type, horsepower, head-capacity, efficiency, materials used, design features, internal construction, weights, and any other information required by ENGINEER for review of all pumping equipment. No pumping equipment will be accepted, and installation will not be allowed, until such review has been completed. All submittals shall clearly state any deviations from specified requirements. Provide the following with the submittal:

1. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. The equipment shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the specified design point.
2. Equipment manufactured shall provide complete and detailed information regarding the installation of the pumps. Any installation requirements or operating conditions which the supplier or manufacturer' feel to be critical to the safe and reliable operation of the pumps should be identified and described in detail.
3. Shop drawings submitted for review also shall include detailed description of motor, including electrical diagrams, schematic control diagrams, and a detailed description of how the control system is to function, where applicable.

1.4 OPERATING CONDITIONS

A. Table I indicates the operating conditions of the pumps.

1.

TABLE I - OPERATING CONDITIONS DEEP WELL TURBINE PUMP

ITEM	SPECIFICATION
Design capacity of pump (gpm)	1,500
Design total dynamic head at discharge of bowl assembly (feet)	490
Pump Setting Depth	500
Nominal Operating Speed (rpm)	1,770
Minimum Efficiency at Design Point	82%
Maximum NPSHR at Design Point	20 feet
Minimum Motor Horsepower	300
Column Size (diameter)	10-inch
Minimum Shaft and Oil Tube Size (inches)	1-15/16 x 3
Diameter of Well Casing	20-inch (19.25" I.D.)
Maximum Bowl Diameter (O.D.)	14.2 inches

ITEM	SPECIFICATION
Approx. Elevation (ft. above MSL)	5,000 feet
Model No: National (See approved equals below)	M14MC
Utility Power (volts, phase, hertz)	480, 3, 60

1.5 MECHANICAL DEFECTS AND REJECTIONS

A. CONTRACTOR furnished pumps that have mechanical defects or do not meet the requirements for head-capacity, horsepower, efficiency, and vibration requirements will be rejected, and shall be replaced without additional cost to OWNER for furnishing, removal, reinstallation, and retesting. Mechanical defects shall include excessive vibration, improper balancing of any rotating parts, improper tolerances, binding, excessive bearing or motor heating, defective materials, including materials that do not conform to the Specifications, improper fitting of parts, and any other defect which will in time damage the pump or unreasonably impair its efficiency or operation.

1.6 WARRANTY

A. CONTRACTOR furnished equipment covered by these specifications shall be warranted against defective parts due to faulty material or workmanship for one (1) year after date of start-up. CONTRACTOR shall guarantee to replace any defective parts within the period of time specified at no additional cost to OWNER. If CONTRACTOR has to pull pump to replace defective parts, CONTRACTOR shall guarantee to pull and replace pump at no additional cost to OWNER.

1.7 MEASUREMENT AND PAYMENT

A. The pumping system and motor shall be measured and paid under the bid item for which it relates.

1.8 FACTORY TESTING

A. Factory testing is not required for this project.

PART 2 PRODUCTS

2.1 DEEP WELL VERTICAL TURBINE PUMP

A. The pumps shall be of the deep well, oil lubricated, vertical turbine pump suitable for pumping culinary water. All material, manufacturing and performance standards shall be in compliance with AWWA E 103, NSF 60, NSF 61 and NSF 372 as applicable.

B. Performance Requirements

1. Pump Speed - The pumps shall operate as specified in Table I.

2. Pump Characteristics - The pump shall be characterized by head capacity curves of steadily decreasing head with increasing capacity. Maximum head shall be at zero flow. The pump shall have a minimum efficiency as provided in Table I during

operation against the system head. Pump head - capacity curves shall indicate that these losses have been included. Pumps shall have head-capacity curves similar to that of the specified pump. Pumps having curves that show a flatter or near horizontal slope over a section in the head – capacity curve will not be accepted. Curves with head-capacity curves with slopes of the curve flatter than that shown for the specified pump will not be accepted.

3. The pump and motor shall be capable of producing the flow rate and total dynamic heads indicated in Table I.

4. Motor Characteristics - Under no operating conditions shall the required pump brake horsepower exceed the nameplate rating of the motor being furnished.

5. The pump shall be designed to operate throughout its entire range without excessive vibration or noise. Pump shall meet the requirements of the Hydraulic Institute (2016) paragraph 9.6.4 vibration limits.

C. Vertical Turbine Pump Components

1. Pumps
   a. The vertical turbine pump for the wells shall be as manufactured by National Pump Company or approved equal and shall be a multi-stage oil lube bowl assembly (or equal). Equals are: Flowserve, Floway, American Marsh if they meet other spec conditions.
   b. Unless otherwise stated herein, the pump shall in all respects conform to the American National Standard ANSI/AWWA-E103 for “Horizontal and Vertical Turbine Line Shaft Pumps” and shall comply with all local and state sanitary and safety regulations.
2. Discharge Head
   a. The discharge head shall be fabricated steel (ASTM A53 Grade B Pipe and ASTM A 36 Steel Plate or as recommended by the manufacturer), accurately machined and with a surface discharge. Discharge flange shall be machined and drilled to ANSI standards for 150 lb. rating and shall be sized to match the specified system. The top of the discharge head shall have a rabbet fit to accurately locate the vertical hollow shaft driver, and have a diameter equal to the driver base diameter (BD). Lifting lugs of sufficient strength to support the weight of the complete unit shall be provided. The base shall be round or square. Head must be able to accept the monitoring tube, sounding tube, and well vent as shown on the drawings. The design shall allow the head shaft to couple above the tube tension assembly. The tube tension assembly shall consist of a tension bearing installed in the top oil tube. CONTRACTOR shall modify the well base dimensions on the drawings to match supplied head.
   b. The discharge head shall be furnished with a one gallon oil reservoir with copper tubing, manual isolation valve, a sight feed drip oiler and a solenoid valve to initiate or shut-off oil feed.
   c. The head shaft not exceed 20 feet in length. Impeller adjustment shall be provided at the top of the head shaft by means of a bronze adjusting nut of ASTM B 584 alloy C876/C903 which shall be positively locked in position.
   d. The pump manufacturer shall include the method of adjusting the pump impellers at the top of the head shaft.

e. CONTRACTOR shall be responsible for ensuring that the discharge head is structurally and mechanically adequate for the provided and installed pump configuration.
f. Head shall be painted inside and out with an NSF 60 approved epoxy paint conforming to AWWA C210 and D102. OWNER shall select the color.

3. Column Assembly
   a. The line shaft for the well shall be of C-1045. They shall be furnished in interchangeable sections not over 20 feet in length.
   b. The butting faces shall be machined square to the axis of the shaft, with maximum permissible axial misalignment of the thread axis with the shaft axis 0.002" in 6". The size of the shaft shall be no less than that determined by ANSI/AWWA E103 Specifications, Section 4.4.2.2 – Line Shaft, for C1045 line shaft, and shall be such that elongation due to hydraulic thrust will not exceed the axial clearance of the impellers in the pump bowls. Maximum runout in 10-feet shall not exceed 0.010-inches.
   c. The outer column piping shall be of ASTM A53 Grade B Standard Wall steel pipe in interchangeable sections not over 20 feet in length with the ends of each section faced parallel and machined with 8 straight threads per inch permitting the ends to butt and ensuring alignment when connected by standard mill steel couplings. The weight of the column pipe shall be no less than that stated in ANSI E 103, Section E.3 Table E.1, "Diameters and Weights of Standard Discharge Column Pipe Sizes". Top and bottom sections of column pipe shall not exceed 5-feet in length.
   d. CONTRACTOR shall be responsible for ensuring that the column piping is structurally and mechanically adequate for the provided and installed pump configuration.
   e. Shaft Enclosing Tubes shall be ASTM A53 Grade A schedule 80 steel pipe with the ends machined square and parallel and shall butt to ensure proper alignment and sealing, they shall be straight within 0.005 in. total indicator reading for a 5 ft. section. Threaded internally to receive the lineshaft bearings. The enclosing tube shall be stabilized and centered in the column pipe by rubber centering spiders spaced at 40 ft. intervals throughout the column pipe assemblies.
   f. Lineshaft Bearings shall be C-844 bronze, internally grooved to allow proper lubrication to enclosed lineshaft and threaded externally for connecting oil tube sections.
   g. LINESHAFT BEARINGS shall be C-844 bronze, internally grooved to allow proper lubrication to enclosed lineshaft
   h. and threaded externally for connecting oil tube sections.
   i. LINESHAFTS shall be C-1045 carbon steel, turned, ground and polished. They shall be furnished in interchangeable sections not over (10) or (20) feet in length to properly match the shaft enclosing tube and discharge column. The shaft shall be sized in accordance with the maximum recommended horsepower for a given size of shaft, taking into account the effect of the hydraulic thrust on the pumping equipment and the weight of the shaft and suspended rotating parts. To ensure accurate alignment of the shafts, they shall be straight within 0.005 in. total indicator reading for a 10 ft. section and 0.010 in. total indicator reading for a 20 ft. section. The butting faces shall be machined with center relief and square to the axis of the shaft. The lineshaft shall be coupled with 1215 steel couplings.

4. Pump Bowl Assembly
   a. Pump bowl castings shall be of close-grained cast iron ASTM A48 Class 30 or ASTM A536 ductile iron Class 60-40-18 where required to meet the hydrostatic pressure criteria listed below. The water passages shall be free of blowholes, sand

holes, and other detrimental defects, shall be lined with porcelain enamel, and shall be accurately machined and fitted. The finished bowls shall be capable of withstanding a hydrostatic pressure equal to twice the head at rated capacity or equal to or greater than the shut-off head, whichever is greater.

b. The impellers shall be ASTM B584 alloy C87600 lead free bronze, enclosed type, and shall be statically balanced, and shall be fastened securely to the impeller shaft with 316 stainless steel collets. Impellers shall be adjustable vertically by an external means. Impeller skirt and series case throat area shall be thick enough to allow for machining and wearing at the time of repair.

c. The pump shaft shall be of A582 Grade 416 Stainless Steel turned, ground and polished. Bearings shall be Morse or Durmax Marine Bearings consisting of sleeve bearings with a Naval Brass outer shell super-bonded to a fluted rubber bearing surface (or approved equal) above and below each impeller. The pump shaft shall have chromed journals at the bearing points. The size of the shaft shall be no less than that determined by ANSI/AWWA Specifications E103.

d. The discharge case shall be threaded on the outside for column sizes up to 14 inches and fitted with a cast iron ASTM A48 Class 30 column adaptor of the proper size to connect to the column selected. Likewise, the suction case shall also be threaded on the I.D. and fitted with a cast iron or steel suction adaptor.

5. Suction Pipe and Strainer
   a. A suction pipe shall not be required.
   b. A stainless steel cone strainer shall be provided having a net inlet area equal to at least four times the suction pipe area. The maximum opening size shall not be more than 75% of the minimum opening of the water passage through the bowl or impeller.

2.2 FLOW CONTROL VALVE

A. An ASR flow control valve shall be provided. The valve shall alternately control the flowrate into the well during injection and allow a vertical turbine pump to operate. The valve shall be actuated by applying pressurized nitrogen gas or by releasing nitrogen gas.

1. The ASR valve shall be manufactured by:

   Baski, Inc.
   4002 S Clay St.
   Englewood, CO 80110
   (303) 789-1200

B. The valve shall be located immediately above the vertical turbine pump.

C. A check valve shall be placed immediately below the vertical turbine pump at the bowl suction to prevent recharge water from going through the bowl while injecting.

D. All nuts, bolts, washers, and fittings for hose or tubing, shall be type 316 or Duplex 2205 stainless steel.

E. ASR valve to have threads matching the column pipe.

F. ASR valve actuation lines shall be protected at each column pipe coupling with metal shields.

G. Wetted parts must be constructed with the following acceptable materials:

1. Stainless steel 316 in standard or L grades, or Duplex 2205
2. Reinforced natural rubber
3. Other materials as approved by ENGINEER

H. CONTRACTOR shall furnish and install the following required appurtenances:

1. Two (2) compressed nitrogen tanks. The nitrogen tanks shall be of the standard K size. (Normally between 200-250 SCF – Approximately 9" diameter and about 48-54" tall.)
2. Two (2) 2-stage nitrogen regulators. Output pressure is 200 psi (CONTRACTOR shall confirm regulator requirements with FCV supplier).
3. Two (2) stainless steel inflation lines to the valve.
4. One (1) Baski automatic control panel.
5. Two (2) Rosemount 3051T Pressure Transmitters with two (2) Rosemount 306 2-Valve Integral Manifolds and two (2) mounting brackets.
6. One (1) outdoor rated, NEMA 3R or NEMA 4 stand alone steel cabinet of the size greater than or equal to 90" H x 84" W x 24" D. This cabinet shall house the control panel and two nitrogen tanks and be mounted to a concrete pad.
7. One (1) 9' x 6' concrete pad. The above-mentioned cabinet will be bolted to the pad.
8. The annular space in the steel cabinet shall be sealed with Sikaflex Construction Sealant or approved equal where the nitrogen exits the cabinet.

I. The ASR manufacturer's controls for automatic operation shall be designed to operate on 115VAC, or other voltage approved by ENGINEER.

J. All control lines shall be secured and protected at every coupling joint of the column pipe. Control lines shall be ¼ inch OD Duplex 2205 stainless steel, tested to a minimum of 10,000 psi, or approved equal.

K. The ASR valve manufacturer shall supply stainless steel protectors for each column pipe coupling. These protectors shall be attached with stainless steel "Band-It" brand industrial clamps or equal. The protectors shall be designed such that they cannot slip up or down off the couplings.

L. CONTRACTOR shall install the ASR valve in accordance with the manufacturer's recommendations.

M. The ASR valve manufacturer shall supply a trained and authorized field service representative for up to two (2) consecutive 8-hour days to act in an advisory capacity during installation of its equipment. After installation, the representative is excused from any further on-site attendance.

N. The ASR valve manufacturer shall supply a trained and authorized field service representative for one 8-hour day for start-up, testing, and training.

2.3 MOTOR

A. Pump motor shall be a vertical hollow shaft, premium efficiency, inverter duty, WP1 enclosure, electric motor, and shall be sized as noted in Table 1. Motor shall have a non-

reverse ratchet, P-base, squirrel cage induction design. Motor shall have Class B or Class F insulation with temperature rise as specified by NEMA standards for class of insulation used and shall have a 1.15 service factor. The pump motor will be operating in an ambient temperature range of 50E - 110E Fahrenheit.

B. Pump motors shall be provided with a vibration switch. Switch rating 120 VAC, 2 amps minimum.

C. Pump motors shall have over temperature protection, which shall consist of a minimum of six RTD's embedded in the motor windings and two RTD's at the two bearings. Wiring to an external junction box shall be provided. RTD's shall be 100– ohm platinum three wire elements.

D. Thrust bearing shall be chosen to handle the continuous down-thrust as specified by the pump manufacturer with an AFMBA L-10 bearing life of 12,320 hours and an L-50 of 61,600 hours. Provisions shall be made for momentary up-thrust equal to 30% of rated down-thrust.

E. The motor shall be suitable for across-the-line starting, soft start, be inverter duty, and shall be capable of reduced-voltage starting. It shall also have shaft grounding rings.

F. The motor rating shall be such that at design it will not be loaded beyond nameplate rating and at no place on the pump curve shall the loading exceed the service factor.

G. The motor temperature shall be rated no higher than the allowable operating temperature of the motor thrust and radial bearings and in no case shall it exceed the temperature rating of the insulation class used to wind the motor.

H. The junction box shall be oversized to accommodate wiring connection, and shall be a minimum of 24"H x 18"W x 14"D with 2 - 4" conduit penetrations on the bottom.

I. Motors connected to VFD's shall have factory installed shaft grounding rings. Supplier shall provide a warranty against VFD-induced bearing damage or failure for the life of the motor. Motor shall also include insulated bearings to prevent circulation and other bearing currents.

2.4 APPURTENANCES

A. Well Monitoring and Sounding Tubes

The CONTRACTOR shall furnish and install two 1 ¼" diameter well monitoring tubes in each well consisting of flush thread schedule 80 PVC pipe. The PVC tube shall be joined and banded to the pump column with stainless steel bands at maximum of 10 feet. A minimum of two 1/4-inch diameter vent holes for every 10 feet of length shall be provided throughout the entire length of the monitoring tube. The depth of the monitoring tube shall be as indicated on the drawings. The bottom end shall be capped with a ¼-inch hole drilled in the end.

B. Well Vent

1. The well vent shall consist of galvanized steel 1 inch diameter pipe through the soul plate extended above the bottom plate of the pump discharge head with a 180

degree bend made of two steel ells. The outlet end of the vent pipe shall be covered with No. 14 stainless steel wire mesh securely fastened by a stainless steel band. The lower end of the vent pipe shall be threaded into the well surface plate and provide a water tight seal. See Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install new pump and motor at the location shown on the drawings and according with manufacturer's recommendations.

B. All pumps, complete with drive system, in place at the jobsite, shall not exceed acceptable field vibration limits given in the latest revisions of the Hydraulic Institute Standards. All pumps shall be free of static unbalance; shall be free of dynamic unbalance up to the maximum speed of the pump and drive system; shall be free of torsional vibration from 10 percent below the minimum speed to 10 percent above the maximum speed of the pump and drive system; and shall be free of apparent unbalance caused by defective bearings, by close fittings parts which may rub on the rotating parts intermittently, or by loose discs or rotor parts, or unbalanced loads.

C. The motor/discharge head assembly shall be shimmed with respect to the well casing flange to bring the motor/discharge assembly into optimum alignment with any variations that the pump column and line shaft may exhibit from being truly plumb. Such shims must be structurally sound and securely attached. The water tight seal between the discharge head and the well casing flange must be maintained.

3.2 FIELD TESTS

A. After installation, the pump shall be given an operating test to demonstrate freedom from mechanical defects, excessive noise, and vibration. The test shall include operating the pump continuously while throttling the discharge as needed. The operating test shall be performed for a minimum of one hour, or as directed by ENGINEER. Pumps with variable speed drives shall be tested at maximum speed, and at the average and minimum speeds listed under the specification for the pumps. A copy of actual test data shall be furnished to ENGINEER.

B. Tests for acceptable vibration shall be made, at no additional cost to OWNER, in the field on each pump system, which in the opinion of ENGINEER, seem to have excessive vibration. All field tests shall be running tests with the pump pumping the product for which it is intended and each pump system shall be tested separately with no other pumps running. All testing shall be done in the presence of ENGINEER. Amplitude as used in this Specification, shall mean total peak-to-peak displacement. The required test for acceptable vibration will be the measurement of this peak-to-peak displacement and will be performed with an IRD Vibration Meter, Model 306; Bently-Nevada TK-8; or equal.

3.3 DISINFECTING

A. Source of Water

1. The Contractor shall assume all responsibility to obtain the necessary water supplies for disinfection of the pumping system.

B. Testing Procedure

1. Leakage and pressure testing must be completed, and all leaks repaired prior to disinfection procedures.
2. Pump and related piping installed under this Contract shall be disinfected using an approved disinfection method in accordance with the "American Water Works Association Standard for Disinfecting Water Mains" (AWWA C651) and “American Water Works Association Standard for Disinfecting Wells” (AWWA C654).
3. Heavily chlorinated water shall not be discharged onto the ground. Upon completion of disinfection, Sodium Bisulfate ($NaHSO_3$) shall be applied to the heavily chlorinated water to neutralize thoroughly the chlorine residual remaining. Water shall be neutralized to less than 1 ppm.
4. After completion of the disinfection, CONTRACTOR shall flush the new system until the chlorine residual is a maximum of 0.3 ppm after which bacteriological test will be performed by OWNER.
5. At the end of 24 hours after the first sample is taken, a second bacteriological test will be performed by OWNER to insure adequate disinfection. If the initial or second disinfection fails to provide satisfactory bacteriological results, or shows the presence of coliform, then the well line shall be re-chlorinated, flushed, and retested until satisfactory results are obtained at the expense to the Contractor.

- END OF SECTION -

SECTION 33 13 00
PIPELINE TESTING AND DISINFECTION

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers testing and disinfection in order to remove bacteriological contamination of the pipeline. Disinfection is only required if the pipeline is used for potable water.

B. CONTRACTOR shall be responsible for obtaining permits for discharging excess testing water and dechlorination of such water, if required.

C. Hydrostatic testing shall meet the requirements of this Section or the requirements provided in each individual pipeline Section, whichever is more stringent.

1.2 RELATED SECTIONS

A. Related Work specified in other Sections includes but is not limited to the following:

1. Section 01 33 00 Submittal procedures
2. Section 33 05 05 Ductile Iron Pipe
3. Section 33 05 11 HDPE Pressure Pipe (AWWA C906)

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. AWWA C-651 - Disinfecting Water Mains
2. Utah Public Drinking Water Regulations

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Furnish a written testing plan and schedule, including water source and methods for conveyance to the project, sequence, control, and disposal. Include the name of the certified bacteriological testing laboratory.

C. 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 parts per million (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.

PART 2 MATERIALS

2.1 DESCRIPTION

A. All test equipment, temporary valves, bulkheads, and other water control equipment, shall be as determined by CONTRACTOR. No materials shall be used which damage the project pipelines for future conveyance of potable water.

B. Disinfecting materials shall consist of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

C. Dechlorination agents may be sodium bisulfate, sodium sulfite, or sodium thiosulfate.

PART 3 EXECUTION

3.1 GENERAL

A. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water for testing and disinfection of the water line system. All testing water used in the pipeline shall be potable water from a State approved drinking water system.
2. All pressure pipelines shall be tested.
3. Disposal of flushing water and water containing chlorine shall be by methods acceptable to the State of Utah, Division of Water Quality.

3.2 HYDROSTATIC TESTING OF PIPELINES PROCEDURE

A. Prior to hydrostatic testing, pipelines 24-inches diameter and larger shall be swept free of debris and visually inspected that all debris has been removed prior to filling.

B. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. CONTRACTOR may test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that do not have isolation valves shall be tested in approximate one-mile segments. Sections that have a zero leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water (maximum filling velocity shall not exceed 0.25 foot per second, calculation based on the full area of the pipe). CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit or for water to be drained. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

C. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to ENGINEER shall be taken. Additional water shall be added to the pipeline to replace any water absorbed by the cement mortar lining.

D. The hydrostatic test shall consist of holding 125% of the design operating pressure on the pipeline segment for a period of 2 hours. Visible leaks that appear during testing shall be repaired. Add water to restore the test pressure if the pressure decreases 5 psi below test pressure during the test period.

E. Pipe with welded joints shall have no leakage. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

F. Exposed piping and valves shall show no visible leaks and no pressure loss during the test.

G. Blowoff isolation gate valves and plug valves (throttling valves) shall be operated and tested during a simulated blow down operation to demonstrate functionality of the valves to the satisfaction of ENGINEER. Isolation valves (gate valves) shall not be used for throttling.

3.3 DISINFECTING OF PIPELINES PROCEDURE

A. Leakage and pressure testing must be completed prior to disinfection procedures.

B. All water and solution piping installed under this Contract shall be disinfected using an approved disinfection method in accordance with the "American Water Works Association Standard for Disinfecting Water Mains" (AWWA C651).

C. CONTRACTOR may use one of the three chlorination methods – tablet, continuous feed, and slug, as outlined in AWWA C651 that is acceptable to OWNER. Care must be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

D. CONTRACTOR shall provide sampling ports along the pipeline as defined in AWWA C651. Taps may be at manways and air valves to help facilitate the spacing requirement.

E. Heavily chlorinated water shall not be discharged onto the ground. Upon completion of disinfection, Sodium Bisulfate (NaHSO4), or other approved dechlorination agent, shall be applied to the heavily chlorinated water to neutralize thoroughly the chlorine residual remaining. Water shall be neutralized to less than 1 ppm total chlorine residual.

F. After approval of disinfection, CONTRACTOR shall flush the new system until the chlorine residual is a maximum of 0.3 ppm.

G. After final flushing and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the pipeline being tested. Sampling and testing will be completed by CONTRACTOR. CONTRACTOR shall collect at least one set of samples from every 1,200 feet of pipeline, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological (chemical and physical) quality in accordance with "Standard Methods for Examination of Water and Wastewater" and shall show the absence of coliform organisms. If the initial disinfection fails to provide satisfactory bacteriological results, or shows the presence of coliform, then the line shall be re-chlorinated, flushed, and retested until satisfactory results are obtained at the expense of CONTRACTOR.

3.4 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

B. Final Fill: After a successful pressure and disinfection tests, the pipeline(s) shall be filled with fresh potable water and shall remain filled.

- END OF SECTION -

SECTION 40 10 00
PROCESS CONTROL AND INSTRUMENTATION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. General requirements applicable to all process control work.
2. The requirements of this Section apply to all components of the Software Systems unless indicated otherwise.
3. General requirements for programming submittals.

B. Related sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all sections to ensure a complete and coordinated project:
   a. Items involving electrical, control, and instrumentation construction may be shown on Drawings or referred to in Specifications that do not apply specifically to electrical, control and instrumentation systems.

C. The Programming Contractor shall program all PLC's and the SCADA system. The Programming Contractor shall provide all software as specified herein for programming the system. The Programming Contractor and the electrical contractor shall be responsible to test each device and loop to verify proper function of all equipment on the project, whether provided by the contractor or by the owner. They shall then work with the owner to test and commission the entire system as described herein. The programming contractor shall be present to test the I/O for each equipment subsystem. The I/O to the PLC systems shall be tested at this time. The programming contractor shall provide and install a simple testing routine in each PLC in order to verify all I/O is functioning properly. All I/O shall be tested from its respective field device to the software level in the PLC. If final PLC programming is complete at the time of testing, the final software programming shall be used to test each device

D. The Programming Contractor shall design the operator interface graphics, human machine interface (HMI) graphics, PLC logic, and control systems hardware as specified herein.

E. Contract Documents:

1. General:
   a. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work, and requirements shown, written or reasonably inferred there from on one is considered as written, shown or implied in all. In the event work is called for in more than one place and there are conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.
   b. Schematic Diagrams:

1) All controls are shown de-energized.
   a) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
   b) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences found in the Drawings or Specifications. Combine all information and furnish a coordinated and fully functional control system program.

1.2 REFERENCES

A. Code Compliance:

1. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
2. The following codes and standards are hereby incorporated into these Specifications:
   a. National Fire Protection Association (NFPA):
      1) NFPA 70 - National Electric Code (NEC).
      2) NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
      3) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.
      4) NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   b. Underwriters Laboratories, Inc. (UL):
      1) UL 508 - Industrial Control Equipment.
   c. American National Standards Institute (ANSI):
      1) ANSI B16.5 - Pipe Flanges and Flanged Fittings.
   d. American Petroleum Institute (API):
      1) API RP551 - Process Measurement Instrumentation.
      2) API RP552 - Transmission Systems.
      3) API RP553 - Refinery Control Valves.
      4) API RP554 - Process Instrumentation and Control.
      5) API RP555 - Process Analyzers.
      6) API RP556 - Fired Heaters & Steam Generators.
      7) API RP557 - Guide to Advanced Control Systems.
   e. American Society of Testing and Materials (ASTM):
      1) ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   f. Instrumentation, Systems, and Automation Society (ISA):
      1) ISA-5.1 - Instrumentation Symbols and Identification.
      2) ISA-5.2 - Binary Logic Diagrams for Process Operations.
      3) ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
      4) ISA-5.4 - Instrument Loop Diagrams.
      5) ISA-5.5 - Graphic Symbols for Process Displays.
      6) ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.
      7) ISA-RP - 12.4 - Pressurized Enclosures.
      8) ANSI/ISA-18.1 - Annunciator Sequences and Specifications.

9) ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
10) ISA-TR20.00.01 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
11) ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
12) ISA-51.1 - Process Instrumentation Terminology.
13) ISA-RP60.3 - Human Engineering for Control Centers.
14) ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
15) ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.
16) ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.
17) ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:

1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. Instrumentation, Systems, and Automation Society.
4. National Fire Protection Association.
5. National Electrical Testing Association.

B. Specific Definitions:

1. Control Circuit: Any circuit operating at 120 volts AC or DC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
2. Panel: An instrument support system that may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term “panel” in these Contract Documents is interpreted as a general term, which includes flat surfaces, enclosures, cabinets and consoles.
3. Power Circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
4. Signal Circuit: Any circuit operating at less than 50 volts AC or DC, which conveys analog information or digital communications information.
5. Digital Bus: A communication network, such as Profibus, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
6. 2-Wire Transmitter (Loop Powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Specification, two-wire transmitter refers to a transmitter

that provides 4 to 20 mA current regulation of a signal in a series circuit with an external 24 VDC driving potential.

7. Field Bus Communications signal or both.
8. Powered Transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Specification, the produced signal may either be a 4 to 20 mA current signal, a Digital Bus communications signal or both.
9. Modifications: Changing, extending, interfacing to, removing or altering an existing circuit.

C. Acronym Definitions:

1. ES:Enterprise System: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
2. FAT: Factory Acceptance Test.
3. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode of control equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode of control equipment is started or stopped, valves are opened or closed through a control algorithm within the PLC software. In the Off mode the equipment is prohibited from responding from the PLC control.
4. HMI: Human Machine Interface: PLC based operator interface device consisting of an alphanumeric display and operator input devices. The HMI is typically a flat panel type of display with either a touch screen or tactile button interface.
5. HVAC Heating, Ventilation, & Air Conditioning.
6. ICSC: Instrumentation and Control System Contractor: Subcontractor who spealizes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
7. IJB: Instrument Junction boxes. A panel designed with cord sets to easily remove, replace or relocate instrument signals.
8. I/O:Input / Output.
9. LCP: Local Control Panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
10. LAN: Local Area Network: A control or communications network that is limited to the physical boundaries of the facility.
11. LOR: Local-Off-Remote control function. In the Remote mode equipment is started or stopped, valves are opened or closed through the PLC based upon the selection of the HOA. In Local control, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
12. OIT: Operator Interface Terminal. PC based interface device used for operator interface with the SCADA system.
13. P&ID: Process and Instrumentation Diagram.
14. PC: Personal Computer.

15. PCIS: Process Control and Instrumentation System, includes the entire instrumentation system, the entire control system, and all of the work specified in Division 17 and depicted on the Instrumentation Drawings.
16. PCM: Process Control Module: An enclosure containing any of the following devices: PLC, RIO.
17. PJB: Power Junction Box: An enclosure with terminal blocks that distribute power to multiple instruments.
18. PLC: Programmable Logic Controller.
19. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.
20. RTU: Remote Telemetry Unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
21. SCADA: Supervisory Control and Data Acquisition system consists of the computer-based software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software.
22. UPS Uninterruptible Power Supply.
23. VCP: Vendor Control Panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
24. WAN: Wide Area Network: A control or communications network that extends beyond the physical boundaries of the facility.

1.4 SYSTEM DESCRIPTION

A. General Requirements:

1. The Work includes everything necessary for and incidental to executing and completing the general requirements for programming the control system described in the Contract Drawings and Specifications and reasonably inferable there from including but not limited to:
   a. Procure all software.
   b. With the electrical contractor, perform post programming tests on panels.
   c. With the electrical contractor, oversee, document, and certify system pre-commssioning.
   d. With the electrical contractor, conduct the Performance Tests.
   e. Prepare Operation and Maintenance Manuals.
   f. Conduct training classes.
   g. Develop all requisite loop descriptions, functional narrative and instructions and record drawings associated with the programs provided under other Divisions of these Specifications.
2. It is the intent of these Specifications that the programmed system be complete and operable.
3. Furnish detailed, complete, and thorough operations and maintenance documentation, including, but not limited to: Operations Manuals, Maintenance Manuals, Training Manuals, As-Built Software Documentation, final as installed software configurations, and software disks including installed program disk.

1.5 SUBMITTALS

A. General:

1. Furnish Submittals that are fully developed for a given section of the work and fully indexed with a tabbed divider for every element and component.
2. Sequentially number the pages within the tabbed sections. Submittals and Operation and Maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Edit all Submittals and Operation and Maintenance Manuals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
4. Submittal Requirements:
   a. Submit copies of shop drawings, and product data, in accordance with the requirements of this Section:
      1) Show information on software to be supplied, SCADA screens, reports, menus, operation, etc.
5. Exceptions to Specifications and Drawings:
   a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
   b. Any exceptions to the Specification and Drawings must be noted and the reason for the exception explained.
   c. If there is insufficient explanation for the deviation, the submittal will be returned requiring Revision and Re-submittal.
   d. Acceptance of any exception is at the sole discretion of the ENGINEER. Furnish all items (materials, features, functions, performance, etc.) that are not listed as exceptions strictly in accordance with the Specifications and Drawings.
   e. Replace all items that do not strictly meet the requirements of the Specifications, which were not previously accepted as exceptions, even if the Submittals contained information indicating the failure to meet the requirements.
6. Submittal Organization:
   a. First page:
      1) Specification Section reference.
      2) Name and telephone number of individual who reviewed submittal before delivery to ENGINEER.
      3) Name and telephone number of individual who is primarily responsible for the development of the submittal.
      4) Place for CONTRACTOR's review stamp and comments.
   b. Next pages:
      1) Provide confirmation of Specification compliance in a tabular form that individually lists each Specification section, paragraph, and sub-paragraphs and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.
      2) Include a response in writing to each of the ENGINEER’s comments or questions for submittal packages which are re-submitted:
   c. In the order that the comments or questions were presented throughout the submittal.
   d. Referenced by index section and page number on which the comment appeared.

e. Acceptable responses to ENGINEER's comments are either:
f. ENGINEER's comment or change is accepted and appropriate changes are made.
g. Explain why comment is not accepted or requested change is not made.
h. Explain how requirement will be satisfied in lieu of comment or change requested by ENGINEER.
i. Any re-submittal, which does not contain responses to the ENGINEER's previous comments, shall be returned for revision and re-submittal.
j. No further review by the ENGINEER will be performed until a response for previous comments has been received.
k. Remaining pages:
    1) Actual Submittal data:
        a) Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.
        b) For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is intended to be used.
l. Specific Submittal requirements:
    1) Furnish the submittals required by each Section or Division 17:
        a) Product Data.
        b) Shop Drawings.
m. Furnish submittals in the following general order, each in a separate bound set:
    1) Product Data.
    2) After approval of the Product Data, submit the Project Shop Drawing submittals
    3) Testing, Calibration and Start-up procedures.
    4) Operation and Maintenance Data.
    5) Training Submittals.
    6) Record Documents.

B. Product Data:

1. General:
    a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
    b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
    c. Include:
        1) Catalog cuts.
        2) Bulletins.
        3) Brochures.
        4) Quality photocopies of applicable pages from these documents.
        5) Identify on the data sheets the project name, applicable specification section, and paragraph.
        6) Identify model number and options for the actual equipment being furnished.
    d. Neatly cross out options that do not apply or equipment not intended to be supplied.
2. Software Data Sheets and Cut Sheets:

a. Provide fully completed data sheets, in hardcopy, for each software package. Including the following information on the data sheet:
    1) License limitations, points, screens available.
    2) Description of software compatibilities with hardware (PLC's, ethernet communications, P.C.'s, modems, HMI's, etc.)
    3) Description of software capabilities, function and use.

3. Software Program Submittal:
    a. Prepare a program submittal to demonstrate how the programs address the following:
        1) Alarm indication and notification.
        2) Alarm acknowledgement.
        3) Operational sequences.
        4) Communications.
        5) Recording and trending – show for each recorded or tended tag.
        6) Report generation with samples.
        7) Maintenance information and notes storage.
        8) Samples of each screen shot and report.

C. Operation and Maintenance Manuals:

1. Furnish the ENGINEER with a complete preliminary set of written Operation and Maintenance Manuals 2 weeks before start-up and/or testing.
2. Furnish in accordance with the following additional requirements.
3. Submit preliminary sets of these manuals to the ENGINEER for review of format and content:
    a. ENGINEER will return 1 set with comments.
    b. Revise and/or amended as required and submit the requisite number of copies to the ENGINEER 15 days before Pre-commissioning of the systems.
4. Incorporate changes that occur during startup and submit as part of the final manuals.
5. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
6. Organize the Operation and Maintenance Manuals for each process in the following manner:
    a. Section A-Description of operation.
    b. Section B- Screen shots.
    c. Section C- Report samples.
    d. Section D- Trending/recording operations.
    e. Section E- Software information with disks.
    f. Section F- Operational Manual.
    g. Section G- Spare Parts List.
7. Training Submittals:
    a. Develop and submit for review a General Training Plan. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
    b. The ENGINEER will review the General Training Plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the

ENGINEER, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system provide more qualified instructors.

c. Training Course Plan submittals:
    1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson.
    2) Describe any student pre-requisites for the course or training activity.
    3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
    4) Submit training materials.
d. Incorporate all submittal review comments into the course.
e. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.

D. Responsibilities

1. The Programming Contractor, shall be responsible to the OWNER for the implementation of the software and programmed systems.
2. Instrumentation & Control System Contractor (ICSC) Responsibilities:
    a. The Programming Contractor shall assume full responsibility to perform all engineering to select, furnish, install, test, calibrate, and place into operation all software for PLC's and SCADA P.C.'s.
    b. The Programming Contractor shall be responsible for coordination with OWNER to provide a complete, integrated and functional software system.
    c. As a minimum, the Programming Contractor shall perform the following work:
        1) Prepare software submittals.
        2) Design, develop, and implement controls, screens, reporting, recording, etc.
        3) Prepare the test plan, the training plan, and the spare parts submittals.
        4) Procure all software.
        5) Perform tests on PLC and SCADA software.
        6) Participate in system pre-commissioning.
        7) Participate in the performance tests.
        8) Prepare Technical Manuals.
        9) Conduct training classes.
3. Owner's Responsibilities:
    a. Assist the Programming Contractor in coordinating and integrating the system controls.
    b. The Programming Contractor shall not be responsible for providing or testing any hardware.
4. The Programming Contractor and the Instrumentation & Control System Contractor will be one and the same for this contract.

E. Programmer Qualifications:

1. The Qualification requirements specified in these paragraphs apply to the portions of the Process Control and Instrumentation System Work to be provided by the Programming Contractor.
2. The Programming Contractor shall meet the following minimum qualifications:

a. The Programming Contractor shall have completed at least five (5) successfully completed projects for a pumping system of similar scope and complexity in which the Programming Contractor used components the same as those intended for use on this project, performed system programming, documentation, including software configuration and documentation, field testing, calibration and start-up, operator instruction and maintenance training.
b. The Programming Contractor company shall be actively involved in the instrumentation, PLC based control systems, and SCADA systems business for a minimum of ten years and has adequate facilities, organization structure, manpower and technical and managerial expertise to properly perform the WORK under and in conformance with these Specifications.

1.6 SEQUENCING

A. General:

1. General scheduling requirements are specified in Section 01313.
2. Refer to Section 01010 for summary of work.
3. Testing requirements are specified in Division 27.
4. Work restrictions and other scheduling requirements are specified in Section 01140.

B. Pre-submittal Conferences:

1. Before producing any submittals, schedule a pre submittal Conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.

C. Training:

1. Complete all training before the pre-commissioning phase of the project may start.
2. Schedule the training sessions a minimum of 15 days prior to the start date of the courses.
3. Submit training manuals to the ENGINEER a minimum of 10 days before starting the training session.
4. Within 10 days after the completion of each session, submit the following:
   a. A list of all OWNER personnel that attended the session.
   b. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

D. Performance Testing:

1. Complete Pre-commissioning test a minimum of 5 days before the Performance Test.
2. Conduct a 90-day Performance Test.

1.7 WARRANTY

A. Warrant the Software and Programming in accordance with the General Conditions:

1. Provide additional warranty as specified in the individual Division 17 Specifications.

1.8 SYSTEM STARTUP

A. Replace or modify software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:

1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the ENGINEER.

1.9 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 DEMONSTRATION AND TRAINING

A. Training: Provide Orientation and training on the process control and instrumentation scope to fulfill the needs as outlined by the owner/operators, not expected to exceed the following:

1. General:
   a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
   b. Conduct all training at the Project Site unless another location is approved by the ENGINEER and OWNER.
      1) Include instruction on the use of all maintenance equipment and special tools provided under the contract.
   c. Tailor training classes to the specific needs of the class participants:
      1) The specific categories and number of personnel in each category are identified below.
      2) Furnish training courses that are a combination of classroom and hands-on training:
      3) Present the minimum number of sessions, specified in Table 1, for each course in order to satisfy class size restrictions and limitations scheduling OWNER staff.
      4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
      5) Schedule individual training classes with the OWNER at least 3 weeks before the start of the class.
      6) Schedule all training classes Monday - Friday between 7:30 AM and 3:30 PM.
      7) Each individual daily training session, travel time excluded:
      8) Minimum duration of 4 hours.
      9) Maximum duration of 7 hours.
      10) Breaks scheduled at least every 90 minutes and 1 hour for lunch.

11) Complete training for maintenance personnel 90-days before Performance Testing.
12) Complete operator training classes before startup of the SCADA system, or any part of it:
13) Refer to Paragraph 1.09 of this Section.
14) Schedule follow-up training classes after SCADA startup on a schedule determined by the OWNER.
    a) Furnish highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
    b) Provide completion reports in accordance with Paragraph 1.09 of this Section.

2. Training Manuals and Materials:
   a. Furnish training manuals and other materials for training courses.
   b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
   c. The manuals are to serve as teaching aids during presentation of the training classes.
   d. Manuals are to serve as reference material after the training has been completed.

Course Title	Minimum Course Length (days per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
SCADA, HMI, PLC Software	1	5	1

3. Training Course Requirements:
   a. Software Training:
      1) Furnish training on software and on related systems, including operation alarms, control, recording, reporting, etc.
      2) Furnish training on features, operation, troubleshooting, and maintenance.
   b. HMI Training:
      1) Provide the following:
         a) Overview of firmware, including starting, stopping, and PLC interface.
         b) Troubleshooting.
   c. Follow-up Training:
      1) Provide on-site follow-up training class beginning after startup of the SCADA system. The intent for these classes is to provide the OWNER's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.
      2) Mutually schedule and develop the content of these classes with the OWNER no later than 1 month before the beginning of the first session:
         a) Schedule at the OWNER's discretion on non-consecutive days spaced out over the start-up and warranty period.

- END OF SECTION -

SECTION 40 12 50
PRESSURE TRANSMITTER

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 20 00 – Instruments, General

PART 2 PRODUCTS

2.1 PRESSURE TRANSMITTERS

A. Pipeline Pressure Transmitters

1. Acceptable manufactures are:
   a. Emerson Rosemount 2088 Series
   b. Schneider Foxboro IAP/IAG Series
   c. ABB 266 series
2. Power supply shall be 24VDC, powered from PLC panel power supply. Process connection shall be 1/2-inch female NPT flange adapter. Signal output shall be 4 to 20 mA.
3. Pressure transmitter shall be capacitance or resonant-wire type. Unless otherwise specified, wetted parts shall be ASTM A276, type 316 stainless steel. Span shall be adjustable over a 6:1 or greater range. Over range capacity without affecting calibration shall be not less than 200 percent of maximum specified range. Volumetric displacement shall not exceed 0.01 cubic inch over the specified span. Fill fluid unless otherwise specified shall be silicone oil. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be 0.25 percent of span or better for spans greater than 5 inches water column and 0.5 percent of span or better for spans less than or equal to 5 inches water column.
4. Transmitter shall be provided with the following adjustable range:

Adjustable range of transmitter, water column	Span specified in the instrument schedule, water column
0.5 to 6 inches	0.5 to 5.5 inches
5 to 30 inches	5.5 to 27.5 inches
25 to 150 inches	27.5 to 137.5 inches
125 to 750 inches	137.5 to 750 inches

5. Higher ranges and spans shall be provided as specified in the instrument schedule. Transmitter for spans less than or equal to 25 psig shall be provided with one 1/2-inch flanged process connection and two 1/4-inch drain/vent ports, one plugged and one provided with bleed valve. Transmitter shall be provided with an evacuated sealed chamber and reference diaphragm shall be provided with a weatherproof, bug proof atmospheric vent. Transmitters for spans greater than 25 psig shall be similar except designed for gage pressure service, and overpressure rating shall be greater than the lesser of 2000 psig and 150 percent of maximum range.

B. Submersible Pressure/Level Transmitters

1. Submersible Pressure transmitter shall be TE Connectivity KPSI 710, or equal. Power supply shall be 24VDC, powered from PLC panel power supply. Process connection shall be 1/2-inch female NPT flange adapter. Signal output shall be 4 to 20 mA.
2. Pressure transmitter shall be capacitance or resonant-wire type. Unless otherwise specified, wetted parts shall be ASTM A276, type 316 stainless steel drinking water grade. Span shall be adjustable over a 6:1 or greater range. Over range capacity without affecting calibration shall be not less than 200 percent of maximum specified range. Volumetric displacement shall not exceed 0.01 cubic inch over the specified span. Fill fluid unless otherwise specified shall be silicone oil. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be 0.25 percent of span or better for spans greater than 5 inches water column and 0.5 percent of span or better for spans less than or equal to 5 inches water column.
3. Transmitter shall be provided with the following adjustable range:

Adjustable range of transmitter, water column	Span specified in the instrument schedule, water column
0.5 to 6 inches	0.5 to 5.5 inches
5 to 30 inches	5.5 to 27.5 inches
25 to 150 inches	27.5 to 137.5 inches
125 to 750 inches	137.5 to 750 inches

4. Higher ranges and spans shall be provided as specified in the instrument schedule. Transmitter for spans less than or equal to 25 psig shall be provided with one 1/2-inch flanged process connection and two 1/4-inch drain/vent ports, one plugged and one provided with bleed valve. Transmitter shall be provided with an evacuated sealed chamber and reference diaphragm shall be provided with a weatherproof, bug proof atmospheric vent. Transmitters for spans greater than 25 psig shall be similar except designed for gage pressure service, and overpressure rating shall be greater than the lesser of 2000 psig and 150 percent of maximum range.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. Refer to Section 40 20 00.

- END OF SECTION -

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SECTION 40 15 10
PROCESS CONTROL STRATEGIES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. This section includes the process control strategies for this Contract. Together with the process input/output schedule, the equipment specifications (including control strategies for local equipment control panels), and the Drawings, the process control strategies describe the required operation, monitoring, and control of the facilities included in this Contract. The Contractor shall provide all equipment, and services necessary to implement all functions described herein.

B. The Contractor shall be responsible for furnishing functioning systems as described herein. The functional descriptions contain requirements for furnishing and installing labor and materials that may not appear elsewhere in the contract documents.

1.2 GENERAL DESIGN INFORMATION

A. Indicator lights on all MCCs, control panels, starter enclosures, interfaces, etc. shall conform to the following color convention:

Condition	**Color**
Running/Open	Green
Auto	White
Ready / Stopped / Off / Closed	Red
Fail	Red
Alarm	Red
Generic Status	Green, Blue or White

B. Running status shall be provided from auxiliary contacts provided with the motor starter. Auto status shall be defined as HOA or OA switch in Auto position. Ready status shall be defined as in remote or auto mode with all interlocks satisfied (no failure conditions present). Stopped and Off status shall be defined as all interlocks satisfied (no failure conditions present), except for no remote or auto mode. Failed status shall be defined as motor overload and/or any other shutdown mode such as over torque, over temperature, low oil pressure, high vibration, etc.

C. A discrepancy failure shall be indicated through the control system for any drive, motor, instrument, etc. that should be running or providing a reading but for which the PLC is not receiving a run status signal or valid reading. An example is a motor which is commanded to run by the control system but is not subsequently detected as running. An adjustable time delay shall be provided for each motor to allow time for the motor to start and satisfy all interlocks.

D. Manual start/stop, open/close, speed/position adjustment, etc., from the Operator work stations shall be provided for all equipment controlled by the control system.

E. Where devices such as temperature, moisture, and/or vibration sensors, over- or under-pressure protection, space heaters, etc. are provided with process equipment and their associated motors under the various sections of Division 11, the Contractor shall provided all required interconnecting wiring between those devices and their associated MCCs, motor starters, VFDs, local control panels, etc.

F. Where setpoints, operating limits, and other control settings are provided by the process control strategies, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable, and based on actual operating conditions, the Contractor shall make all necessary adjustments to provide smooth, stable operation.

G. The control system shall be capable of receiving inputs of initial run-times for existing and proposed equipment. Initial run-time shall not automatically assumed to be zero.

H. All PLC control strategies shall return to a normal control mode upon restoration of power.

I. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the integral and derivative functions to zero. All PLC-controlled variable speed equipment shall be provided with individual speed control PID modules in the PLC which shall be cascaded with the overall setpoint PID modules as required. All setpoints, sequence timers, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the Operator work stations.

J. All setpoints, alarms, etc. based upon an analog input signal or field variable shall be provided with time delays and dead bands to prevent nuisance tripping of controls and alarms.

K. Elapsed run time shall be determined through an auxiliary contract on the starter which is an input to the PLC.

1. Elapsed run time shall be displayed at the SCADA level for each and every motor controlled through the PLC system.
2. Individual elapsed run time accumulation may be reset by the operator after entering a password if the proper security level is associated with said password.
3. Elapsed run time shall be displayed as 99,999.9 hours after which the elapsed run time registers shall recycle to 0.0 hours.
4. Provisions shall be made to allow the operator to enter a start value for runtime accumulation.
5. Elapsed run time shall be accumulated and stored in PLC registers and not in the SCADA system.

L. PID control algorithms.

1. PID control algorithms shall have operator selectable slew rates for setpoints that will allow the setpoint to slowly ramp to its final value in order to minimize system disturbance.
    a. Individual setpoint slew rates shall be set at a local HMI if available as well as through the SCADA system.
2. Each PID control algorithm shall have a face plate associated with the individual PID control algorithm that shall be displayed at its associated HMI and at the SCADA terminal. Said face plate shall have the following functions:
    a. Display Output, CV.
    b. Display Setpoint, SP.
    c. Display Process Variable, PV.
    d. Allow for operator selection of Automatic or Manual control of Output.
    e. Under manual control of output allow the Operator to enter the desired output value.
    f. Allow for input of the three PID tuning parameters.

M. Programmable settling and proving timers shall be provided in all control sequences for starting and stopping of pumps, in order to let the process settle down before proceeding with any additional control functions.

1. These timers shall be imbedded in the PLC logic, tuned in the field, and listed separately as part of the software submittal and O & M manual.

N. Status indication:

1. The associated pilot light, HMI display, and SCADA display for each valve and pump shall indicate valve or slide gate position if available by constantly illuminating the corresponding status indication and report this condition to the SCADA system.
2. As previously described a fault condition shall flash the associated status indicator and alarm within the SCADA system.
3. When a valve is in transition, not fully closed and not fully opened, then the valve open and valve closed status indicator shall:
    a. For HMI and graphic displays state that the valve is in transition.
    b. For pilot lights shall alternately flash on and off the valve fully opened and fully closed pilot lights.

O. When setpoints or actions are identified to occur on more than one HMI, or both the HMIs and SCADA, the last action or setpoint shall override the current condition, unless otherwise noted.

P. Control software and/or hardware shall be so configured and designed as to monitor for loss of analog signal (signal <4 mA), analog signal too large (signal > 20 mA), or rate of signal change too fast (individual rate parameter for each analog input signal to be imbedded in software), when any of these conditions are detected the control system shall alarm this condition, and close the appropriate valve and or stop the appropriate motor in order to prevent the process from running away.

Q. The manual control mode shall be completely manual and under the operator control, there shall be no programmed interlocks requiring completion of a previous step before operating a device, unless specifically identified in the individual loop descriptions as occurring in the manual mode.

R. Number of starts shall be accumulated for each motor.

1. The number of starts for the current day shall be moved into a register and held as the previous day's number of starts at 0:01 hours each day.
2. The number of starts for the current day shall be entered into the historical data base time and date stamped at 0:01 hours each day.
3. The current day number of starts shall be reset at 0:01 hours each day.

S. Alarm/Fault Indication/Acknowledgement

1. Furnish an alarm acknowledgement pushbutton at each VCP, HMI, or LCP that shall signal the PLC that an alarm or fail condition has been acknowledged. This device shall only affect the alarms that are present on the panel where the device is located.
2. In general any fault condition shall flash the appropriate pilot light and/or graphic at a rate of on for 0.5 seconds and then off for 0.5 seconds.
3. The individual alarm acknowledgement pushbutton or action shall function as follows:
   a. Shall change the flashing alarm indication to continuously ON if the alarm or fail condition persists after the acknowledgement button or action has been depressed.
   b. Shall turn OFF the alarm indication if the alarm or fail condition has been corrected and the alarming system has returned to normal.
4. An alarm beacon and horn shall be located as needed.
   a. The alarm silence pushbutton or HMI command shall silence the horn but continue to show the visual alarm.
5. All alarm and fail conditions shall flash their respective pilot lights, indicators, HMI, or SCADA graphics, until the condition is acknowledged by the operator.
   a. Once the operator acknowledges the alarm or fail condition the pilot light, indicator, HMI, or SCADA graphic shall remain ON in a steady condition.
      Once the alarm has been cleared and the operator again acknowledges the alarm or fail condition the pilot light, indicator, HMI, or SCADA graphic shall turn OFF.
6. All valves, pumps, motors, and other process equipment shall have fail alarms displayed and reported at the HMI and SCADA level.

T. Tank and vessel levels.

1. All tank and vessels levels shall be displayed both in feet (XX.XX) and gallons, whether or not specifically identified in the P & IDs or Loop descriptions.
2. All identified tanks and/or vessels that have a level measurement shall include, whether or not identified, the following minimum functions that shall be displayed on the associated HMI and SCADA System.
   a. Numerical readout of process material level in the tank.
   b. Setpoint for high level and high level alarm
   c. Setpoint for low level and low level alarm.
   d. Setpoints for high level and low level shall be entered as a level or volume as directed by the ENGINEER.

U. Power failure.

1. The control system upon sensing a power failure shall store, within, the PLC memory the current accumulation of all time records and flow totals and as necessary, the status of all devices, i.e. ON or OFF, to allow a return to normal operating condition.

V. PLC System Status

1. There shall be a minimum of one screen that shall include the status of all PLCs in the system and the status of the PLC communications LAN.
2. The PLC shall monitor communications status with equipment including with heartbeat status and alarm on communications failure.

W. Analog device calibration override.

1. Provide a SCADA screen for each and every analog input that allows the Operator to access said analog input to:
   a. Disable the analog input in the PLC control system.
   b. Enter a value for the analog input from the SCADA system to the PLC.
   c. Hold the last analog input value while the actual analog input is disabled.
2. Provide a SCADA screen for each and every analog output that allows the Operator to access said analog input to:
   a. Force an output value entered from the SCADA system to the PLC.
   b. Hold the last analog output value while the programmed output is disabled.

PART 2 PRODUCTS

2.1 CONTROL DESCRIPTION

A. The drinking water system for the purposes of this project consists of a well pump that draws water from a well and directly feeds the drinking water system or irrigation system. The water when starting is pumped to waste (i.e. storm drain). There is a gas chlorination system that introduces chlorine gas to a boosted stream of water and correctly doses the right amount of chlorine into the egress line.

B. Under normal operation, the well pump controls to a desired flow rate setpoint.

C. The control system shall permit the manual operation of the well pump and valves and all necessary auxiliaries to pump water to either the drinking water or irrigation water system, all without the requirement of the PLC. The PLC will have more sophisticated I/O and algorithms available for advanced monitoring, controls, and alarms, but the well must run independently without the need of the PLC using manual controls on the control panel, and manual operation/monitoring of valves, equipment, etc.

D. This control description does not cover all requirements from the City for standard HMI screens, operator interface and overrides, which data to display on the HMI, etc. Refer to City for standards.

2.2 AUTOMATED WELL STARTUP SEQUENCE

A. The waste valve is held waiting in the open position.

B. The Well startup sequence begins when the control switch is set to Auto and the PLC sends a Run command. The pre-lube water solenoid opens the solenoid and upon

detection of flow from the flow switch, begins a 10 minute timer. If there is no flow detected within a set time, an alarm is generated and the pump shuts down and locks out. There is a redundant lube flow meter that will alarm if there is low flow during a lube cycle.

C. During the pre-lube cycle, if the waste valve is not in the open position, the system prepares for a flush by opening the waste valve. If the valve does not show open during the lube cycle, it will alarm and shut down.

D. Once the 10 minute pre-lube cycle is complete and the valves are detected to be in the correct position for a flush, the VFD to the Well Pump is commanded to run. The pre-lube water continues to be delivered for the first 1 minute of runtime.

E. The waste valve is used to modulate the pump discharge pressure 10PSI below the system pressure. The VFD speed is controlled to maintain the Flushing Flow Setpoint. The controller will be designed to prevent wind-up of the controller until the flow rate can be detected. There may be a process delay from the point in time the pump starts to the time the flow is sensed in the flow meter. During that time, the controller will command a speed equal to the anticipated speed necessary to obtain the flushing flow setpoint of 900 gpm. Standard PID control will be resumed when a flow is detected in the meter. If no flow is detected within a time delay, there will be an alarm and shutdown of the well pump.

F. After 2 minutes of indication of flow through the main flow meter, the solenoid valve for the turbidimeter will open. This feeds water to the turbidity meter and to the chlorination system. The flushing cycle will continue until the turbidity meter shows turbidity below the acceptable limit, which is 0.5 NTU. During the initial 2 minutes of the flushing cycle, a solenoid will prevent the flow of water to the turbidity meter to prevent grit from reaching the meter. Note that the solenoid fails closed.

G. At the conclusion of the flushing cycle, the waste valve will begin to close. The VFD speed will be adjusted by the controller to maintain the normal water delivery flow rate setpoint.

H. If at any time during normal water delivery the turbidity exceeds the maximum allowable turbidity of 1.0 NTU, the waste valve will open, and a flushing cycle will recommence. An appropriate bandwidth between minimum turbidity and maximum turbidity will be adjusted for field conditions on startup of the well. In all cases, the flushing cycle will not be shorter than a minimum setpoint as determined by the City. Any flushing cycle that continues longer than a maximum setpoint as determined by the City will result in an alarm.

I. The controller speed setpoint to the VFD will be calibrated in the VFD so that 4mA will correspond to the minimum acceptable VFD speed, and 20mA will be the maximum acceptable VFD speed. This will be field-verified as to the minimum and maximum speeds. The VFD will not interpret 4mA as a zero speed, and 20mA as a maximum speed, but will rather function as aforementioned.

J. All setpoints and timers used in the PLC for control shall be adjustable by the operator via the HMI interface.

2.3 MANUAL WELL STARTUP SEQUENCE

A. The waste valve switch is turned to the “WASTE” position. When the waste valve is shown “OPEN” by indicator lamp, then the operator turns the Hand-Off-Auto switch to HAND. When ready, and confirms all instrumentation, valve positions, and conditions are acceptable for a start, the Operator presses the Start pushbutton.

B. The pre-lube water solenoid opens the solenoid and upon detection of flow from the flow switch, begins a 10 minute timer. If there is no flow detected within a set time, an fault condition is generated and the pump shuts down and locks out. During the pre-lube cycle, the operator confirms the correct position for a flush.

C. Once the 10 minute pre-lube cycle is complete the VFD to the Well Pump will automatically start. If the PLC is functioning, the pre-lube water continues to be delivered for the first 1 minute of runtime, otherwise the lube solenoid will close when the run status is seen back from the VFD controller.

D. The waste valve will be fully open, and the operator will manually control the VFD speed via a speed pot on the control panel, and attempt to control to the flushing flow setpoint. If no flow is seen by the operator after a reasonable amount of time, the operator presses the stop pushbutton.

E. During the flushing cycle, the operator opens a manual bypass valve around the turbidity water supply solenoid valve, and monitors the turbidity. When the turbidity falls below the acceptable limit. During the initial 2 minutes of the flushing cycle, if the PLC is functioning, a solenoid will prevent the flow of water to the turbidity meter to prevent grit from reaching the meter. Note that the solenoid fails closed if the PLC fails, and will not be functional during the manual operation.

F. At the conclusion of the flushing cycle as determined by the operator, the operator then switches waste valve switch to “SYSTEM”, and as the waste valve closes, the flows will be redirected to the system piping. The operator will adjust the VFD speed via the speed pot on the controller to the desired flow rate.

G. It is the controllers responsibility to monitor for turbidity and to interrupt passing turbid water to the system. It is the controller’s responsibility to monitor well levels and to shut down the pump on low-low level.

H. The PLC (if functioning) continues to monitor conditions and provide alarms. The PLC has an input to indicate when the controls are in Auto. When not in Auto, the PLC does not attempt to perform any pump or valve control, but does still send a lube command for 1 minute following the start of the well pump, and continue to control the turbidity, and chlorination solenoids and booster pump.

2.4 WELL PERMISSIVES

A. The Well Pump will shut down and/or not allow startup for any of the following conditions:

B. Hardwired:

1. High discharge pressure as detected by the high discharge pressure switch, or the discharge pressure transmitter reading a high signal. The discharge pressure transmitter alarm will have a time delay adjustable in the system. The high discharge pressure switch will either be selected by hardware to be properly delayed and debounced for momentary high pressures during startup, or if it does not have the capability, then the controller will provide the appropriate debounce delay. This condition will lock in the shutdown and require a reset to resume operation of the pump.
2. Low-Low well level will shut down the pump. This condition will lock in the shutdown and require a reset to resume operation of the pump. An alarm will register for a Low well level.
3. High motor temperature will shut down the pump. This condition will lock in the shutdown and require a reset to resume operation of the pump.
4. VFD Failure will shut down the pump. This condition will lock in the shutdown and require a reset to resume operation of the pump.
5. Pre-lube failure will prevent startup of the pump. This condition will lock out the permissive and require a reset to resume operation of the pump. Upon resuming, the startup sequence restarts from the beginning requiring the full 10 minute timer to elapse before starting the pumps.
6. The operator places the control hand switch in the OFF position or E-STOP is depressed. This switch will electrically drop the run command to the VFD. The E-STOP will kill power to all signals.
7. The HMI will have the capability to cause an Emergency Stop or a stop command.
8. PLC:
9. Low water flow as measured by the well pump discharge flowmeter will shut down the pump.
10. Failure of the valves to be in the correct position for the current cycle (flushing or normal) will on a time delay prevent startup or cause a shutdown of the pump. This condition will lock out the permissive and/or lock in the shutdown and require a reset to resume operation of the pump.
11. The PLC will detect that the hand switch is not in AUTO and drop the run command in the controller.

2.5 WELL SHUTDOWN SEQUENCE

A. A normal stop will slow the VFD Via the PLC and then completely stop. It will not be permitted to slow down more abruptly than the rate set in the VFD configuration.

B. An operator stop will involve the operator depressing the Stop button. The VFD slow down rate will be used. The operator must remember to place the valve in WASTE position for the next start.

C. A Hard shutdown stop or E-Stop, the run command to the VFD will drop which will cut power to the pump which will stop on its own with mechanical ratcheting. All valves will remain in their current position.

2.6 WELL COOLDOWN SEQUENCE

A. The Well pump shall not be permitted to restart until 10 minutes have gone by following a shutdown, with a maximum number of starts being limited to 4 per hour.

2.7 CHLORINE SYSTEM

A. Safety:

1. A Chlorine Gas detector is installed in the Chlorine room. The PLC will monitor the chlorine levels and alarm on high levels. On high-high levels, the PLC will also alarm, and a corresponding switch within the detector will hardwire into a gas alarm panel that will turn on the vent fan, and illuminate two gas beacons. The hardwired gas alarm latches in the gas alarm panel.
2. Power OK is sent to the PLC so that the PLC can alarm if the gas alarm panel circuit loses power. Fail safe so loss of power or open circuit in the input alarms the PLC.
3. Gas Detector Fault produces an alarm in the PLC.
4. The Chlorine room vent fan will start when the lights of the room are turned on (via switch at either door), or the fan switch is turned on (at either door), or when the room temperature exceeds 80 deg F.

B. Dosing:

1. The chlorine system has a manual regulator that is set to deliver the right amount of gas into the flowing water stream as delivered by the booster pump.
2. The booster pump is commanded ON when the water is being pumped, and it is not in a flush cycle. The booster pump will be OFF during flush cycles, and any time the waste valve is sensed not closed (it does not need to be open, just not closed). The solenoid valve feeding the booster pump is kept closed for the initial 2 minutes of operation to allow for grit to clean out before sending it to the turbidity meter and booster pump. During this time the booster pump is commanded OFF.
3. Operators can disable the chlorination via the booster pump through its circuit breaker, and by manual valves. When Irrigation mode is selected via HMI, there is no chlorination dosing. The Booster Pump does not run, and chlorination is not injected.
4. The Chlorine analyzer alarms on High or Low chlorine levels.

2.8 DRINKING WATER VS IRRIGATION WATER

A. The piping in the pump room is set up so that the well can only push to drinking water or to irrigation water, and only by physically removing a section of piping and placing it in the other pipeline. It is not a frequent event to switch pumping methods, and not intended to be instantaneously swung over.

B. Operators close the valves to the system, and move the section of piping, and then open the valve to the correct system. Then the operators change the piping mode in the HMI.

C. In the irrigation water mode, the chlorination is not added. The PLC will have an operator selectable mode, either to drinking water or to Chlorination water mode. It will produce an informational status in SCADA when the mode changes to notify operations and make a note of the change. On the HMI, any diagram showing piping will change to indicate which piping is active, and which piping is inactive. It will be clear to operators on applicable views of the HMI which mode the system is in.

2.9 ADDITIONAL I/O ALARMS AND CONTROLS

A. Master Reset:

1. The VFD will lock in its alarms and fault conditions, and the PLC will lock in shutdown conditions. A single Master Reset pushbutton will clear all VFD alarms and fault conditions, and indicate to the PLC to reset its shutdown conditions.

B. PLC I/O, Control, and Alarms:

1. DO Start Pump: Request to run the pump is sent. This should not be sent unless all PLC conditions are satisfied.
2. DO Waste Open CMD: Request to open the Waste valve. Sent when the pump is Off. Sent during a flush cycle (triggered by start of pump or turbidity high). Dropped when the "OPEN" status is received. Controlled during a flush cycle to keep the pressure 10PSI below system pressure. Alarm if open command without open status in time delay while in AUTO.
3. DO Waste Close CMD: Request to close the Waste valve. Sent when normal pump to system mode. Sent when a flush cycle completes. Dropped when the "CLOSED" status is received. Controlled during a flush cycle to keep the pressure 10PSI below system pressure. Alarm if close command without closed status in time delay while in AUTO.
4. DO Lube CMD: Request to open Lube Water. FAIL OPEN. Lube on start request in code, and Start Pump DO. Timer adjustable on HMI. Send command also 1 minute after run status comes in.
5. DI VFD In Auto: When in AUTO, PLC Performs all the control decisions with the information it has. VFD still handles key hardwired safety lockouts, but communicates lockouts with the PLC. This should continue to be used in the PLC as well to shutdown, and latch the shutdowns. When not in Auto, PLC should drop the Start Pump Command and any Waste valve commands, no speed reference should be sent (4mA).
6. DI Pump Running: Indicator and trigger for HMI graphics. Alarm if run command and no run status after delay while in AUTO.
7. DI Hi Press: Alarm and locked shutdown AUTO or not.
8. DI Lube Fail: Alarm and locked shutdown AUTO or not.
9. DI VFD Fault: Alarm and locked shutdown AUTO or not.
10. DI E-STOP Engaged: Alarm and locked shutdown AUTO or not. Also all outputs go to safe state AUTO or not.
11. DI Waste Valve Open Status: Indicator, and trigger for HMI Graphics. Command open prior to a start. Do not send start until open, but once started it is not a shutdown. Alarm if command open and open status not received within timer while in AUTO. No mismatch alarm during flush cycle
12. DI Waste Valve Closed Status: Indicator, and trigger for HMI Graphics. Alarm if command close and close status not received within timer. No mismatch alarm during flush cycle. Alarm if not closed during normal operation mode while in AUTO.
13. DI PLC Reset DI: Master Reset button input from control panel. Locked-out shutdowns release. This does not reset the PLC or counters or timers or totalizers.
14. AO Pump Speed CMD: PID controller during flush cycle controls to flush cycle flow setpoint. Separate PID controller during normal cycle controls to discharge pressure. Start ramp per HMI-accessible max start ramp rate. Stop ramp per HMI-accessible max stop ramp rate.
15. AI Pump Speed REF: Indicator and data for HMI. Alarm on mismatch with delay while in AUTO.
16. DI PLC Power Fail: Relay drops power when PLC Cabinet loses primary power. Secondary power (UPS) continues. Alarm AUTO or not.

17. AI Well Level: Indicator and data for control panel. Alarm on low Well Level. Alarm and shutdown on Low-Low Level. Coordinate Low vs LowLow alarms with Level shutdown switch settings of Level Controller. PLC Low and Low-Low should occur prior to switch.
18. DI Pump Rm Flood: Alarm AUTO or not.
19. DI CL2 Rm Flood: Alarm AUTO or not.
20. AI Discharge Pressure: Indicator and data for HMI. Alarm on High pressure after timer. Locked shutdown on HiHi Press after timer. Coordinate shutdown with high pressure switch. Should shutdown prior to switch. During flush cycle while in AUTO, used to control waste valve position to control discharge pressure to be just below system pressure. During normal operation while in AUTO, used to control VFD speed to pressure setpoint.
21. AI Lube Water Flow: Alarm and locked shutdown low flow with HMI-accessible delay during lube cycle in AUTO or during Lube command AUTO or not.
22. AI Well Flow Rate: Indicator and data for HMI. Historize. Totalize based off of communications with flow meter. Separate totalizers when running to system from when running to waste. Not Closed is trigger for waste totalizer.
23. DO Water Feed Solenoid: Command to feed water to the chlorination system and to the turbidity meter. See Chlorination System for chlorination booster pump run strategy. Valve must be open for chlorination and turbidity analysis.
24. AI Water Feed Flow: When the water feed solenoid is open, the water should be flowing either to the turbidity meter, or the chlorination booster pump, or both. If flow is low, there will be an alarm.
25. DO Water Feed Blowdown Solenoid: Command to open the blowdown solenoid. It empties the strainer of grit and debris. Operate on a recurring timer basis, keeping the solenoid open for a timed amount. Timers HMI-accessible. Timers accrue only while Water Feed Solenoid is open.
26. AI Turbidity Analyzer: Information and data to HMI. Alarm on Hi Turbidity. In AUTO, Flush cycle completes when turbidity is below HMI-accessible min setpoint. Flush cycle recommences when turbidity rises above HMI-accessible max setpoint. See flush cycle description in AUTOMATED WELL STARTUP SEQUENCE.
27. DI Booster Pump Run Status: Information and data to HMI. Alarm on command/status mismatch AUTO or not.
28. DO Booster Pump Run Command: See CHLORINE SYSTEM Dosing strategy for booster run philosophy. Alarm on command/status mismatch AUTO or not.
29. AI CL2 Tank Weight: Information and data to HMI. Alarm on low tank weight.
30. AI CL2 Tank Weight: (tank 2) Information and data to HMI. Alarm on low tank weight.
31. AI Chlorine Analyzer: Information and data to HMI. Alarm on low/high chlorine. See also CHLORINE SYSTEM Dosing strategy.
32. AI Well Pressure: Information and data to HMI. Used during flush cycle to control waste valve pressure to just below this value.
33. AI Pump Room Temperature: Information and data to HMI. Alarm on high/low temperature. High > 40 deg C (104 deg F). Low < 5 deg C (40 deg F).
34. AI CL2 Room Temperature: Information and data to HMI. Alarm on high/low temperature. High > 40 deg C (104 deg F). Low < 5 deg C (40 deg F).
35. DI Intrusion Alarm: Alarm on intrusion.
36. AI CL2 Gas Detector: Information and data to HMI. Alarm on high CL2 Gas. Alarm on high-high CL2 Gas. Coordinate with switch on gas detector. Both alarms should occur prior to switch causing beacons and vent fan response. See also CHLORINE SYSTM Safety strategy.

37. DI CL2 Panel Power Ok: Alarm when not OK.
38. DI CL2 Gas Alarm: Alarm when initiated. Lock alarm. Display on HMI.
39. DI Gas Detector Fail: Alarm when initiated. Lock Alarm. Display trouble on HMI.

- END OF SECTION -

SECTION 40 20 00
INSTRUMENTS GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in operation process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with all instrumentation, panels, controls, and process equipment control panels with the process control system as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets, and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of the process instrumentation on process lines shall be provided under this Contract.

C. Taps and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation, and dimensions of the connections and taps for instrumentation as such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 – Process Control and Instrumentation Systems

B. Division 26.

1.3 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1. API RP550: Manual on Installation of Refinery Instruments and Control Systems, Part I – Sections 1 Through 13
2. ISA S20: Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
3. ISA S51.1: Process Instrumentation Terminology

1.4 GENERAL INFORMATION AND DESCRIPTION

A. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the

equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery, and complete installation and field testing of all instruments and appurtenances whether specifically mentioned in the Specification or not.

B. The instruments shall be furnished and installed with all necessary accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. The installations shall incorporate the highest standards for the type of service shown on the Drawings including loop testing of the entire installation and instruction of operating personnel in the care, operation, calibration, and maintenance of all instrumentation.

C. All instrumentation shall be of first class workmanship and shall be entirely designed and suitable for the intended services. All materials used in fabricating the equipment shall be new and undamaged.

PART 2 PRODUCTS

2.1 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, all instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

B. Equipment installed in hazardous areas shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electric Code.

C. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

D. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in paragraph 3.1.B. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable, except for speed and valve position. Floating outputs shall be provided for all transmitters.

E. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass, or PVC coated copper free cast aluminum NEMA 4X construction.

F. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

G. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture, and fungus. Solid-state components shall be conservatively rated for long term performance and dependability over ambient atmospheric fluctuations. Ambient conditions shall be –15 to 50 degrees C and 10 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and

system components shall be designed for installation in dusty, humid, and corrosive service conditions.

H. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

I. All non-loop powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage reduction, constant voltage transformers shall be supplied.

J. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

K. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials is available.

2.2 ACCESSORIES

A. Isolation Valves – Valves shall be full port ball valves with ASTM A276, Type 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Parker CPI, Whitey, Hoke, or equal.

B. Gage Valves – Gage valves shall be machined from ASTM A276 bar stock and shall be provided with 1/2 inch NPT connections and integral bleed valve. Valves shall be Anderson, Greenwood & Company M9530, Hoke 6801L8Y, or equal.

C. Root Valves – Root valves shall be ASTM A276, Type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, Type 316 stainless steel bleed valve. ASTM A276, Type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5 AVS-44, Hoke 6802L8Y, or equal.

D. Manifolds – Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4TVS, Hoke 8123F8Y, or equal.

E. Tubing – Instrument tubing between the process connection and instruments shall be 1/2-inch x 0.065-inch seamless annealed ASTM A269, Type 316 stainless steel. Tubing fittings shall be Type 316 stainless steel. Fittings shall be of the swage ferrule design

and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or equal.

F. Chemical Seals

1. Diaphragm – Seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body and Type 316L diaphragm unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.
2. Annular Ring – Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be Type 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 psig with not more than 5-inch WC hysteresis. Seals shall be Ronningen-Petter Iso-Ring, Red Valve series 40, or equal.
3. Fill Fluid – Chemical seals and associated instruments shall be factory filled as follows: Instrument side of seal, capillary tubing, and instrument shall be evacuated to an absolute pressure of 1.0 Torr or less; filled; and sealed. Unless otherwise specified, fill fluid shall be silicone oil, Dow Corning DC200, Syltherm 800, or equal.

G. Bushings and Thermowells – Bushings or thermowells shall comply with SAMA PMC17-10. Temperature taps shall be 1/2-inch NPT, and lagging extensions shall be provided on insulated vessels or pipes. Thermowells and bushings shall be machined from Type 316 stainless steel bar stock unless otherwise specified.

H. Purge Assemblies

1. Air – Air purge assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 scfh rotameter. Assembly shall be Moore Products 62VA, Fischer & Porter 10A3137N-3BR2110, or equal.
2. Water – Water purge assembly shall consist of a strainer, constant-differential regulator, needle valve, check valve, and 20 to 200 cc/m rotameter. Assembly shall be Moore Products 63BD4A, Fischer & Porter 10A3137N-53BR2110, or equal. Strainer shall be 155 micron wye-type, ASCO 8600A2, Crane, or equal.

2.3 POWERED INSTRUMENTS GENERAL REQUIREMENTS

A. Powered instruments are those instruments which require power (120 VAC or 24 VDC loop power) to operate. Each instrument includes an element or analyzer and a transmitter/controller.

B. Transmitters shall be 4 to 20 milliampere output two-wire type with operating power derived from the transmission circuit. Transmitter shall support an external load of 0 to 600 ohms or greater without requiring trimming resistors with a transmission circuit power supply of 24 volts. Transmitter output shall be galvanically isolated from the process and the transmitter case. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds. Transmitter output shall increase with increasing measurement except where "reverse action" is specified in the instrument schedule.

C. Electrical parts of transmitter and/or primary element mechanisms shall, as a minimum be housed in enclosures meeting NEMA 250, Type 4 require¬ments. Where electrical

mechanisms are located outdoors or in areas specified as corrosive, enclosures shall meet NEMA 250, Type 4X requirements.

D. Transmitters located outdoors shall be provided with surge protectors: Rosemount Model 470A, Taylor 1020FP, or equal.

E. Where two-wire transmitter is located in an area classified as hazardous, it shall be made safe by means of an intrinsic safety barrier. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD. type MT3042, Stahl 9005/01-252/100/00, or equal.

2.4 PROCESS SWITCHES GENERAL REQUIREMENTS

A. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC. Contacts monitored by electromagnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures. Switch electrical enclosures shall be rated NEMA 250, type 4 minimum. Contacts in Class 1, Division 1 areas and monitored by solid-state circuits shall be made safe by suitable intrinsic safety barriers as specified in Section 26 09 13 .

PART 3 EXECUTION

3.1 INSTALLATION

A. General – Equipment shall be located so that it is accessible for operation and maintenance. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square, ½-inch thick aluminum steel baseplate. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than ½-inch by use of phenolic spacers. Expansion shields in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.
2. Embedded pipe supports and sleeves shall be schedule 40, 304 stainless steel pipe, with stainless steel blind flange for equipment mounting as shown on the Drawings.
3. Materials for miscellaneous mounting brackets and supports shall be 304 stainless steel.
4. Pipe stands, mounting brackets, and supports shall comply with the requirements of Division 5.

5. Where transmitters are supported from process piping, leveling saddles shall be provided. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring – Electrical, control, and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.2 CLEANING AND ADJUSTMENT

A. General

1. The Contractor shall comply with the requirements of Division 1 and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserve the right to witness any test, inspection, calibration, or start-up activity. Acceptance by the Engineer of any plan, report, or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.
2. The Contractor shall provide the services of factory trained technicians, tools, and equipment to field calibrate, test, inspect, and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provided all personnel, equipment, and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Bureau of Standards.
2. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures, name of person performing the calibration, listing of published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required, and corrections made.
3. If doubt exists as to the correct method for calibrating or checking calibration of an instrument, the manufacturer's recommendations shall be used as an acceptable standard, subject to approval of the Engineer.
4. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature

variations. Caution shall be exercised to prevent such devices being subjected to overvoltages, incorrect voltages, overpressures, or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

5. Upon completion of instrumentation installation, the Contractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

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SECTION 40 21 20
MAGNETIC FLOW METERS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the magnetic flowmeter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 – Process Control and Information Systems

B. Section 40 20 00 – Instruments, General

PART 2 PRODUCTS

2.1 MAGNETIC FLOWMETERS

A. Acceptable Manufactures are:

1. Siemens Sitrans FM MAG 5100 W.
2. Or equal

B. Process connections shall be flanged, ANSI B16.5, Class 150, raised face.

C. Magnetic flow meter shall be provided as a system consisting of a flow tube and separate converter/ transmitter complete with interconnecting cables. Converter/transmitter shall be suitable for full-scale flow rates from 3.0 to 30 feet per second. System error shall not exceed the greater of 0.5 percent of rate or 0.1 foot per second. Flow tubes located in lined or nonconductive pipelines shall be provided with grounding spools or swages fabricated from ASTM A312, Type 316 stainless steel. Grounding spools or swages inside diameter shall be 1/16 inch smaller than flow tube inside diameter. Where pipe run size is different from specified flow tube size, uniformly diverging swages with a total angle between walls not exceeding 15 degrees shall be provided. Excitation power requirements shall not exceed 100 volt-amperes.

D. Flow tubes size 0.5 through 6 inches shall be ceramic lined wafer-style ductile-iron body with platinum electrodes. Flow tubes larger than 6 inches shall be cast aluminum full-body flanged construction with 316L stainless steel electrodes. Unless otherwise specified, liner shall be polyurethane.

E. The transmitter shall contain all electronics associated with the magnetic flow meter system. Enclosure shall be NEMA 4 cast aluminum compartment for power, field connections and calibration adjustments separate from digital circuitry. Transmitter shall contain means to calibrate the metering system without use of external calibration units. The transmitter shall contain self-diagnostics and shall be interchangeable with other units of the same type without special recalibration. Transmitter shall include an integral 3 digit LCD flow indication calibrated in process units. Adjustable dampening shall be provided. Provision for accepting an external contact to force signal output to zero shall be provided. Where pulse frequency output is specified, pulse frequency shall cut out at

flows below 2 percent of maximum range. The signal cable between the primary element and transmitter shall be provided by the system manufacturer. A sufficient length of cable shall be provided for installation of a continuous run between the primary element and the transmitter.

F. Remote mounted display/transmitters shall be provided where indicated on the drawings. Flow tubes with integral display/transmitters shall be provided where indicated on the drawings.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. Refer to Section 40 20 00.

- END OF SECTION -

SECTION 40 24 10
LEVEL DETECTOR

PART 1 GENERAL

1.1 REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the Ultrasonic level sensor and transmitter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00-Process Control and Information Systems

B. Section 40 20 00-Instruments General

PART 2 PRODUCTS

2.1 LEVEL DETECTOR/WITH REMOTE DISPLAY/TRANSMITTERS

A. The level detector shall be of the non-contact microprocessor based type for the continuous measurement of liquid levels.

B. The unit shall be a two piece transmitter/display meter and transducer with interconnecting cables.

C. The transmitter shall store the level profile in the computer memory and moment by moment, analyze the profile to determine the actual liquid level.

D. All program data shall be safeguarded internally in non-volatile EEPROM memory.

E. The transducer shall be encapsulated and shall be capable of:

1. Accuracy of ± 0.25% of range.
2. Range 0.8 to 26.2 feet or the maximum depth of the measured material whichever is greater.
3. Provide for flange mounting, or provide wall mounted mounting bracket as detailed on the drawings.
4. With integral temperature compensation or without temperature factors playing into the level measurements.
5. The unit shall utilize a narrow beam transducer which is rated Class 1 Division 1, explosion proof. The unit shall be provided with factory fabricated lead cable integral to sensor unit and shall extend to the meter unit within the electrical room.

F. The control transmitter shall be in a NEMA 4X enclosure with an integral from panel mounted meter indicating in scaled engineering units.

1. The unit shall provide a 4-20 mA analog output signal directly proportional to level, driven from the PLC and its associated power supplies.
2. The unit shall be capable of displaying by software selection:
   a. Distance to liquid surface from transmitter.

3. The unit shall contain four relays for use as programmable alarm or hard-wired control points.
4. Power requirements shall be 24VDC (fed from a UPS via a power supply.)
5. 4-20 mA output into 750 Ohms at 24 VDC.
6. Selectable damping 1 to 10 m/min.
7. 4 button HMI, wall mounted controller allowing for programming from the panel face, including blanking distances and obstruction blanking.

G. The programming unit shall be incorporated into the body of the instrument.

H. Operating temperature range -40º to 60° C.

I. Mount transducer with non-metallic mounting only.

J. Three wire extended range.

K. As manufactured by:

1. Siemens Hydroranger 500 with LR100 series radar.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. Refer to section 40 20 00.

B. Transducers shall be provided with flange mounting options. Mount to flanged support rigidly attached to wall or concrete square and plumb to building. Sensor shall be mounted to avoid all signal interferences.

- END OF SECTION -

SECTION 40 27 60
PRESSURE SEALS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure switches and seals with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 MANUFACTURERS

A. Section 40 20 00 – Instruments General

PART 2 PRODUCTS

2.1 Pressure Instrumentation

A. Seals

1. All pressure switches and/or transmitters shall be provided with seals.
2. Pressure switches, gages, and/or transmitters and seals shall be assembled, and oil filled at the factory prior to shipment. Filling fluid shall be compatible with piping contents and temperature.
3. Pressure switches and/or transducers attached to systems involving chemical solutions, corrosive fluids, or other liquids containing one percent or more of solids, shall be equipped with diaphragm or annular seals whether shown or not on the drawings, or equal protective pressure sensing devices, as follows:
   a. Clear process water applications:
      1) Type 316 stainless steel for pressures over 15 psi.
      2) Elastomer for pressures of 15 psi and below.
      3) Type 316 stainless steel nuts and bolts, fill connection and valved flush port size of ¼-inch NPT, capable of disassembly without loss of filler fluid.
      4) As manufactured by:
         a) Ashcroft Type 101
         b) Or prior approved equal.
4. Materials
   a. Body is 316 Stainless Steel unless otherwise required. Two assembly flanges are 316 S.S. Flexible elastomeric cylinder is Silicone. Captive sensing liquid is glycerin, Silicone or Halocarbon as required for the piped fluid.
5. As manufactured by:
   a. Ashcroft Type 80, 81.
   b. Prior Approved Equal.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. See Section 40 20 00.

- END OF SECTION -

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SECTION 40 91 20
PRESSURE GAUGES

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure gauges and seals with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED SPECIFICATION SECTIONS

A. Section 40 20 00 – Instruments, General

B. Section 40 27 60 – Pressure Seals

1.3 SUBMITTALS

A. Furnish complete submittals in accordance with Section 01 30 00.

B. Product Data

1. Complete manufacturer's brochures; identify instrument construction, accuracy, ranges, materials and options.
2. Complete instrument data sheets, including catalog number and source for determining catalog number for all gauges and seals.

PART 2 PRODUCTS

2.1 PRESSURE INSTRUMENTATION

A. Seals

1. All pressure gauges shall be provided with seals. See Section 40 27 60.
2. Pressure gauges and seals shall be assembled and oil filled at the factory prior to shipment. Filling fluid shall be compatible with piping contents and temperature.

2.2 PRESSURE GAUGES MANUFACTURED UNITS

A. Pressure, Vacuum, Compound Gauges.

1. General
   a. Furnish and install pressure and vacuum gauges as specified; complete, including all fittings, snubbers, connections, gaskets, supports and accessories in the locations shown or specified, in accordance with the Contract Documents.
   b. Pressure gauges shall be provided whether or not shown on the plans:
      1) On suction and discharge connection to all pumps.
      2) On discharge connection from blowers and compressors.
      3) On each side of pressure reducing valves.
      4) In other locations as shown on the P&IDs and/or mechanical plans.
   c. Vacuum gauges shall be provided whether or not shown on the plans:
      1) On all supply side educator type chemical feeders.

2) In other locations as shown on the P&IDs and/or mechanical plans.

d. Sleeve pressure gauges
   1) Shall be provided where shown on the plans.
   2) Pressure shall be sensed by a flexible sleeve contained in a flanged cast iron or steel spool or wafer body, and transmitted to the gauge through a captive fluid.
   3) Sleeve shall be of BUNA A and fabricated so as to isolate the body from the process liquid.
   4) Gauges shall be calibrated to read in applicable units.
   5) Accuracy of ±1% to 150% of the working pressure of the system to which they are connected.

2. Construction
   a. Gauges shall be industrial quality type with Type 316 stainless steel movement.
   b. Phenolic case.
   c. Liquid filled.
   d. Unless otherwise shown or specified, gauges shall have:
      1) A 4 ½ inch dial.
      2) ½ inch threaded connection.
      3) Type pulsation dampener adapter.
         a) Pulsation Dampener as manufactured by:
         b) Cajon Co.
         c) Weksler Instruments, Corp.
         d) Ashcroft.
         e) No equals.
      4) A block and bleed valve – ½ inch national pipe thread process connection and bleed/calibrate valve between block valve and outlet port.
   e. Gauges shall be calibrated to read in applicable engineering units.
   f. Accuracy of ±0.5% to 150% of the working pressure or vacuum of the pipe or vessel to which they are connected.
   g. All gauges shall be vibration and shock resistant.
3. Seals
   a. Gauges attached to systems without particulates shall be equipped with seals. See Section 40 27 60.
4. Gauges general as manufactured by:
   a. Ashcroft Industrial Instruments (Dresser). With Plus Performance.
   b. Forboro/Jordan, Inc. Equivalent model
5. Gauges sleeve pressure as manufactured by:
   a. Red Valve Co., Inc.
   b. Ronningen-Petter.
   c. Onyx.
   d. No Equal.
6. Snubbers as manufactured byL
   a. Cajon Co.
   b. Weksler Instruments, Corp.
   c. Ashcroft.
   d. No Equal.
7. Pulsation dampeners as manufactured by:
   a. Cajon Co.
   b. Weksler Instruments, Corp.
   c. Ashcroft.
   d. No Equal.

2.3 ACCESSORIES

A. Gauges shall be liquid filled or have some equivalent technology.

2.4 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.

1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure the mechanical system has all necessary appurtenances, weldolets, valves, orientation, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacturer's recommendations.

1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.
2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendations.
3. Install two 2 –valve instrument manifolds for each gauge pressure transmitter.
4. Bolt 3 valve manifolds at non-flange diaphragm type differential pressure transmitters in place of standard flange adapters.
5. Install root valves at process taps except insertion elements.
6. Install gauge valves on process connections to instruments where multiple instruments are connected to one tap or where root valves are not readily accessible.
7. All gauges shall be installed with the face in the vertical position.
8. In strict accordance with the manufacturer's printed instructions.
9. At the locations shown on the drawings, when so shown.
10. Care shall be taken to minimize the effect of water hammer or vibrations on the gauges.
11. In extreme cases, and with the approval of the ENGINEER, gauges may be mounted independently, with flexible connectors.

3.4 FIELD QUALITY CONTROL

A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 10 00.

3.5 ADJUSTING

A. All instruments shall be field verified.

3.6 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

3.7 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning.

B. The CONTRACTOR shall replace any instruments damaged prior to commissioning.

1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.8 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the CONTRACTOR's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The CONTRACTOR shall provide documented evidence for a differential, plus or minus, that results from these changes.

B. The CONTRACTOR shall supply complete instrument data sheets for each and every instrument and submit this information.

1. Instrument data sheets shall be furnished in both hard copy and electronic format.

- END OF SECTION -

SECTION 40 91 23
MISCELLANEOUS PROPERTIES MEASUREMENT DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers the Work necessary to install a ready to use and tested process and analysis system. CONTRACTOR shall provide all components required for a complete and functional system.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 207 Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
2. AWWA C 751 Magnetic Inductive Flowmeters

C. NSF INTERNATIONAL (NSF)

1. NSF/ANSI 61 Drinking Water System Components - Health Effects

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit catalog cuts on all process equipment including: switches, meters, sensors, or other items shown on Contract Drawings referencing each item by mark number. Information shall indicate manufacturer specification compliance and dimensional data.

C. CONTRACTOR shall supply operation and maintenance manuals for all process equipment.

1.5 WARRANTY

A. Manufacturer shall provide to OWNER written guarantee against defects in material or workmanship for a period of one (1) year.

1.6 DELIVERY AND STORAGE

A. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants. Each system shall be factory calibrated and certified prior to delivery.

1.7 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for any systems. Full compensation for the system shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

1.8 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of manufacturers regularly engaged in the design and manufacturing of this type of equipment. The manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving CONTRACTOR from responsibility for the proper installation and functionality of the work.

PART 2 PRODUCTS

2.1 GENERAL

A. Each process measurement system shall typically consist of a sensor and analyzer/transmitter. Where shown on the Contract Drawings, the analyzer/transmitter may be utilized for multiple sensors. When an analyzer/transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each analyzer/transmitter shall be equipped with a means to transmit process measurement data to the plant SCADA system.

1. For hardwired signals, unless indicated otherwise on Contract Drawings, provide the following:
   a. 4-20 mA output signals for each process measurement (for up to 500 Ohm loads).
   b. Two programmable SPDT relay outputs, rated at 5A up to 230 VAC, for each process measurement.

2. Where shown on the Contract Drawings, provide the following digital communications to the plant SCADA system:
   a. HART Protocol
   b. PROFIBUS
   c. MODBUS

C. Each analyzer/transmitter shall be powered by 115VAC (+/- 10%) at 60 Hz unless shown on Contract Drawings as being powered by 24 VDC (+/- 15%). Each analyzer/transmitter shall retain its programmable settings in non-volatile memory. Battery powered instruments, analyzer, or transmitters will not be accepted.

D. Each sensor and corresponding analyzer/transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners.

When installed outdoors, the analyzer/transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All analyzers/transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 INLINE FULL BORE MAGNETIC FLOW METER

A. General: Electromagnetic full bore flow meter for permanent installations both above and below ground and with or without the typical inlet/outlet straight pipe run mounting requirements. The full bore magnetic flowmeter shall maintain zero pressure loss while achieving 0.5% of rate accuracy even when mounted directly before or after a piping elbow, T-fitting, or insertion device. The meters shall utilize bipolar pulse DC coil excitation to measure voltage induced by the flow of conductive liquid through a magnetic flux. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second.

B. The flow meter shall be a flanged sensor which complies with AWWA C 751 and transmitter which may be mounted integral (compact) to the sensor as indicated on the Contract Drawings.

1. The flow metering system shall be microprocessor-based and possess a non-volatile memory to store the sensor calibration and transmitter setup information. The electronics shall be interchangeable for meters sizes 1-inch through 120-inch diameter.
2. The sensor shall be the proper size to measure the design flow rate of the piping and measure bi-directional flow as a standard.
3. The sensor shall consist of a stainless-steel flow tube with AWWA C207 Class D flanges. The flanges shall be Class 150 for 1-inch through 24-inch diameter and AWWA C 207 Class D for 28-inch diameter and larger as specified.
4. The sensor liner and electrode material shall be chosen to be compatible with the process fluid. All fluids require a minimum conductivity of 5µS/cm (20µS/cm for deionized water).
5. The sensor tube shall be lined with Ebonite Hard Rubber.
6. For drinking water applications, the sensor shall have NSF-61 approval.
7. The sensor shall house four measuring electrodes (1-inch through 2.5-inch diameters) and six measuring electrodes (3-inch through 120-inch diameters), plus a grounding electrode, and one empty pipe detection electrode with no exceptions. The electrodes shall be bullet-nosed shaped and made of Hastelloy.
8. The external sensor housing shall enclose the coil assemblies and internal wiring. The materials shall be designed and constructed to prevent moisture ingress and promote corrosion resistance.
9. The electrode circuit shall have a minimum impedance of 1012 ohms to overcome moderate coating buildup.
10. The sensor shall be rated for NEMA 4X service as standard.
11. If NEMA 6P is specified, the transmitter shall be remotely mounted and custom length cables shall be attached at the factory.
12. In the event of industrial treatment or corrosive/brackish environments, the flow sensor shall be painted and certified according to ISO-12944 corrosion class. Third

party modification or sensor preparations shall not be accepted without type test documentation to support the exposure conditions, depth, and duration of resistance.

C. The transmitter (series 400) shall be a three-stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The transmitter shall incorporate a universal 100-240 VAC/18-30 VDC power supply. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

1. The transmitter shall allow local programming that can be operated through the enclosure window without opening the electrical enclosure.
2. The transmitter display shall indicate simultaneous flow rate and total flow with 3 totalizers (forward, reverse and net total) and user-selectable engineering units, readout of diagnostic error messages, and support 12 standard languages.
3. The transmitter shall safeguard against entering of invalid data for the particular meter size and all programming parameters shall be access-code protected with a minimum requirement of dual passwords according to data sensitivity.
4. The transmitter output shall be specified as specified on the Electrical and Controls Drawings.
5. The transmitter output(s) shall be integral to the magnetic flowmeter transmitter electronics and using an external third-party signal converter is unacceptable.
6. There shall be no limitation of transmitter operational capability or diagnostic dependency between integral and compact mounting orientation.
7. The transmitter output selected must be supported by add-on instructions (AOI), Level 3 add-on profiles (AOP), device drivers (DD), general station description (GSD) files, instructions and pre-engineered code.
8. The transmitter shall support commissioning options via a service interface or device driver less operation via an internal web server accessible through a transmitter accessible RJ-45 Ethernet port or a WLAN (Wireless Local Area Network) connection as specified.
9. The transmitter shall retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure. The memory unit shall be transferrable from a damaged unit or used for a duplicate device with no loss of device parameters or data stored.
10. The transmitter shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.
11. Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.
12. The transmitter shall provide access to service and monitoring parameters designed to identify transient or permanent process influences.
13. The transmitter and sensor shall include a method to verify flow meter performance to the original manufacturer specifications.

a. The system shall be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
b. The verification technique shall not require external handhelds, interfaces, special tooling or electrical access for a verification to be performed.
c. The transmitter shall store up to eight verifications in the microprocessor.
d. A verification of the system shall be possible at any time, locally or remotely, on demand and under process conditions.
e. The verification report shall be compliant to common quality systems such as ISO 9000 7.6.a to prove reliability of the meter specified accuracy.

D. Provide grounding rings as per the manufacturer's recommendations.

E. Source Quality Control and Calibration

1. Magnetic flow meters shall be factory calibrated on an ISO-17025 accredited test stand per "General Requirements for the Competence of Testing and Calibration Laboratories" with certified accuracy traceable to NIST.
2. Evidence of accreditation shall originate from a national verification agency such as A2LA.
3. Each meter shall ship with a certificate of a 2-point calibration report exceeding stated standard accuracy of 0.5% of rate. The 0.5% accuracy shall be maintained with zero upstream/downstream piping requirements i.e., mounted directly before or after a piping elbow, T-fitting, or insertion device.
   a. Optional factory calibration of 0.2% of rate accuracy (magnetic flowmeter must be installed with the proper upstream five (5) times and downstream two (2) times the pipe run diameter requirements)
   b. An optional performance calibration for a Flat Accuracy Specification shall be performed in the event of low initial design flow rate.
4. A real-time computer-generated printout of the actual calibration data points shall indicate apparent and actual flows. The flow calibration data shall be confirmed by the manufacturer and shipped with the meters to the project site.
5. The manufacturer shall provide complete documentation covering the traceability of all calibration instruments.
6. The manufacturer shall provide ISA data sheet ISA-TR20.00.01 as latest revision of form 20F2321. The manufacturer shall complete the form with all known data and model codes and dash out the inapplicable fields. Incomplete data sheets submitted will result in a rejected submittal.

F. Inline Full Bore Magnetic flow meters shall be **SITRANS F M MAG 5100 W by Siemens**.

PART 3 EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted and installed as per manufacturer recommendations. Coordinate final location with ENGINEER.

3.2 FLOW METER FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and ENGINEER shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC
2. Each instrument shall provide direct control of totalizer reset functions through the PLC
3. Each instrument shall be supported with a device profile permitting direct integration in the PLC

B. ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services shall be provided for start-up and commissioning by a Factory field service representative or a manufacturer's authorized service provider (ASP).

1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.
2. Manufacturer representative shall notify ENGINEER in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.
4. Manufacturer representative shall generate a configuration report for each meter.

3.3 TESTING

A. After installation of the equipment is complete, operating tests shall be carried out to assure that the equipment operates properly. All piping shall be tested hydrostatically and for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

- END OF SECTION -

SECTION 40 92 57
ELECTRIC MOTOR ACTUATORS

PART 1 GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR shall furnish and install electric motor actuators and appurtenances for segmented ball valves; complete and operable, in accordance with the Contract Documents.

B. The valve manufacturer shall be made responsible for coordination of design (valve stem diameter, threading, key and keyway adaptation, and other dimensional information), assembly, testing, and installation of actuators on the valves; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves and actuators with the Contract Documents.

C. Where two or more valve actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

1.2 RELATED WORK

A. Related work specified in other sections:

1. Section 01 33 00 Submittals

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. American Water Works Association (AWWA)

1. AWWA C 542 Electric Motor Actuators for Valves and Slide Gates

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittals.

B. Shop drawing information for actuators, floor stands, and extension stems shall be submitted together with the valve submittals as a complete package.

C. Submit information on electric motor actuator including cut sheets, technical brochures, electrical diagrams, control schematics, and operation and installation manuals.

D. Submit calculations showing dynamic seating and unseating torques versus output torque of the actuator.

1.5 MEASUREMENT AND PAYMENT

A. Electric motor actuators shall not be measured or paid as a separate item but shall be included as part of the item to which it relates.

PART 2 PRODUCTS

2.1 GENERAL

A. All electric motor actuators shall conform to the requirements of AWWA C 542.

B. Actuators shall contain motor, gearing, manual over-ride, limit switches, torque switches, selector switch, drive coupling, integral reversing motor controls, control voltage transformer, indicator lights, handwheel, lubricants, heating elements, wiring, terminals, position feedback transmitter, and mechanical dial position indicator.

C. In order to maintain the integrity of the enclosure, setting of the torque levels, position limits and configuration of the indication contacts, etc. shall be carried out without removal of any actuator covers over an Infra-Red or wireless interface. Sufficient commissioning tools shall be provided with the actuators and must meet the enclosure protection and certification levels of the actuators. Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage. In addition, provision shall be made for protection of the configured actuator settings by a means independent of access to the commissioning tool.

D. The electric motor actuator shall mount directly to the valve.

E. Position and limit switches, position transmitters, controls, indicating lights, devices, and selector switches shall be coordinated with the input/output requirements of the control system as indicated in the Drawings and specified herein.

2.2 ACTUATOR SIZING

A. The actuator shall be sized to guarantee valve closure at the specified maximum pressure and flow within specified time shown in Table 40 92 57 -1 below.

B. One actuator size shall be available covering output speeds from 4 to 180 rpm for a given torque range to avoid over-sizing and unnecessary weight load on the valve stem, flange, and yoke. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight over-sizing actuators. Actuators must be selected to provide sufficient torque required for safe valve operation. Actuator output torque must be available at 90% of nominal voltage.

2.3 ENVIRONMENT

A. Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from 25°F to 140°F, up to 100% relative humidity.

2.4 ENCLOSURE

A. Actuators shall be o-ring sealed, watertight, NEMA 4. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed for site cabling, the terminal compartment having the same ingress protection rating as the actuator with the terminal cover removed.

B. The enclosure must allow for temporary site storage without the need for electrical supply connection. All external fasteners shall be plated stainless steel. The use of un-plated stainless steel or steel fasteners is not permitted.

2.5 MOTOR

A. The motor shall be specifically designed for the valve actuator service. The motor will be of the induction type with Class F insulation and protected by means of thermal switches imbedded in the motor windings. Motor enclosure will be total enclosed, non-ventilated.

B. Motors shall be capable of operating on 480 volt, 3 phase, 60 Hz power.

C. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gearcase.

D. Protection shall be provided for the motor as follows:

1. Stall – the motor shall be de-energized within 8 seconds in the event of a stall when attempting to unseat a jammed valve
2. Over Temperature – thermostat will cause tripping of the motor, auto-reset on cooling
3. Single phasing – lost phase protection
4. Direction – phase rotation correction

2.6 GEARING

A. The actuator gearing shall be totally enclosed in an oil-filled gearcase suitable for operation at any angle. Grease lubrication is not permissible. All drive gearing and components must be of metal construction and incorporate a lost-motion hammerblow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design shall be such as to permit opening the gearcase for inspection or disassembly without releasing the stem thrust or taking the valve out of service. For 90 degree operating type of valves drive gearing shall be self-locking to prevent the valve back-driving the actuator.

2.7 HAND OPERATION

A. A handwheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to electrical operation automatically by starting the motor. The handwheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

B. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise noted. For linear type valves the actuator handwheel drive must be mechanically independent of the motor drive and should be such as to permit valve operation in a reasonable time with a manual force not exceeding 90 lbs through stroke and 180 lbs for seating/unseating of the valve.

2.8 DRIVE INTERFACE

A. The actuator shall be furnished with a drive bushing easily detachable for machining to suite the valve stem or gearbox input shaft. The drive bushing shall be positioned in a detachable base of the actuator. Thrust bearings shall be sealed for life and the base shall be capable of withstanding five times the rated thrust of the actuator.

2.9 LOCAL CONTROLS

A. The actuator shall incorporate local controls for Open, Close and Stop, and a Local/Stop/Remote mode selector switch lockable in any one of the following three positions: Local control only, stop (no electric operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

B. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

C. The local controls and display shall be rotatable through increments of 90 degrees to suit valve and actuator orientation.

2.10 TORQUE AND LIMITS

A. Torque and turns limitation to be adjustable as follows:

1. Position Setting Range – multi-turn: 2.5 to 8,000 turns, with resolution to 7.5 degrees of actuator output.
2. Position Setting Range – direct drive part turn actuators: 90° ±10°, with resolution to 0.1 degree of actuator output.
3. Torque Setting: 40% to 100% rated torque

B. Position Measurement: Absolute position measurement should be incorporated within the actuator. The technology must be capable of reliably measuring position even in the case of a single fault. The design must be simple with the minimum amount of moving parts.

C. Measurement of torque shall be from direct measurement of force at the output of the actuator. Methods of determining torque-using data derived from the motor such as motor speed, current, flux, etc. are not acceptable.

D. A means for automatic “torque switch bypass” to inhibit torque off during valve unseating and “latching” to prevent torque switch hammer under maintained or repeated control signals shall be provided.

E. The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.

2.11 REMOTE VALVE POSITION AND STATUS INDICATION

A. Four contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during handwheel operation when all external power to the actuator is isolated.

B. The contacts shall be rated for 5mA to 5A, 120V AC, 30V DC.

C. As an alternative to providing valve position indication any of the four above contacts shall be selectable to signal one of the following:

1. Valve opening, closing or moving
2. Thermostat tripped, lost phase
3. Motor tripped on torque in mid travel, motor stalled
4. Remote selected
5. Actuator being operated by handwheel
6. Actuator fault

D. Provision shall be made in the design for an additional eight contacts having the same functionality.

E. A configurable monitor relay shall be provided as standard, which can be used to indicate either Availability of Fault. The relay should be spring return type with a Normally Open/ Normally Closed contact pre-wired to the terminal bung.

F. The Monitor (Availability of Fault) relay, being energized from the control transformer will de-energize under any one or more of the following conditions:

Available Mode	Fault Mode
Loss of main or customer 24V DC power supply	Loss of main or customer 24V DC power supply
Actuator control selected to local or stop	Motor thermostat tripped
Motor thermostat tripped	Actuator internal fault
Actuator internal fault	

G. Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analog signal corresponding to valve travel and/or torque for remote indication when required. The transmitter will auto range to the set limits.

2.12 LOCAL POSITION INDICATION

A. The actuator display shall include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully close in 0.1% increments. Valve closed and open positions shall be indicated by symbols showing valve position in relation to the pipework to ensure that valve status is clearly interpreted. With main power connected, the display shall be backlit to enhance contrast at all ambient light levels and shall be legible from a distance of at least 10 feet.

B. Red, green, and yellow LEDs corresponding to open, closed, and intermediate valve positions shall be included on the actuator display when power is switched on. The yellow LED should also be fully programmable for on/off, blinker, and fault indication. The digital display shall be maintained and updated during handwheel operation when main power to the actuator is isolated.

C. The actuator display shall include a fully configurable dot-matrix display element with a minimum pixel resolution of 168 x 132 to display operation, alarm, configuration, and graphical data logger information. Provision shall be made to upload a different

language without removal of any covers or using specialized tools not provided as standard with the actuator.

D. Data logger graphical displays should as a minimum be able to display log and trend graphs on the local LCD for the following:

1. Torque versus Position
2. Number of Starts versus Position
3. Number of starts per hour
4. Dwell time
5. Average temperature

E. The main display shall be capable of indicating 4 different home-screens of the following configuration:

1. Position and status
2. Position and torque (analog)
3. Position and torque (digital)
4. Position and demand (positioning)

F. Provision shall be made for the addition of an optional environment cover to protect the display for high levels of UV radiation or abrasive materials.

G. The local controls and display shall be rotatable through increments of 90 degrees to suit valve and actuator orientation.

2.13 INTEGRAL STARTER AND TRANSFORMER

A. The reversing starter, control transformer and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tapping and be adequately rated to provide power for the following functions:

1. Energizing of the contactor coils
2. 24V DC or 110V AC output for remote controls (maximum 5W/VA)
3. Supply for all the internal electrical circuits

2.14 REMOTE CONTROL FACILITIES

A. The necessary control, wiring, and terminals shall be provided integral to the actuator enclosure. Open and close external interlocks shall be made available to inhibit local and remote valve opening/closing control. It shall be possible to configure the interlocks to be active in remote control only.

B. Remote control signals fed from an internal 24V DC (or 110V AC) supply and/or from an external supply between 20V and 60 V DC or 40V and 120 V AC, to be suitable for any one or more of the following methods of control:

1. Open, Close, and Stop Control
2. Open and Close maintained or “push to run” (inching) control

3. Overriding Emergency Shut-down to close (or open) valve from a normally closed or open contact.
4. Two-wire control, energize to close (or open), de-energize to open (or close)

C. Additionally provision shall be made for a separate ‘drive enable’ input to prevent any unwanted electrical operation.

D. It shall be possible to reverse valve travel without the necessity of stopping the actuator. The motor starter shall be protected from excessive current surges during rapid travel reversal. The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2 kV.

E. Provision shall be made for operation by distributed control system utilizing the following network systems:

1. Profibus
2. Modbus
3. Foundation Fieldbus
4. Pakscan (wired and wireless)
5. HART

2.15 MONITORING FACILITIES

A. Facilities shall be provided for monitoring actuator operation and availability as follows:

1. Actuator text display indication of the following status/alarms:
   a. Closed limit, open limit, moving open, moving closed, stopped
   b. Torque trip closing, torque trip opening, stalled
   c. ESD active, interlock drive
   d. Thermostat trip, phase lost, 24V supply lost, local control failure
   e. Configuration error, Position sensor failure, torque sensor failure
   f. Battery low, power loss inhibit

2. Integral data logger to record and store the following operational data:
   a. Opening last/average torque against position
   b. Closing last/average torque against position
   c. Opening motor starts against position
   d. Closing motor starts against position
   e. Total open/close operations
   f. Maximum recorded opening and closing torque values
   g. Event recorder logging operational conditions (valve, control, and actuator)

B. The data logger shall record relevant time and date information for stored data.

C. Data logger data shall be accessed via non-intrusive wireless communication and data displayed on the local LCD. Sufficient standard intrinsically safe tools shall be provided for downloading data logger and actuator configuration files from the actuators and subsequent uploading to a PC. The actuator manufacturer shall supply PC software to enable data logger files to be viewed and analyzed.

2.16 WIRING AND TERMINATION

A. Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end. The terminals shall be embedded in a terminal block of high tracking resistance compound.

B. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal and shall be provided with a minimum of 3 threaded cable entries with provision for an additional 5 extra conduit entries.

C. All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable. A durable terminal identification card showing a plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

1. Serial number
2. External voltage values
3. Wiring diagram number
4. Terminal layout

D. The code card shall be suitable for the CONTRACTOR to inscribe cable core identification alongside terminal numbers.

2.17 COMMISSIONING KIT

A. Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram, and cover seals to make good any site losses during commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set-up and adjustment during valve/actuator testing and site installation commissioning.

2.18 PERFORMANCE AND TEST CERTIFICATE

A. Each actuator must be performance tested and individual test certificates shall be supplied with additional cost to the OWNER. The test equipment should simulate a typical valve load, and the following parameters should be recorded:

1. Current at maximum torque setting
2. Torque at maximum torque setting
3. Flash test voltage
4. Actuator output speed or operating time

B. In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.

Table 40 92 57 – 1 Actuator Schedule						
Valve ID	**Location**	**Service**	**Valve Type**	**Max Pressure/Max Flowrate**	**Motor Type**	**Open/Close Speed (seconds)**
LC-0152-01	SIB #1 Meter Vault	Flow Control and Isolation	Segmented Ball Valve	35 psi/ 3,000 gpm	AC Modulating	120/120
LC-0153-01	SIB #2 Meter Vault	Flow Control and Isolation	Segmented Ball Valve	35 psi/ 2,500 gpm	AC Modulating	120/120

2.19 MANUFACTURER, OR APPROVED EQUAL:

A. Limitorque

B. AUMA Actuators SQ

C. Rotork IQTM

PART 3 EXECUTION

3.1 INSTALLATION

A. Electric motor valve actuators shall be installed in accordance with the manufacturer's written instructions. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways.

3.2 SERVICES OF MANUFACTURER

A. Field Adjustments: Field representatives of valves with electric motor actuators shall adjust actuator controls and limit switches in the field for the required function.

B. Inspection, Start-up, and Field Adjustment: The manufacturer shall furnish an authorized representative who shall visit the site and witness the following:

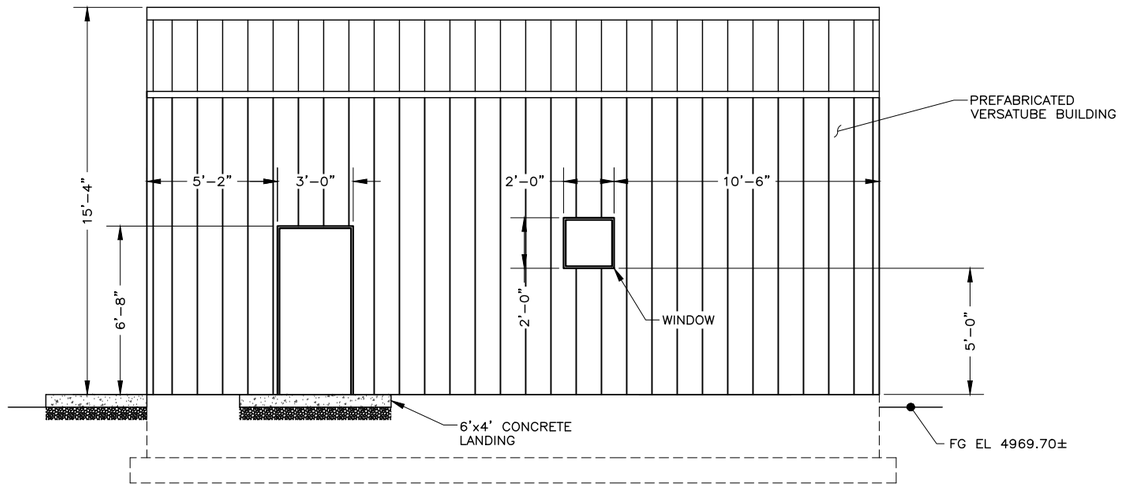
1. Installation of the equipment – not less than 2 hours
2. Inspection, checking, and adjusting the equipment – not less the 2 hours
3. Start-up and field testing for proper installation – not less than 2 hours

C. Instruction of OWNER's Personnel: The authorized representative shall visit the site for not less than 4 hours to instruct the OWNER's personnel in the operation and maintenance of the equipment including step by step troubleshooting procedures with necessary test equipment.

- END OF SECTION -

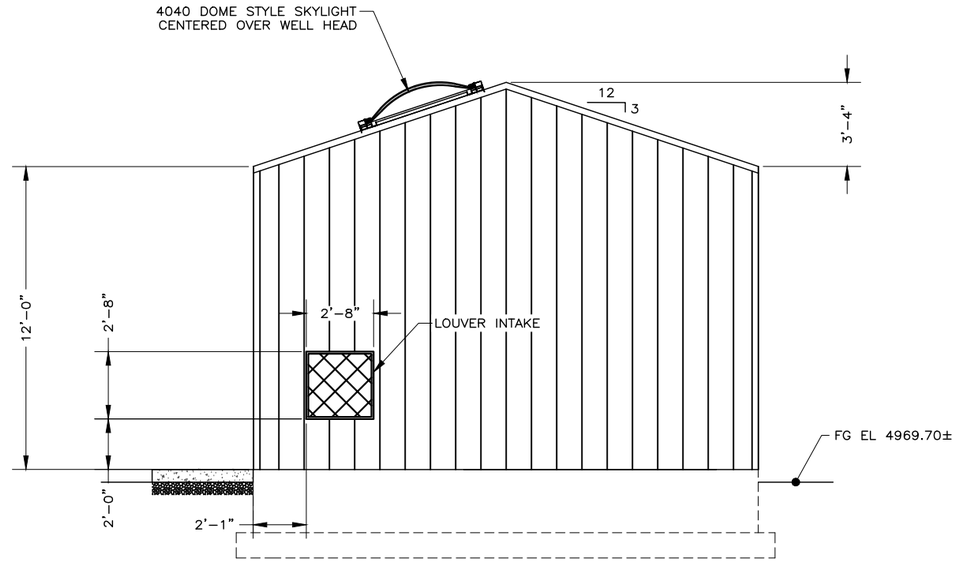
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APPENDIX
PREFABRICATED ASR WELL HOUSE



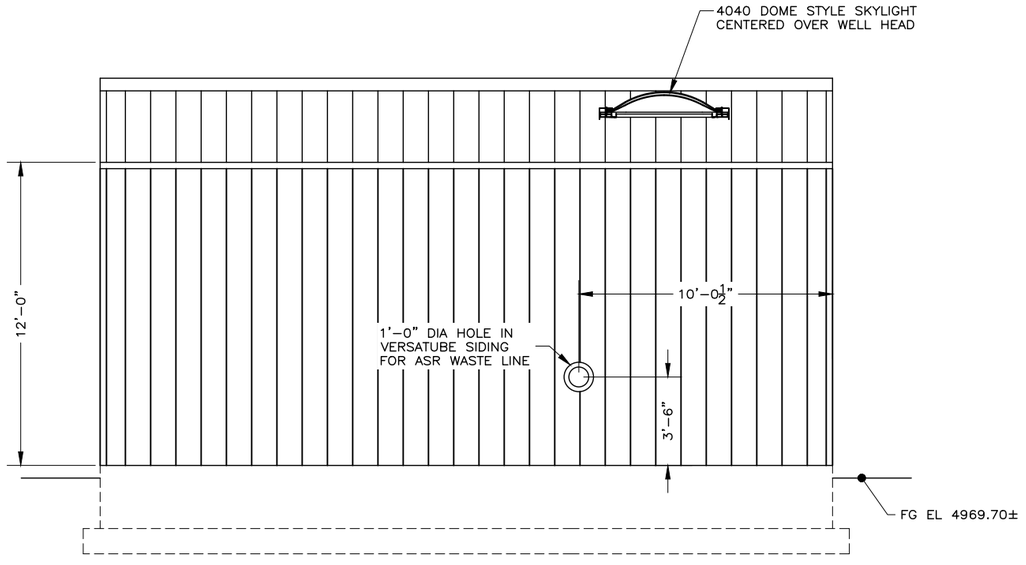
FRONT ELEVATION

0 3 6
SCALE IN FEET



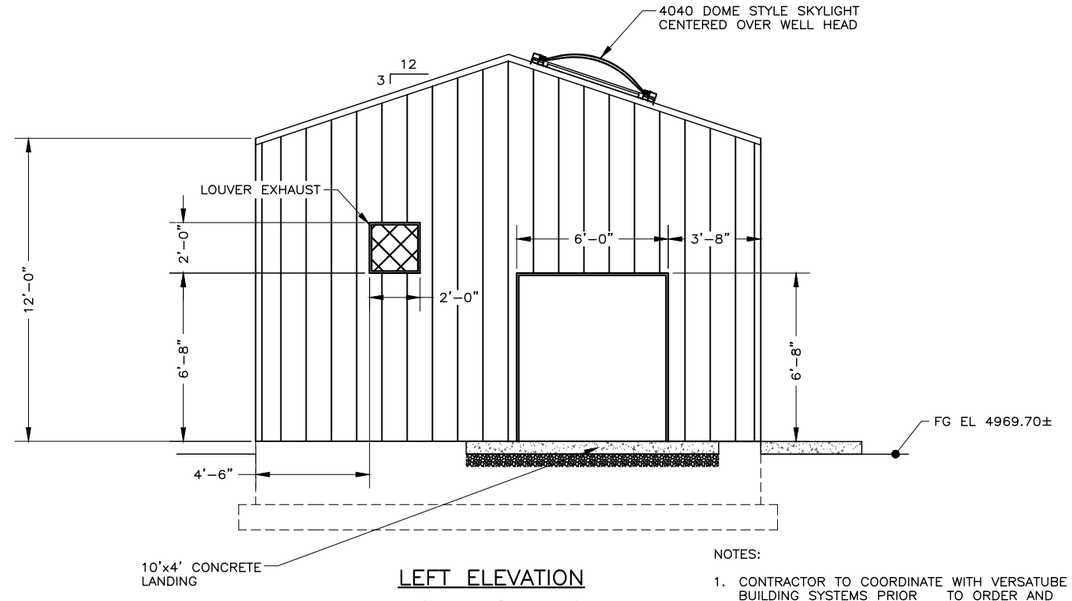
RIGHT ELEVATION

0 3 6
SCALE IN FEET



BACK ELEVATION

0 3 6
SCALE IN FEET



LEFT ELEVATION

0 3 6
SCALE IN FEET

NOTES:

1. CONTRACTOR TO COORDINATE WITH VERSATUBE BUILDING SYSTEMS PRIOR TO ORDER AND INSTALLATION OF PREFABRICATED ASR WELL HOUSE.

CONTACT INFORMATION
SHEENA WOODSON (PRODUCT SPECIALIST)
SWOODSON@VERSATUBE.COM
(902) 250-2155

FILE NAME:PROJECTS\262 - METROPOLITAN WATER DISTRICT\08.200 - PHASE 1 MAR\CAD\FIGURES\FIG. 1 - VERSATUBE WELL HOUSE.DWG
FILE DATE: 4.11.2023 09:57:02 (SWM)

HANSEN ALLEN & LUCE, Inc. ENGINEERS

PROJECT ENGINEER

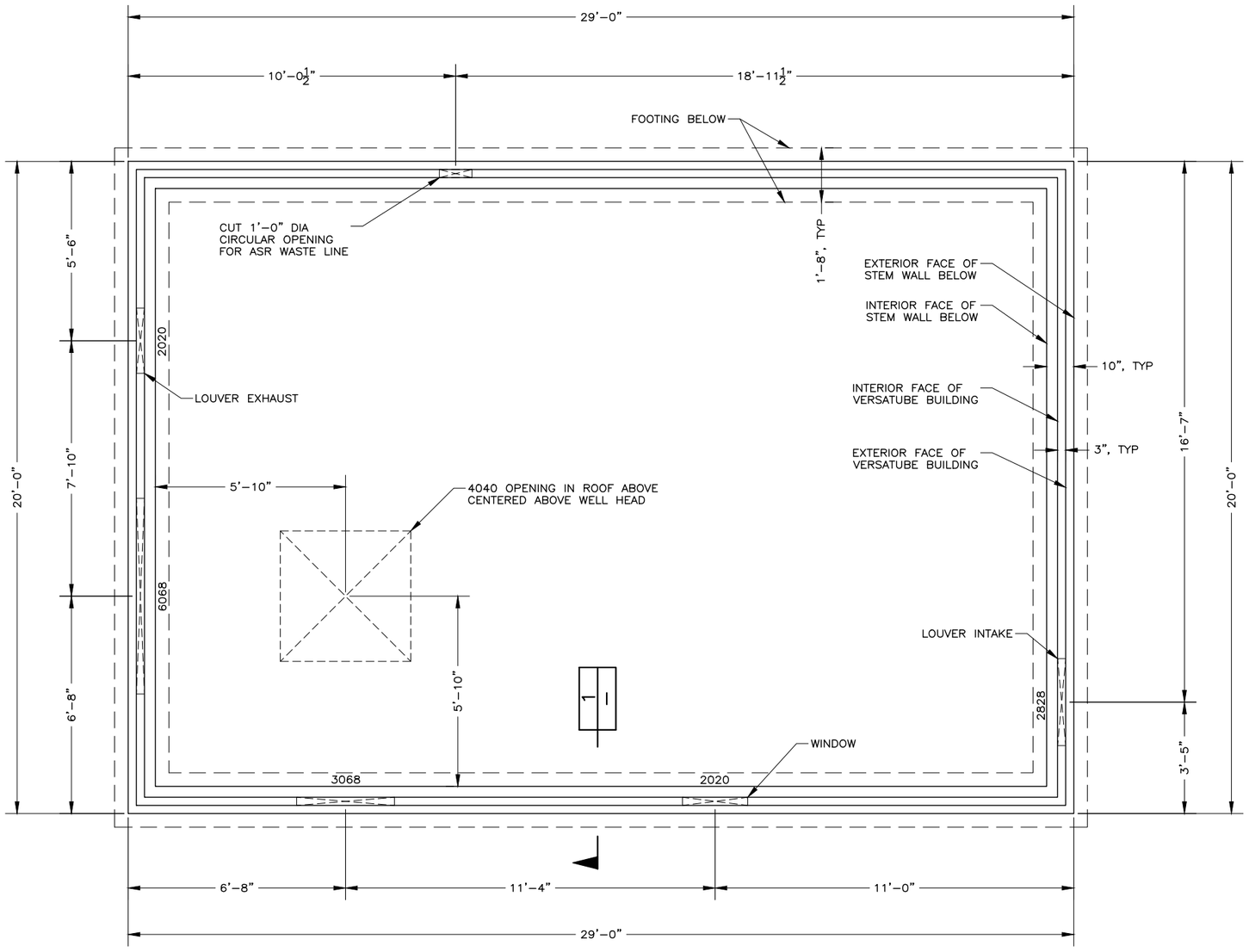
DESIGNED	SWM	3			
DRAFTED	SWM	2			
CHECKED	GST	1			
DATE	APRIL 2023	NO.	DATE	REVISIONS	BY APVD.

SCALE: AS SHOWN

METROPOLITAN WATER DISTRICT
OF SALT LAKE & SANDY
3430 EAST DANISH ROAD
COTTONWOOD HEIGHTS, UT 84093

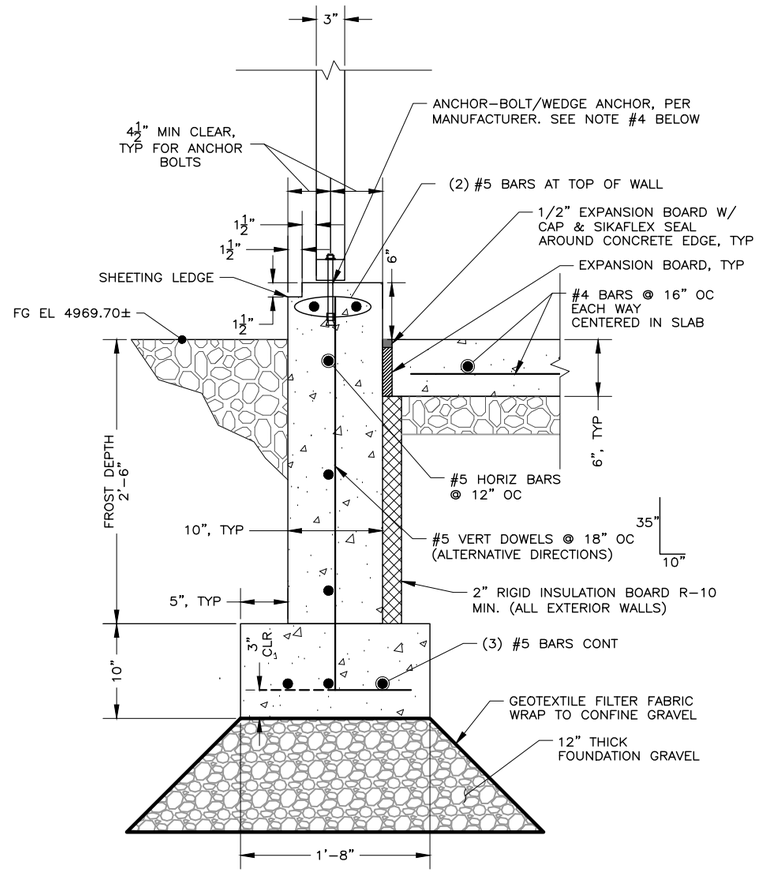
LC063 ASR PILOT TESTING – PHASE 1
PREFABRICATED ASR WELL HOUSE
BUILDING ELEVATIONS

SHEET: FIG 1
262.08.200



ASR WELL HOUSE FLOOR PLAN

0 2 4
SCALE IN FEET



TYPICAL SECTION 1

0 0.5 1
SCALE IN FEET

NOTES:

1. CONTRACTOR TO COORDINATE WITH VERSATUBE BUILDING SYSTEMS PRIOR TO ORDER AND INSTALLATION OF PREFABRICATED ASR WELL HOUSE.

   CONTACT INFORMATION
   SHEENA WOODSON (PRODUCT SPECIALIST)
   SWOODSON@VERSATUBE.COM
   (902) 250–2155

2. CONTRACTOR TO VERIFY FOOTING AND FOUNDATION DESIGN AND DIMENSIONS WITH BUILDING MANUFACTURER.

3. VERSATUBE BUILDING SHALL BE FULLY ENCLOSED WITH 3" FIBERGLASS INSULATION. COORDINATE EXTERIOR COLOR WITH OWNER.

4. ANCHOR BOLTS/WEDGE ANCHORS (SPECIFIED AND PROVIDED BY VERSATUBE) TO HAVE MINIMUM EDGE DISTANCE TO FACE OF FOUNDATION WALL OF 4–1/2" (VERIFY WITH VERSATUBE ENGINEERING). BOLTS TO EMBED INTO FOUNDATION WALL 4–1/2" (3–1/2" MIN.) AS REQUIRED BY BUILDING MANUFACTURER.

FILE NAME:PROJECTS\262 – METROPOLITAN WATER DISTRICT\08.200 – PHASE 1 MAR\CAD\FIGURES\FIG. 1 – VERSATUBE WELL HOUSE.DWG
FILE DATE: 4.11.2023 09:57:02 (SWM)

HANSEN ALLEN & LUCE, Inc. ENGINEERS

PROJECT ENGINEER

DESIGNED SWM
DRAFTED SWM
CHECKED GST
DATE APRIL 2023

NO.	DATE	REVISIONS	BY	APVD.
3				
2				
1				

SCALE: AS SHOWN

METROPOLITAN WATER DISTRICT
OF SALT LAKE & SANDY
3430 EAST DANISH ROAD
COTTONWOOD HEIGHTS, UT 84093

LC063 ASR PILOT TESTING – PHASE 1
PREFABRICATED ASR WELL HOUSE
FLOOR PLAN

SHEET
FIG 2
262.08.200