CONTRACT DOCUMENTS

FOR THE CONSTRUCTION OF

SERWTP DISINFECTANT CONCENTRATION-TIME IMPROVEMENTS PROJECT

VOLUME 1 OF 3
SPECIFICATIONS

DISTRICT PROJECT NO. 4393

JORDAN VALLEY WATER
CONSERVANCY DISTRICT

For Information Regarding this Project Contact:
Josh Curtis, P.E.
154 East 14075 South
Draper, Utah 84020
(801) 495-2224

BOWEN COLLINS & ASSOCIATES

October 2026

CONTRACT DOCUMENTS FOR

SERWTP Disinfectant Concentration-Time Improvements

JVWCD PROJECT #: 4393

October 6, 2026

OWNER

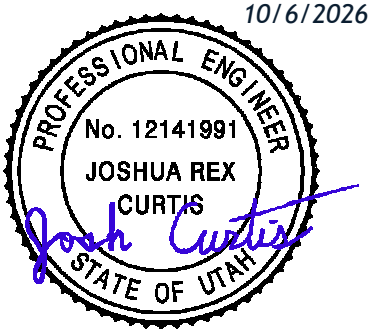
Jordan Valley Water Conservancy District
8215 South 1300 West
West Jordan, Utah 84088
801-565-4300

ENGINEER

Bowen, Collins and Associates
154 East 14075 South
Draper, Utah 84020

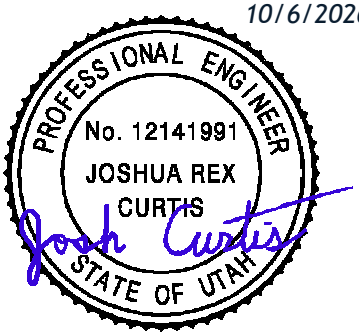
SEAL SHEET

10/6/2026



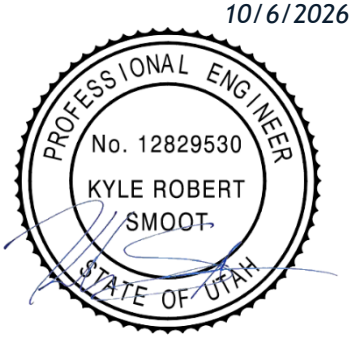
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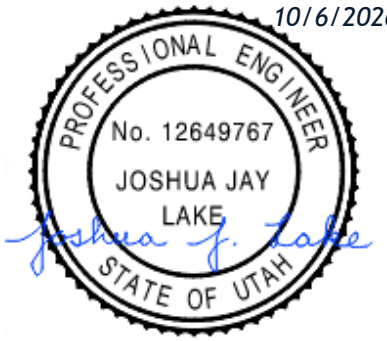
[MECHANICAL]

10/6/2026



[STRUCTURAL]

10/6/2026



[ELECTRICAL/INSTR. AND CONTROLS]

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NOTICE INVITING BIDS

PROJECT NAME: Southeast Regional Water Treatment Plant (SERWTP) Disinfection Concentration-Time Improvements

DESCRIPTION OF WORK: The work shall all occur at or near an existing treatment plant. Work includes:

- Installing membrane baffle curtains inside an existing 1-MG and 3-MG reservoirs.
- Installing new 33” piping to separate the reservoir inlet and outlet piping.
- Installing new washdown systems in both reservoirs.
- Interior reservoir modifications such as coating, repairs, and a new SST ladder.
- Rehabilitating a vault with new valves, electronic actuators, access, piping, sample pumps, and water quality instrumentation.
- New check valve and water meter in an existing meter vault.

SITE OF WORK: The Southeast Regional Water Treatment Plant, 11574 South Wyndcastle Drive, Sandy Utah.

OBTAINING CONTRACT DOCUMENTS: All Contract Documents may be obtained by electronic download from the District’s Website www.jvwcd.gov beginning on October 7, 2026.

PRE-BID SITE VISIT: A non-mandatory pre-bid site visit will be held at the site of the work on October 14, 2026, at 2:00 pm.

PREQUALIFIED CONTRACTORS: The owner authorized use of a prequalification procedure to determine and select General Contractors eligible to bid and construct this project. Based on the prequalification submittals received by JVWCD, only the following General Contractors are prequalified to submit a bid for the construction of this project:

FX Construction	**Gerber Construction**
ProBuild Construction	**Ralph L. Wadswoth Construction**

RECEIPT OF BIDS: Sealed bids will be received at the office of the Jordan Valley Water Conservancy District, Owner of the Work, located at 8215 South 1300 West, West Jordan, Utah 84088, until 2:30 pm, on October 27, 2026, for construction of SERWTP Disinfection Concentration-Time Improvements Project Electronic bids may also be submitted in adobe .pdf format to ellisad@jvwcd.gov. JVWCD requests that electronic bids be submitted 15 minutes prior to the bid opening deadline.

NOTICE INVITING BIDS

AWARD OF CONTRACT: An Award of Contract, if it were awarded, will be made within 60 calendar days of the opening of bids.

NOTICE TO PROCEED: A Notice to Proceed, if it were issued, will be made within 60 calendar days of the Notice of Award.

COMPLETION OF WORK: All work shall be completed within 480 calendar days from the date of the Notice to Proceed.

DISTRICT WEB SITE AND PLANHOLDERS LIST
Prospective bidders must register at the District's web site (www.jvwcd.gov) under "Engineering Projects". Prospective bidders are required to check the District's web site for any addenda prior to submitting a responsive bid. The District's web site will be used to publish updated information relative to the project, including a planholders list.

BID SECURITY: Each bid shall be accompanied by a certified or cashier's check, money order or bid bond in the amount of five percent of the total bid price payable to the Jordan Valley Water Conservancy District as a guarantee that the bidder, if its bid is accepted, will promptly execute the contract, provide evidence of worker's compensation insurance, and furnish a satisfactory faithful performance bond in the amount of 100 percent of the total bid price and a payment bond in the amount of 100 percent of the total bid price.

ADDRESS AND MARKING OF BID: The envelope enclosing the bid shall be sealed and addressed to the Jordan Valley Water Conservancy District and delivered or mailed to 8215 South 1300 West, West Jordan, Utah 84088. The envelope shall be plainly marked in the upper left-hand corner with the name and address of the bidder and shall bear the words "Bid for," followed by the title of the Contract Documents for the work and the date and hour of opening of bids. The certified or cashier's check, money order, or bidder's bond shall be enclosed in the same envelope with the bid.

PROJECT ADMINISTRATION: All questions relative to this project prior to the opening of bids shall be directed to the Engineer for the project. It shall be understood, however, that no interpretations of the specifications will be made by telephone, nor will any "or equal" products be considered for approval prior to award of contract.

Engineer
Bowen, Collins, and Associates
Project Manager: Josh Curtis, P.E.
154 East 14075 South
Draper, Utah 84020
Telephone: (801) 495-2224
Email: jcurtis@bowencollins.com

NOTICE INVITING BIDS

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.

Owner
Jordan Valley Water Conservancy District
Project Manager: Conor Tyson, P.E.
8215 South 1300 West
West Jordan, Utah 84088
Telephone: (801) 565-4300
Email: conort@jvwcd.gov

JORDAN VALLEY WATER CONSERVANCY DISTRICT

INSTRUCTIONS TO BIDDERS

FORM OF BID: The bid shall be made on the bidding schedule(s) bound herein. The bid shall be enclosed in a sealed envelope bearing the name of the bidder and name of the project. In the event there is more than one bidding schedule, the bidder may bid on any individual schedule or on any combination of schedules.

BID APPURTANCES: Bidders must provide bid appurtenances including Information required of bidder and experience reference projects. Bids not including the required information may be deemed non-responsive.

DELIVERY OF BID: The bid shall be delivered by the time and to the place stipulated in the Notice Inviting Bids. Alternately electronic bids will be accepted in adobe acrobat (.pdf) format. Electronic bids must be sent to ellisad@jvwcd.gov. It is the bidder's sole responsibility to see that the respective bid is received in proper time.

WITHDRAWAL OF BIDS: Bids shall be unconditionally accepted without alteration or correction, excepting that bidder may by means of written request, signed by the bidder or his properly authorized representative withdraw his bid. Such written request must be delivered to the place stipulated in the Notice Inviting Bids for receipt of bids prior to the scheduled closing time for receipt of bids.

OPENING OF BIDS: The bids will be publicly opened and read at the time and place stipulated in the Notice Inviting Bids.

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. Oral, telegraphic, or telephonic bids or modifications will not be considered.

DISCREPANCIES IN BIDS: In the event there is more than one bid item in a bidding 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 bidding 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 Contractor shall be bound by said Correction. In the event there is more than one bid item in a bidding 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 Contractor shall be bound by said correction.

INSTRUCTIONS TO BIDDERS

BID SECURITY: Each bid shall be accompanied by a certified or cashier's check or approved bid bond in the amount stated in the Notice Inviting Bids. Said check or bond shall be made payable to the Owner and shall be given as a guarantee that the bidder, if awarded the work, will enter into a contract within 10 calendar days after receipt of the contract 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 Notice Inviting Bids. In case the apparent low bidder refuses or fails to enter into such contract or fails to provide the required insurance and insurance certificates, the check or bid bond, as the case may be, shall be forfeited to the Owner. If the bidder elects to furnish a bid bond as his bid guarantee, he shall use the bid bond bound herein, or one conforming substantially to it in form.

BIDDER'S EXAMINATION OF CONTRACT DOCUMENTS AND SITE

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

1. Examine Contract Documents thoroughly.

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

3. Consider federal, state and local laws and regulations that may affect cost, progress, and performance of furnishing of the work.

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

5. Notify the Engineer of all conflicts, errors, or discrepancies in the Contract Documents.

Reference is made to the Supplemental General Conditions for identification of:

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

2. 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 by the Engineer in the preparation of the Contract Documents. Copies of such reports and drawings are available for inspection at the office of the Owner.

INSTRUCTIONS TO BIDDERS

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 to the Owner and the Engineer by the owners of such underground facilities or others, and the Owner does not assume any responsibility for the accuracy or completeness thereof including any damages whatsoever that may be incurred by the Bidder or the Contractor through his reliance thereon unless it is expressly provided otherwise in the Supplemental General Conditions and/or the Technical Specifications.

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 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 and Contract Documents.

The Owner assumes no responsibility for any understanding or representations made by any of its officers or agents during or prior to the execution of this Contract, for information contained in any reports, subsurface studies, or other information which may be made available for the Contractor's information and which are not included as Contract Documents, for any understanding or representations by the Owner or by others which are not expressly stated in the Contract Documents which liability is not expressly assumed by the Owner or its representatives or Engineer in the Contract Documents. Such information shall be deemed to be for the information of the Contractor and the Contractor 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 there from by the Contractor.

The lands upon which the work is to be performed, right-of-ways and easements for access thereto together with other lands designated for use by the Contractor 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 Contractor. 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.

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 means, methods, techniques, sequences, or procedures of construction as may be indicated in or required by the Contract Documents; and that such means, methods, 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

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 amount of the Contract.

The Bidders nor the ultimate Contractor on the Project shall at any 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.

INSTRUCTIONS TO BIDDERS

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," bound herein. No bid for the work will be accepted from a contractor who does not hold an active Contractor's license in good standing applicable to the type of work bid upon at the time of opening bids.

After an award of the contract no substitution of the Project Manager or 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 GUARANTEE: Within 10 calendar days after award of the contract, the Owner will return the bid guarantees accompanying such of the bids as are not considered in making the award. All other bid guarantees will be held until a Notice to Proceed has been issued and accepted. They will then be returned to the respective bidders whose bids they accompany.

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 different 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 bidding schedule. In the event the entire work is contained in more than one bidding schedule, the Owner may award schedules individually or in combination. In the case of two bidding schedules which are alternate to each other, only one of such alternate schedules will be awarded.

INSTRUCTIONS TO BIDDERS

EXECUTION OF CONTRACT: The Bidder to whom the award is made shall secure all insurance and shall furnish all certificates and bonds required by the specifications within ten calendar days after receipt of the Notice of Award from the Owner. The Bidder to whom the award is made shall execute a written contract with the Owner on the form of agreement provided within ten calendar days after receipt of the Agreement from the Owner. Failure or refusal to enter into a contract 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 forfeiture of the bid guarantee. If the successful bidder refuses or fails to execute the contract, the Owner may award the contract to the second lowest responsible bidder, or reject all bids and re-advertise the project for rebidding. If the second lowest responsible bidder refuses or fails to execute the contract, 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 contract, each such bidder's guarantees shall be likewise forfeited to the Owner.

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, Purchase Order Assignment(s), (if applicable), bonds and insurance certificates from the successful bidder. If the Contract Time is expressed as a specific completion date in the Notice Inviting Bids and paragraph 3.1 of the Agreement rather than a specific number of successive days following the start date identified in the Notice to Proceed, 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.

LICENSES: Contractor must be licensed as a business qualified to do business within the state of Utah prior to issuance of a Notice of Award. Contractor must hold a current contractor’s license with classifications appropriate to the work being contracted.

BID

BID TO: JORDAN VALLEY WATER CONSERVANCY DISTRICT

The undersigned Bidder hereby proposes to furnish all plant machinery, labor, services, materials, equipment, tools, supplies, transportation, utilities, and all other items and facilities necessary to perform all work required under the Bidding Schedule of the Owner's Contract Documents entitled "SERWTP Disinfectant Concentration-Time Improvements" drawings and all addenda issued by said Owner prior to opening of the bids.

Addenda are only delivered by e-mail and through the internet.

The undersigned bidder acknowledges receipt of the following addenda:

No.	Date Received	No.	Date Received

Bidder agrees that, within 10 calendar days after receipt of Notice of Award from Owner, he will execute the Agreement in the required form, of which the Notice Inviting Bids, Instructions to Bidders, Bid, Information Required of Bidder, Technical Specifications, Drawings, and all addenda issued by Owner prior to the opening of bids, are a part, and will secure the required insurance and bonds and furnish the required insurance certificates; and that upon failure to do so within said time, then the bid guarantee furnished by Bidder shall be forfeited to Owner as liquidated damages for such failure; provided, that if Bidder shall execute the Agreement, secure the required insurance and bonds, and furnish the required insurance certificates within said time, his check, if furnished, shall be returned to him within five days thereafter, and the bid bond, if furnished, shall become void. It is further understood that this bid may not be withdrawn for a period of 45 days after the date set for the opening thereof, unless otherwise required by law.

Dated: _____ Bidder: _____

By: _____
(Signature)

Title: _____

Bidder further agrees to complete all work required within the time stipulated in the Contract Documents, and to accept in full payment therefore the price(s) named in the above-mentioned Bidding Schedule(s).

BID

BID SCHEDULE

PART 1 – GENERAL

1.01 CONSTRUCTION CONTRACT

A. Name of Project: SERWTP Disinfection Concentration-Time Improvements

B. Owner's Project Number: 4393

1.02 SCHEDULES TO BE ADDED TO THE AGREEMENT

A. Bid Schedule contains the schedules of prices which will be incorporated into the Agreement (Document 00500) by reference.

1.03 SCHEDULES OF PRICES

A. The Contract will be bid in a single Bid Schedule. The Owner intends to award a single contract for construction of the Project.

Base Bid: Generally includes all Work associated with construction of baffle curtains, piping, and vault modifications as indicated on the Contract Documents. The Work associated with the Base Bid includes reservoir repairs, vault modifications, yard piping, new valves, site work and miscellaneous piping and facilities associated with the project.

C. The Contract, if awarded, will be on the basis of materials and equipment specified or described in the bidding documents without consideration of possible substitution of "or equal" items.

D. Identify Steel Pipe and Coating Supplier:

1. _____ (Name Supplier)

BID

Bid Schedule – Lump Sum

E. **BASE BID – SERWTP DISINFECTANT CONCENTRATION-TIME IMPROVEMENTS PROJECT:**

Item No.	Description	QNT Unit	Unit Price	Amount
1.	Mobilization, Demobilization, Temporary Facilities, and Administrative Items.	1 Lump Sum	$	$
2.	Construction of Improvements inside 1-MG Reservoir: Tension Fabric Baffle Curtains, New Washdown System, New SST Ladder, Existing Pipe Recoating, and Anodes.	1 Lump Sum	$	$
3.	Construction of Improvements inside 3-MG Reservoir: Tension Fabric Baffle Curtains, New Washdown System, 33” Steel Inlet Pipe Extension and Supports, Existing Pipe Recoating, and Anodes.	1 Lump Sum	$	$
4.	Replace Joint Sealant in 3-MG Reservoir Floor	580 LF	$	$
5.	Construction of Improvements to 3-MG Reservoir Valve Vault: New Piping, Butterfly Valves, Sample Pumps and Water Quality Instrumentation, Demo Existing Stairs and Install New Landing, Railings, and Ladders.	1 Lump Sum	$	$
6	Construction of New Meter and Check Valve in WaterPro Meter Vault.	1 Lump Sum	$	$
7.	Construction of Yard Piping and other Site Work: Buried 33” Outlet Pipe, Buried 4” Washdown Piping, Air Valve Manholes, Buried Gate Valves, Concrete Sidewalk, New Gate in Existing Fence, and Landscape Restoration.	1 Lump Sum	$	$
8.	Construction of Electrical Work and Instrumentation, complete.	1 Lump Sum	$	$

BID

Item No.	Description	QNT Unit	Unit Price	Amount
9.	Additional Work, not included in Bid items 1 through 9 above.	1 Lump Sum	$	$
10.	Add or Deduct (indicate which)	1 Lump Sum	$	$
	Total Bid Price (Sum of Items 1 through 10) $ _____			
	_____ (Price in Words)			

Bid Adjustment (Item 10 Lump Sum Add or Deduct)

The bid adjustment allows the Bidder to adjust their base bid just prior to bid opening without the need to adjust individual bid item amounts. The sum of the extended total shall be increased or (decreased) by this Bid Adjustment amount. Indicate decrease in parenthesis (_____). For payment purposes, this correction amount will be applied to Bid Items No. 1 through 10 proportionally to the amount bid for those items.

BASE BID SCHEDULE A –Total of Items 1 through 10 Including Bid Adjustment

1. Bidder agrees to accept as full payment for Work proposed with the Bidding Documents, based upon the undersigned's own estimate of quantities and costs and including sales, consumer, use, other taxes, and overhead and profit.

2. Based upon Bidder's own estimate of quantities and costs, the Bidder, if awarded the contract, shall provide costs for the items as outlined in Section 10 20 00 – MEASUREMENT AND PAYMENT.

2. Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all unit

price Bid items will be based on actual quantities, determined as provided in the Contract Documents.

Bidder (Company name): _____

By: _____ Dated: _____
(Signature)

Name: _____ Title: _____

BID BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____
as Principal, and _____
as Surety, are held and firmly bound unto the Jordan Valley Water Conservancy District (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 bidding Schedule of the Owner's Contract Documents entitled “SERWTP Disinfectant Concentration-Time Improvements”, (hereafter called the “Project Title”).

NOW THEREFORE, if Principal is awarded 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 judgment 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___.

_____ _____

By: _____ By: _____

Its: _____ Its: _____

(SEAL) (SEAL)

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 shall be attached as required.

1. Contractor firm information:

Contractor's name: _____

Contractor's address: _____

_____

_____

Contractor's Primary Contact: _____

Email address of Contractor's primary contact: _____

Contractor's telephone number: _____

2. Any Changes from prequalification submittals:

(Current president, license number or expirations, insurance company etc.)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____, as Contractor, and _____ as Surety, are held firmly bound unto the Jordan Valley Water Conservancy District 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 Bidding Schedule(s) of the Owner's Contract Documents entitled “SERWTP Disinfectant Concentration-Time Improvements”

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, Utah Code Ann., as amended, and 63-56-38 Utah Code Ann., as amended.

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

_____ _____

By: _____ By: _____

Its: _____ Its: _____

(SEAL) (SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGMENT OF SURETY)

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____ as Contractor, and _____ as Surety, are held firmly bound unto the Jordan Valley Water Conservancy District 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 Bidding Schedule(s) of the Owner's Contract Documents entitled, “SERWTP Disinfectant Concentration-Time Improvements”

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 and 19 Utah Code Ann., as amended, and 63-56-38 Utah Code Ann., as amended.

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

_____ _____

By: _____ By: _____

Its: _____ Its: _____

(SEAL) (SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGMENT OF SURETY)

NOTICE OF AWARD

To: Contractor's Name and Address

Re: "SERWTP Disinfectant Concentration-Time Improvements"

You are hereby notified that the OWNER has accepted your bid for the above referenced project in the amount of $_____.

Furnish the required Contractor's 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, together with all future correspondence regarding this project, shall be sent to the District's Project Manager: Conor Tyson, PE.

When the Agreement is provided, sign and return it within ten calendar days from receipt of the agreement.

Dated this ____ day of _____, 20___.

_____
Shane K Swensen, PE
Chief Engineer

ACCEPTANCE OF NOTICE

Receipt of the above Notice of Award is hereby acknowledged by:

____(Contractor's Name goes here - underlined)_____

This _____ day of _____, 20___.

Signature:_____

Printed Name:_____

Title: _____

NOTICE TO PROCEED

To:

Re: "SERWTP Disinfectant Concentration-Time Improvements"

You are hereby notified to commence work in accordance with the Agreement dated _____, on (or before/after) _____, and you are to complete the work by, _____.

An acknowledged copy of this Notice to Proceed should be returned to the Owner, attention:_____.

Dated this _____ day of _____.

_____
Shane K Swensen, P.E.
Chief Engineer

ACCEPTANCE OF NOTICE

Receipt of the above Notice to Proceed is hereby acknowledged by:

____(Contractor's Name goes here - underlined)_____

This _____ day of _____, 20___.

Signature:_____

Printed Name:_____

Title: _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

PAYMENT APPLICATION AND CERTIFICATE No. ___ DATE: _____

SHEET _____ OF _____

PERIOD FROM _____ TO _____, 20___

PROJECT: "SERWTP Disinfectant Concentration-Time Improvements"

JVWCD PROJECT NO.: _____

CONTRACTOR: _____

ADDRESS: _____

ENGINEER: _____

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. LESS AMOUNT RETAINED (5%) ..... $_____

7. MATERIALS ON HAND..... $_____
(95% of Value, Listing Attached)

8. SUBTOTAL (Sum of Lines 4, Line 6 and Line 7)..... $_____

9. LESS PREVIOUS PAYMENTS ..... $_____

10. CURRENT PAYMENT DUE: ..... $_____
(Line 8 & 9)

JORDAN VALLEY WATER CONSERVANCY DISTRICT

Payment Application and Certificate No _____

SHEET _____ OF _____

CONTRACTOR'S Certification:

The undersigned CONTRACTOR certifies that: (1) all previous progress payments received from OWNER on account of 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 1 through _____ 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 amount due this application is recommended.

ENGINEER

Dated _____ _____

Project Representative

Dated _____ _____

Project Manager

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CHANGE ORDER

Change Order No. _____

Date: _____

Page ___ of ___

NAME OF PROJECT: "SERWTP Disinfectant Concentration-Time Improvements"

PROJECT NUMBER: _____

CONTRACTOR: _____

CONTRACT DATE: _____

The following changes are hereby made to the CONTRACT DOCUMENTS:

1)

2)

3)

Total Change to CONTRACT PRICE: ..... $

Original CONTRACT PRICE: ..... $

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

The new CONTRACT PRICE including this CHANGE ORDER will be ..... $

The CONTRACT TIME will be increased by _____ calendar days.

The date for Substantial Completion will be _____, 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 will become a supplement to the Contract, and all provisions will apply hereto, upon approval by the Owner.

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CHANGE ORDER
(CONTINUED)

Change Order No. _____

Date: _____

Page ___ of ___

Recommended:

Engineer – Bowen, Collins, and Associates	Date

Accepted:

Contractor -	Date

Approved:

Owner - Jordan Valley Water Conservancy District	Date

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CONTRACTOR'S CERTIFICATE
OF
SUBSTANTIAL COMPLETION

OWNER:	ENGINEER:
Jordan Valley Water Con. District 8215 South 1300 West West Jordan, Utah 84088 801-565-4300	Bowen, Collins, and Associates 154 East 14075 South Draper, Utah 84020 (801) 495-2224

PROJECT: _____

ATTENTION: _____

FROM: _____
Firm or Corporation

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 substantially performed and all materials used and installed to date are in accordance with, and in conformity to, the contract drawings and specifications. A list of all incomplete work is attached.

The Contractor hereby releases the Owner and its agents from all claims of and liability to the Contractor for anything done or furnished for or relating to the work, as further provided in Article 14.08B of the General Conditions, except demands against the Owner for the remainder of progress payments retained to date, and unresolved written claims prior to this date.

The contract work is now substantially complete, ready for its intended use, and ready for your inspection. You are requested to issue a Certificate of Substantial Completion.

SIGNATURE: _____

DATE: _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CONTRACTOR'S CERTIFICATE
OF
FINAL COMPLETION

OWNER:	ENGINEER:
Jordan Valley Water Con. District 8215 South 1300 West West Jordan, Utah 84088 801-565-4300	Bowen, Collins, and Associates 154 East 14075 South Draper, Utah 84020 (801) 495-2224

PROJECT: "SERWTP Disinfectant Concentration-Time Improvements"

ATTENTION: Project Representative: _____

FROM: _____
Firm or Corporation

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 drawings and specifications.

The Contract 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 of our Contract (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, etc.) are submitted herewith, if any:

_____

_____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

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 or claim against the Contractor under the terms of the guarantee provisions of the Contract Documents.

SIGNATURE: _____

DATE: _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

CONSENT OF SURETY FOR FINAL PAYMENT

PROJECT NAME: "SERWTP Disinfectant Concentration-Time Improvements"

LOCATION: _____

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 Company named herein of any of its obligations to the following named Owner (as set forth in said Surety company's bond):

_____

_____

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

_____
(Name of Surety Company)

_____
(Signature of Authorized Representative)

_____
(Name of Authorized Representatives)

_____
(Title)

JORDAN VALLEY WATER CONSERVANCY DISTRICT

AFFIDAVIT OF PAYMENT

To All Whom It May Concern:

WHEREAS, the undersigned has been employed by the Jordan Valley Water Conservancy District to furnish labor and materials under a contract dated _____for the project entitled "SERWTP Disinfectant Concentration-Time Improvements", in the County of Salt Lake, State of Utah, of which Jordan Valley Water Conservancy District 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 (Name of sole ownership, corporation or partnership)

(affix corporate seal here)

_____

(Signature of Authorized Representative)

Title: _____

GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents 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.

Bonds - Performance, and Payment Bonds and other instruments which protect 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 - Information and Instructions, forms (including the Schedule of Prices and all required certificates and affidavits), Agreement, Performance Bond, Payment Bond, General Conditions, Supplemental General Conditions, Technical Specifications, Drawings and all Addenda and Change Orders executed pursuant to the provisions of the Contract Documents.

Contract Price - The total monies payable by the OWNER to the CONTRACTOR under the terms and conditions of the Contract Documents.

Contract Time - The number of successive Days stated in the Contract Documents for the 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.

Cost Proposal - The offer or proposal of the pipeline installation subcontractor to the CONTRACTOR to provide the work required under these Contract Documents.

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 ENGINEERS'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, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

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

Field Order - A written order issued by the ENGINEER which may or may not involve a change in the WORK.

Laws and Regulations; Laws or Regulations - Laws, rules, regulations, ordinances, codes, and/or orders promulgated by a lawfully constituted body authorized to issue such Laws and Regulations.

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 Jordan Valley Water Conservancy District.

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.

Proposer - Any person, firm or corporation submitting a proposal for the work.

Schedule of Prices - The offer or proposal of the CONTRACTOR setting forth the price or prices for the work to be performed.

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 at the site.

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 Certificate 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 make 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 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 furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

GENERAL CONDITIONS

ARTICLE 2 - PRELIMINARY MATTERS

2.01 DELIVERY OF BONDS/INSURANCE CERTIFICATES

A. The CONTRACTOR shall deliver to the OWNER the Agreement, Bonds, Insurance Policies and Certificates required by the Contract Documents within ten (10) days after receiving the Notice of Award from the OWNER.

2.02 COPIES OF DOCUMENTS

A. The OWNER shall furnish the CONTRACTOR 5 copies of the Contract Documents, together with 5 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 in each section of the Technical Specifications.

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 Technical Specifications.

GENERAL CONDITIONS

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. Contractor's Bid (Bid Form)
5. Supplemental General Conditions
6. Notice Inviting Bids
7. Instructions to Bidders
8. General Conditions
9. Technical Specifications
10. Referenced Standard Specifications
11. Drawings

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 any of them on the extensions of the Project or any other project without written consent.

GENERAL CONDITIONS

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 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 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 paragraph entitled "Physical Conditions" of the Supplementary General Conditions identifies 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 paragraph entitled "Physical Conditions" of the Supplementary General Conditions identifies 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.

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 differing 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 differing 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 and/or the Section entitled "Protection and Restoration of Existing Facilities" of the Technical Specifications, 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, the safeguard and protect the of 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 Contact 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 give written notice to the OWNER of that utility and the ENGINEER, specifying the location of the utility in question.

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 ENGINEER for alignment control. Unless otherwise specified in the Technical Specifications, 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.

GENERAL CONDITIONS

ARTICLE 5 - BONDS AND INSURANCE

5.01 PERFORMANCE AND OTHER BONDS

A. The CONTRACTOR shall furnish Performance and Payment Bonds, each in the amount set forth in the Supplementary General Conditions as security for the faithful performance and payment of all the CONTRACTOR's obligations under the Contract Documents. All insurance companies, sureties, and bond companies shall have an AM Best rating of A- or better, with a Financial Size Category of XII or better. Sureties shall also be listed on the Department of the Treasury's Circular 570, with an acceptable underwriting limitation limit. 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. All insurance companies, sureties, and bond companies shall have an AM Best rating of A- or better, with a Financial Size Category of XII or better. Sureties shall also be listed on the Department of the Treasury's Circular 570, with an acceptable underwriting limitation limit. 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 and ENGINEER with certificates indicating the type, amount, class of operations covered, effective dates and expiration dates of all policies. All insurance policies purchased and maintained (or the certificates or other evidence thereof) shall contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 30 days' prior written

notice has been given to the OWNER by certified mail. All insurance shall remain in effect until the ENGINEER issues the Notice of Completion and at all times thereafter when the CONTRACTOR may be correcting, removing, or replacing defective work in accordance with Paragraph 13.06 or completing punch list items required by the Notice of 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.

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; and (c) uninsured 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, and 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.

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 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. When required in writing by the OWNER or ENGINEER, the CONTRACTOR or any subcontractor shall discharge any person who is, in the opinion of the OWNER or ENGINEER, incompetent, disorderly, or otherwise unsatisfactory and shall not again employ the discharged person on the WORK without the consent of the OWNER or ENGINEER. 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 the WORK, or property at the site or adjacent thereto, all work at the site shall be performed during regular working hours, and the CONTRACTOR will not permit overtime work or the performance of work on Saturday, Sunday or any legal holiday 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 by 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 Technical Specifications.

6.04 SUBSTITUTES OR "OR-EQUAL" ITEMS

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 a 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 Document.

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 Technical Specifications 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 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 substitute item 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 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 evaluation each such proposed substitute.

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

6.05 CONCERNING 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 federal, state, and local laws, ordinances, codes, orders, 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 law, ordinance, code, order, or regulations, the CONTRACTOR shall report the same in writing to the ENGINEER. The CONTRACTOR shall indemnify, defend and hold harmless the OWNER, the ENGINEER and their officers, agents, and employees against all claims and from violation of any law, ordinance, code, order, or regulation, whether by CONTRACTOR or by its employees or subcontractors. 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. Where an individual State act on occupational safety and health standards has been approved by Federal authority, then the provision of said State act shall control.

6.08 EQUAL OPPORTUNITY

A. The Contractor agrees to abide by: the provisions of Title VII of the Civil Rights Act of 1964 (42USC § § 2000e et seq.), which prohibits discrimination against any employee or applicant for employment on the basis of race, religion, color, or national origin; Executive Order No. 11246, as amended, which prohibits discrimination on the basis of sex; 45 CFR 90, which prohibits discrimination on the basis of age; Section 504 of the Rehabilitation Act of 1973, (42 USC § 794), which prohibits discrimination on the basis of handicap; Utah Executive Order dated June 30, 1989, which prohibits sexual harassment in the workplace; and the Americans with Disabilities Act (42 USC § § 12111 et seq.), which prohibits discrimination against qualified employees and applicants with a disability.

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 employees on the WORK and other persons and organizations who may be affected thereby.

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 duty shall be 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 Technical Specifications, 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 Technical Specifications.

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 Technical Specifications.

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.

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 fullest extent permitted by Laws and Regulations, the CONTRACTOR shall indemnify, defend, and hold harmless the OWNER, the ENGINEER, and their officers, agents, and employees, against and from all claims and liability arising under or by reason of the Agreement or any performance of the WORK, but not from the sole negligence or willful misconduct of the OWNER and/or the ENGINEER. Such indemnification by the CONTRACTOR shall include but not be limited to the following:

1. Liability or claims resulting directly or indirectly from the negligence or carelessness of the CONTRACTOR or its agents in the performance of the WORK, or in guarding or maintaining the same, or from any improper materials, implements, or appliances used in its construction, or by or on account of any act or omission of the CONTRACTOR or its agents;

2. Liability or claims arising directly or indirectly from or based on the violation of any law, ordinance, regulation, order, or decree, whether by the CONTRACTOR or its agents;

3. Liability or claims arising directly or indirectly from the use or manufacture by the CONTRACTOR, its agents, or the OWNER in the performance of this Agreement of any copyrighted or uncopyrighted composition, secret process, patented or unpatented invention, article, or appliance, unless otherwise specifically stipulated in this Agreement.

4. Liability or claims arising directly or indirectly from the breach of any warranties, whether express or implied, made to the OWNER or any other parties by the CONTRACTOR or its agents;

5. Liabilities or claims arising directly or indirectly from the willful misconduct of the CONTRACTOR or its agents; and,

6. Liabilities or claims arising directly or indirectly from any breach of the obligations assumed herein by the CONTRACTOR.

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 work day.

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 latent or nonapparent defects and deficiencies in the other work, 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.

GENERAL CONDITIONS

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 Paragraphs 14.05 and 14.09.

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.

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.

GENERAL CONDITIONS

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 REPRESENTATION

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 chief Owner/Engineer 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 chief authorized representative of the Owner and the Engineer at the site of the work 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 variation 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 parties are unable to agree as the amount or extent thereof, the CONTRACTOR may make a claim therefor as provided in Article 11 or 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 Technical Specifications.

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 with respect to Applications for Payment, see Article 14.

9.08 DECISIONS ON DISPUTES

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 or the safety precautions and programs incident thereto.

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.

GENERAL CONDITIONS

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 and/or a Change Order issued by the ENGINEER. 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 or 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.

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. Changes in the quantity of all bid items established in the Contract Documents, regardless of whether the changes are more or less than 25 percent and at the unit price established in the Contract Documents or adjusted otherwise, shall be documented by Change Orders.

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.

GENERAL CONDITIONS

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 11.01B.

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 Supplementary General Conditions. 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. If it is deemed necessary by the CONTRACTOR to use equipment not listed in the Supplementary General Conditions an equitable rental rate for the equipment will be established by the ENGINEER. The CONTRACTOR may furnish cost data which might assist the ENGINEER in the establishing the rental rate.

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 termination 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:

ACTUAL NECESSARY COST 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 the subcontractor, the allowance specified herein shall be applied to the labor, materials, and equipment costs of the subcontractor, to which the CONTRACTOR may add 5 percent of the subcontractor's total cost for the extra work. Regardless of the number of hierarchical tiers of subcontractors, the 5 percent increase above the subcontractor's total cost which includes the allowances for overhead and profit specified herein may be applied one time only for each separate work transaction.

GENERAL CONDITIONS

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. All 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 12.01A.

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 15.01 (a) 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 paragraph entitled "Inclement weather delays" of the Supplementary General Conditions. No extension of the Contract 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 time named in the Contract Documents for the completion of the WORK, 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, accidents, failure on the part of the CONTRACTOR to carry out the provisions of the Contract 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. In the event that Contract completion is delayed beyond the Contract Time named in the Specifications 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, 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 reason of changes made under the provisions of Article 10 or changed conditions as provided under Article 4.03, or by failure of the OWNER to acquire or clear right-of-way as provided under Article 15.01, or by any act of the ENGINEER or of the OWNER, not contemplated by the Contract, 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, except, that if the WORK is increased as a result of changes, the OWNER, at his sole discretion, may grant an adjustment in the number of calendar days for completion of the Contract. 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.

GENERAL CONDITIONS

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

13.01 WARRANTY, GUARANTEE AND MAINTENANCE 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. 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 Engineer's Notice of 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 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-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 have made, such inspections and test as the ENGINEER deems necessary to see that the WORK is being accomplished in accordance with the requirements of 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 or the OWNER-ENGINEER Agreement, 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. In 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 and replaced 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 found 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.

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.

GENERAL CONDITIONS

ARTICLE 14 - PAYMENTS TO CONTRACTOR, LIQUIDATED DAMAGES AND COMPLETION

14.01 SCHEDULE OF VALUES (LUMP SUM PRICE BREAKDOWN)

A. The schedule of values or lump sum price breakdown established as provided in the Technical Specifications shall serve as the basis for progress payments and will be incorporated into the form of Application for Payment included in the Contract Documents.

14.02 UNIT PRICE BID SCHEDULE

A. Progress payments for unit price work 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 Value of Materials at the Site which have not yet been incorporated in the WORK, and less a deductive adjustment for materials installed which were not previously incorporated in the WORK, but for which payment was allowed under the provisions of payment for Materials Stored at the Site but not yet 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 withhold and retain 5% of each approved progress payment to the CONTRACTOR. The total retention proceeds withheld shall not exceed 5% of the total construction price. All retention proceeds shall be placed by the OWNER in an interest-bearing account. The interest accrued shall be for the benefit of the CONTRACTOR and its subcontractors, and it shall be paid after the WORK has been completed and accepted by the OWNER. CONTRACTOR shall ensure that any interest accrued on the

retainage is distributed by the CONTRACTOR to its subcontractors on a pro rata basis.

E. Any retention proceeds withheld, and any accrued interest, shall be released by the OWNER pursuant to an Application for Payment from the CONTRACTOR within 45 days from the later of:

1. the date the OWNER receives the final Application for Payment from the CONTRACTOR;

2. the date that a certificate of occupancy or final acceptance notice is issued to:

   (a) the Contractor who obtained the building permit from the building inspector or from a public agency;

   (b) the OWNER; or

   (c) the ENGINEER.

3. the date the CONTRACTOR accepts final payment for the Work; or

4. the date that a public agency or building inspector having authority to issue its own certificate of occupancy does not issue the certificate but permits partial or complete occupancy of a newly constructed or remodeled building; provided, however, that if only partial occupancy of a building is permitted, any retention proceeds withheld and retained, and any accrued interest, shall be partially released in direct proportion to the value of the part of the building occupied.

Each Application for Payment from the CONTRACTOR shall include documentation of lien releases or waivers.

F. Notwithstanding any other provision in this Article to the contrary,

1. If the CONTRACTOR is in default or breach of the terms and conditions of the Contract Documents, the OWNER may withhold from payment to the CONTRACTOR for so long as reasonably necessary an amount necessary to cure the breach or default of the CONTRACTOR; or

2. If the WORK or a portion of the WORK has been substantially completed, the OWNER may retain until completion up to twice the

fair market value of the WORK of the CONTRACTOR that has not been completed:

(a) in accordance with the Contract Documents; or

(b) in the absence of applicable provisions in the Contract Documents to generally accepted craft standards.

3. If the OWNER refuses payment under subparagraphs (F)(i) or (ii), it shall describe in writing within 45 days of withholding such amounts what portion of the WORK was not completed according to the standards specified in the Contract Documents.

G. The CONTRACTOR shall distribute retention proceeds as outlined below:

1. Except as provided in Paragraph 14.03.G.2, below, if the CONTRACTOR receives retention proceeds, it shall pay each of its subcontractors from whom retention has been withheld each subcontractor's share of the retention received within ten days from the day that all or any portion of the retention proceeds is received from the OWNER.

2. Notwithstanding Paragraph 14.03.G.1, above, if a retention payment received by the CONTRACTOR is specifically designated for a particular subcontractor, payment of the retention shall be made to the designated subcontractor.

H. Except as otherwise provided in the Supplementary General Conditions, the value of materials stored at the site shall be valued at 95 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 than $5,000 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 in these General Conditions 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 later 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 LIQUIDATED DAMAGES

A. The CONTRACTOR shall pay to the OWNER the amount specified in the Supplemental 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 time or times agreed upon. The periods for which these damages shall be paid shall be the number of Days from the agreed date or 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 certifies Substantial Completion of WORK or specified parts of the WORK 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 Supplemental 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. Said damages are not in lieu of but in addition to other actual or consequential damages to which the OWNER may be entitled.

C. 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, and the CONTRACTOR has 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, the CONTRACTOR may notify the OWNER and the ENGINEER in writing that the WORK is substantially complete and request that the ENGINEER prepare a Certificate of Substantial Completion. 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 Certificate of Substantial Completion signed by the ENGINEER and CONTRACTOR, which shall fix the date of Substantial Completion.

B. The Certificate 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 Certificate 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 Certificate 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 ENGINEER's Notice of 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 required additions and modifications to 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 ENGINEER's 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 ENGINEER's filing of the Notice of Completion, the OWNER will make final payment including all deducted retainage (except as noted below) 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 damages, as applicable.

2. All amounts retained by the OWNER under Paragraph 14.03(F).

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 Certificate 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 Certificate of Substantial Completion.

GENERAL CONDITIONS

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 proceed. Whenever the OWNER temporarily suspends work for any conditions enumerated in this Article 15.01 A, 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 the written order suspending the work and shall be terminated upon receipt by the Contractor of the 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 Contact 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 or 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.

GENERAL CONDITIONS

ARTICLE 16 - MISCELLANEOUS

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 ASBESTOS

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

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 17- GENERAL

17.01 GENERAL

1. These Supplemental 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.

2. The terms used in these Supplemental 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.

17.02 SUPPLEMENTAL DEFINITIONS

1. ENGINEER

The "Engineer" is Bowen, Collins, and Associates, Inc.

17.03 TESTING COSTS

1. Paragraph 13.03 of the General Conditions is amended as follows: the CONTRACTOR shall pay all testing costs. The Owner reserves the right to have additional tests performed by a testing organization selected by the OWNER and at the OWNER’s expense.

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 18 - AMOUNTS OF LIQUIDATED DAMAGES, BONDS AND INSURANCE

18.01 AMOUNT OF LIQUIDATED DAMAGES

A. As provided in Article 14.07 of the General Conditions, the Contractor shall pay to the Owner as liquidated damages the amount of $1,000 for each calendar day's delay beyond the Contract Time for substantial completion. The Contractor shall pay to the Owner as liquidated damages the amount of $200 for each calendar day's delay beyond 45 calendar days from the date of substantial Completion until the Engineer issues the Notice of Final Completion.

18.02 PERFORMANCE AND OTHER BOND AMOUNTS

A. The CONTRACTOR shall furnish a satisfactory Performance Bond in the amount of 100 percent of the Contract Price and a satisfactory Payment Bond in the amount of 100 percent of the Contract Price.

18.03 INSURANCE AMOUNTS

The limits of liability for the insurance required by Paragraph 5.02 of the General Conditions shall provide for not less than the following amounts or greater where required by Laws and Regulations:

A. Workers' Compensation under Paragraph 5.02B.1 of the General Conditions:

1. State: Utah — Statutory

B. Comprehensive General Liability: (under Paragraph 5.02B.2 of the General Conditions):

1. Bodily Injury (including completed operations and products liability):

$ 500,000 — Each Occurrence
$ 1,000,000 — Annual Aggregate

Property Damage:

$ 500,000 — Each Occurrence
$ 1,000,000 — Annual Aggregate
or a combined single limit of — $1,000,000

2. Property Damage liability insurance including, Explosion, Collapse and Underground coverages, where applicable.

3. Personal Injury, with employment exclusion deleted

$ 1,000,000 Annual Aggregate

C. Comprehensive Automobile Liability: (Under Paragraph 5.02B.3 of the General Conditions:)

1. Bodily Injury

$ 500,000 Each Person
$ 1,000,000 Each Occurrence

2. Property Damage:

$ 500,000 Each Occurrence

or combined single limit of $1,000,000

D. Builders Risk: Not required.

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 19 - PHYSICAL CONDITIONS AND WEATHER DELAYS

19.01 INCLEMENT WEATHER DELAYS

A. The Contractor's construction schedule shall be based upon the inclusion of at least five (5) day(s) of inclement weather delays. Reference Article 12, paragraph 12.02 of the General Conditions for additional requirements.

SUPPLEMENTAL GENERAL CONDITIONS

ARTICLE 20 - SUBCONTRACT LIMITATIONS

20.01 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 21 - MISCELLANEOUS

21.01 PATENTS AND COPYRIGHTS

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.

DIVISION 01
GENERAL REQUIREMENTS

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The Work to be performed under this Contract consists of furnishing all plant, tools, equipment, materials, supplies, and manufactured articles and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all Work, or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The Work shall be complete, and all Work, materials, and services not expressly indicated or called for in the Contract Documents, which may be necessary for the complete, safe, and proper construction of the Work in good faith shall be provided by Contractor as though originally so indicated, at no increase in cost to Owner.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of this Contract comprises the construction of construction of new membrane baffle curtains inside existing 1 MG and 3 MG buried concrete drinking water storage reservoirs; reservoir inlet pipe extension inside one reservoir; recoating existing piping inside both reservoirs, new washdown piping systems inside both reservoirs; modifications to existing valve vault including piping modifications to separate 3 MG reservoir inlet and outlet, replacement of three valves with new actuated butterfly valves, new sample pumps and sampling instrumentation equipment, and demolition of existing metal stairs and construction of new landing and ladders; installation of buried 33-inch welded steel pipe and buried 4-inch C900 washdown piping, including tie-ins to existing piping; installation of a new water meter and check valve in an existing meter vault; landscape restoration; electrical, instrumentation and controls; testing, disinfection, commissioning and startup.

B. The Work is located in Sandy, Utah at the existing Southeast Regional Water Treatment Plant site, as indicated on the Drawings.

1.3 CONTRACT METHOD

A. The Work hereunder will be constructed under a single lump-sum contract.

1.4 STREAMLINED SPECIFICATIONS

A. These specifications are written in streamlined or declarative style, often using incomplete sentences. This imperative language is directed to Contractor unless specifically noted otherwise.

B. Omissions of such words and phrases as “Contractor shall,” “in conformity therewith,” “shall be,” “as shown on the Drawings,” “a,” “an,” “the,” and “all” are intentional in streamlined sections.
   1. Omitted words shall be supplied by inference in the same manner as when a note appears on the Drawings.

2. Omission of such words shall not relieve Contractor from providing the items and work described herein or indicated on the Drawings.
3. Words “shall be” are included by inference where a colon (:) is used within sentences or phrases.

1.5 WORK BY OTHERS

A. Owner reserves the right to perform or award other work concurrent with the Work included in this Contract
1. Work may be conducted at or adjacent to the Site by other contractors during the performance of the Work under this Contract. Conduct operations to cause a minimum of interference with the Work of such other contractors and cooperate fully with such contractors to provide continued safe access to their respective portions of the Site, as required to perform Work under their respective contracts.

B. Interference With Work On Utilities:
1. Cooperate and coordinate fully with all utility forces of Owner or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the Work.
2. Schedule the Work to minimize interference with said relocation, altering, or other rearranging of facilities.

1.6 WORK SEQUENCE AND SCHEDULING CONSTRAINTS

A. Schedule and perform the Work in such a manner as to result in the least possible disruption to the public's use of roadways, driveways, and utilities. Utilities shall include but not be limited to water, sewerage, drainage structures, ditches and canals, gas, electric, cable television, and telephone. Refer to Utility Adjustment and other plan and profile sheets for approximate location of utilities. However, there is no guarantee as to accuracy or completeness. Contractor shall incorporate as-built locations on the reproducible record plans, in red ink, showing proper location on each sheet where these utilities are located.

A. Except as specified in Section 01 14 40 – Construction and Schedule Constraints, no interruption in the water storage and supply process can be accommodated. Schedule construction operations so that no interference with the operation of the existing 2 MG reservoir and associated supply piping will occur outside of allowed shutdown periods.

B. Access to the site is limited to the hours of 7:00 a.m. to 7:00 p.m. Monday through Friday.

1.7 CONTRACTOR USE OF PROJECT SITE

A. Use of the Project Site shall be limited to construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

B. Do not use the indicated portion of the site until Notice to Proceed has been provided to Contractor for any of its construction operations.

1.8 OWNER USE OF THE PROJECT SITE

A. Owner and WaterPro Irrigation Company may utilize all or part of the existing facilities during the entire construction period for conduction the Owner's and WaterPro's normal operations. Cooperate and coordinate with Owner and WaterPro to facilitate Owner's operations and projects and to minimize interference with Contractor's operations at the same time. In any event, Owner and WaterPro shall be allowed safe access to the Project Site during the period of construction.

1.9 PARTIAL UTILIZATION OF THE WORK BY OWNER

A. Owner will take partial utilization of the Work upon substantial completion of the project. Partial utilization will involve the placing into service of facilities that are substantially complete and ready for use for water transmission and storage.

1.10 CONTRACTOR'S WORKING HOURS

A. Perform work within Owner's regular working hours from 7:00 a.m. to 7:00 p.m., Monday through Friday. If Contractor desires to work overtime or work on a Saturday, Sunday, or any legal holiday, obtain prior approval from Owner and Engineer.

1.11 STORAGE

A. Storage conditions shall be acceptable to Owner for all materials and equipment not incorporated into the Work but included in Applications for Payment. Such storage arrangements and conditions shall be presented in writing for Owner's review and approval and shall afford adequate and satisfactory security and protection. Off-site storage facilities shall be accessible to Engineer. The stored materials shall be insured for full value. Certificates of liability insurance coverage must be submitted to Engineer with the request for payment by Contractor. All arrangements and costs for storage facilities shall be paid by Contractor, unless specifically designated in the Contract Documents to be furnished by Owner.

1.12 NOTICES TO OWNERS OF ADJACENT PROPERTIES AND UTILITIES

A. Notify Owners of adjacent property and utilities when prosecution of the Work may affect them.

B. When it is necessary to temporarily deny access by owners or tenants to their property, or when any utility service connection must be interrupted, Give notices sufficiently in advance to enable the affected person(s) to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit any resulting inconvenience.

C. Utilities and other concerned agencies shall be contacted at least seven days prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines.

D. Review with the various utility companies the construction methods, safety procedures, and Work to be done in the vicinity of utilities. When temporary relocation of utilities is necessary, provide sufficient advance notice to the utility involved.

1.13 LINES AND GRADES

A. Perform all Work to the lines, grades, and elevations shown on the Drawings.

B. Basic horizontal and vertical control points will be established or designated as provided in General Conditions paragraphs. Use these points as datum for the Work. Perform any additional survey, layout, or measurement work needed for proper construction of the Work as a part of the Work at no additional cost to Owner.

C. Employ experienced instrument personnel, competent assistants, and such instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement work. In addition, furnish, without additional charge, competent personnel and such tools, stakes, and other materials as Engineer may require in establishing or designating control points or in checking survey, layout, and measurement of Work performed.

D. Keep Engineer informed, a reasonable time in advance, of the times and places at which Work is to be done, so that horizontal and vertical control points may be established, and any checking deemed necessary by Engineer may be done with minimum delay to the Project.

E. Remove and reconstruct Work, which is improperly located.

1.14 PROJECT MEETINGS

A. Preconstruction Conference
   1. 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, its Safety Representative, and its Subcontractors as Contractor deems appropriate. Other attendees will be:
      a. Engineer
      b. Representatives of Owner
      c. Governmental representatives as appropriate
      d. Others as requested by Contractor, Owner, or Engineer
      e. Engineer’s Representative
   2. Bring to the conference, any submittals so indicated in Section 01 33 20 - Contractor Submittals.
   3. The purpose of the conference is to designate responsible personnel, discuss contract requirements and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished by Engineer prior to the meeting date. However, be prepared to discuss all the items listed below.
      a. Contractor's assignments for safety and first aid, including Designated Competent person(s) and Contractor's Safety Representative.
      b. Status of Contractor's insurance and bonds.
      c. Contractor's tentative schedules.
      d. Transmittal, review, and distribution of Contractor's submittals.
      e. Processing applications for payment.

f. Maintaining record documents.
g. Critical Work sequencing.
h. Field decisions and Change Orders.
i. Use of project site, office and storage areas, security, housekeeping, and Owner's needs.
j. Major equipment deliveries and priorities.
k. Permits required for construction.
l. Utilities required for construction.
m. Contract Owner and channels of communication.
n. Coordination with others.

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

B. Progress Meetings

1. Engineer will schedule and hold regular on-Site progress meetings at least weekly and at other times as deemed necessary by Engineer or as required by progress of the Work. Contractor, Engineer, and all Subcontractors active on the Site must attend each meeting. Contractor may at its discretion request attendance by representatives of its Suppliers, manufacturers, and other Subcontractors.
2. Engineer will preside at the meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings will be to review the progress of the Work, discuss safety, maintain coordination of efforts, discuss commercial issues, discuss changes in scheduling, and resolve other problems, which may develop. During each meeting, all parties are required to present any issues, which may impact its Work, with a view toward resolving these issues expeditiously.

1.2 UTILITY SERVICE

A. Water: Temporary connections required for construction water will be installed by the Contractor at the Contractor's expense. Water used by the Contractor for construction will be provided by the Contractor at the Contractor's expense. Water for testing of tank and pipelines will be provided by the Owner as described in the specifications.

B. Power: The Owner has existing power service available at the site. Temporary power required for construction shall be provided by the Owner at no charge to the Contractor provided that construction power requirements do not interfere with operation of existing facilities; however, the Contractor shall install any necessary transformers, conduits and conductor needed for temporary power service. Any additional temporary power required for construction shall be provided by the Contractor at the Contractor’s expense, including any necessary generators, fuel, conduit, conductors and appurtenances.

C. Temporary utilities needed for construction are subject to the requirements of Section 01 51 00 - Temporary Utilities.

1.3 PLC PROGRAMMING AND SCADA INTEGRATION

A. The Owner will perform programming and integration of instrumentation associated with the new reservoir and appurtenances. The Contractor is required to furnish and install all instruments, enclosures, and equipment, including terminating all wiring, loop testing,

startup and troubleshooting of instruments. The Contractor will be responsible to ensure that all instrumentation is complete and operable as part of the construction contract.

B. The Owner, herein called Integrator, will provide modification to the following services associated with the new reservoir and appurtenances:
   1. Modifications in the existing PLC cabinet including addition of I/O cards, fuse and terminal blocks, and internal wiring (see drawings for more information.)
   2. PLC programming
   3. SCADA integration
   4. Assistance with point-to-point I/O checks
   5. Assistance with control loop tests
   6. Communication testing
   7. System operation testing.

C. Contractor shall be responsible for the following:
   1. Labeling and termination of all conductors and cabling on both ends. (Owner shall terminate conductors and cabling on PLC end.)
   2. Assistance to Integrator to perform point to point checkout of system.
   3. Providing PDF file to Owner documenting loop testing.
   4. All instrumentation and associated setup and calibration.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 40
CONSTRUCTION AND SCHEDULE CONSTRAINTS

PART 1 - GENERAL

1.1 SUMMARY

A. Schedule, sequence, and perform the Work in a manner, which minimizes disruption to the public and to the operation and maintenance of existing facilities.

B. Allow for construction and schedule constraints in preparing the construction schedules required under Section 01 32 16 – Construction Progress Schedule. The schedule shall include the activities necessary to satisfy all constraints included and referenced in the Contract Documents.

1.2 PERMITS

A. Abide by the conditions of all permits, easements, and private agreements made and obtain written acceptance of the constructed conditions from each issuer of the permit, easement, or private agreement prior to acceptance of Work by Owner, at no additional expense to Owner.

1.3 COORDINATION WITH OTHER CONSTRUCTION

A. Be responsible for coordinating the Work depicted in the Contract Documents with Owner, Engineer, and all other contractors or suppliers working at, or near the Project Site in accordance with the General Conditions and Supplementary General Conditions.

B. When two or more contracts are being executed at one time on the same, or adjacent land, and in such a manner that work on one contract may interfere with work on another, Owner will determine the sequence and order of the Work. When the territory of one contract is the necessary or convenient means of access for the execution of another contract, such privilege of access or any other reasonable privilege shall be shared unless granted specifically by Owner to one contractor. No such decision as to the method or time of conducting the Work or the use of territory shall be made the basis of any claim for delay or damage, except as provided for in the General Conditions and Supplementary General Conditions.

1.4 SCHEDULING AND COORDINATION OF SHUTDOWNS

A. Continuous operation of the Owner's facilities is of critical importance. Construction of the Work will require disruptions of service to make critical connections, replace existing pipelines and equipment, or modify existing facilities. Contractor shall schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified. Contractor shall provide temporary facilities, bypass systems, or other approved means to ensure continuous supply of water and water storage availability to meet system operational and emergency demands.

B. Contractor shall notify Engineer and Owner in writing at least 14 days in advance of any operation that will disrupt Owner's facilities or operations or any required shutdown. Prior

to removing any portion of the existing facilities, submit and obtain Engineer and Owner approval for all submittals required to construct the proposed improvements.

C. Clearly demonstrate in the CPM Schedule and other submittals, to the satisfaction of the Owner and the Engineer, the Contractor's ability to complete the Work requiring an interruption of service (shutdown work) within the allowable duration.

D. If the Contractor does not clearly demonstrate the ability to complete the shutdown work in the CPM Schedule proposed during a shutdown period, the Owner reserves the right to limit the scope of the shutdown work which the Contractor may undertake.

E. **Opportunities for shutdown of existing reservoirs, pipelines, and other facilities will be limited to periods of low demand (typically winter, between October and April) and limited in duration.**

1.5 SCHEDULE CONSTRAINTS

A. Be responsible to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall Work.

B. Portions of the Work will be required to be constructed in sequence or limited in timing and duration in order to ensure uninterrupted water supply and water storage availability during the construction period. Critical Work activities and construction constraints are presented and discussed below. The construction constraints described do not include all activities necessary to complete the Work or the activity described. The construction constraints are intended to show the order and/or nature of critical activities necessary to minimize disruption to water supply and storage.

C. Construction Schedule Milestones: The Contractor shall meet the following construction completion and milestone dates. These milestones shall be included in the CPM Construction Schedule:
   1. March 17, 2028: Substantial completion of new SERWTP Disinfection Contact Time Improvements Project.
   2. April 28, 2028: Final completion of all Work.

D. Shutdown Time and Duration: Constraints on the timing and duration of required shutdowns needed to complete critical work activities are shown in the tables below and described in the paragraphs that follow. These constraints shall be included in the CPM Construction Schedule. Allowable shutdown durations include dewatering of pipe or reservoirs.

E. The listing of schedule constraints below does not mean that all constraints or special conditions have been identified. The list is not a substitute for the duty to coordinate and plan for completion, all Work by the Substantial/Contract Completion Dates specified in the Contract Documents.

F. Special Listing: The following constraints affect the construction schedule.

1. SERWTP Disinfection CT Improvements Construction

No.	Construction Activity	Shutdown Required?	Facility Impacted (Allowable Duration)
1	3 MG Reservoir Interior Work: Install baffle curtains, install inlet pipe extension, install and commission new washdown piping, recoat existing piping and install anodes. Clean and disinfect reservoir and place back in service.	Yes	3 MG Reservoir (6 Weeks)
2	3 MG Reservoir Vault - Pipe and Valve Work: Remove portion of existing piping, install new vault piping to separate inlet and outlet, replace 3 existing butterfly valves with new electrically actuated valves.	Yes	3 MG Reservoir (6 Weeks, concurrent with Activity 1)
3	Install buried 3 MG Reservoir 33" outlet pipe between 3 MG Reservoir valve vault and tie-in point. Disinfect and test new piping.	No	--
4	Complete 3 MG Reservoir Outlet Pipe Tie-in to Existing Buried 33" Pipe: Cap existing 33" pipe south of reservoir inlet, complete outlet pipe tie-in.	Yes	1 MG Reservoir, 3 MG Reservoir SERWTP Treatment Plant (1 Week)
5	1 MG Reservoir Interior Work: Install baffle curtains, install and commission new washdown piping, replace ladder, recoat existing piping and install anodes. Clean and disinfect reservoir and place back in service.	Yes	1 MG Reservoir, SERWTP Treatment Plant (6 Weeks)
6	3 MG Reservoir Vault - Access Modification Work: Remove bottom stairs, construct new landing and access ladders.	No	--
7	3 MG Reservoir Vault – New Sample Pumps and Instrumentation: Install new sample pumps and sampling instrumentation panel mounted on wall above new upper landing.	No	--
8	Install buried washdown piping from system tie-in up to the outside of the 1 MG and 3 MG reservoir walls.	No	--
9	Install and commission new flow meter and check valve inside of WaterPro Meter Vault.	Yes	WaterPro Meter Vault (2 Weeks)
10	Install new electrical, instrumentation, and panels for new actuated butterfly valves, and place in service. Commission new instrumentation.	No	--
11	Landscape Restoration.	No	--
12	Final site improvements and paving.	No	--

a. Construction activities 1 through 8 do not have to be completed in the order they are listed. Contractor to coordinate with Owner to determine optimal

order of construction activities in coordination with allowable shutdown periods for the treatment plant, 1 MG reservoir, and 3 MG reservoir.

b. Activity 1: Complete all 3 MG Reservoir interior work: Install baffle curtains, install inlet pipe extension and pipe supports, install and commission new washdown piping, recoat existing piping and install anodes. Clean and disinfect reservoir and place back in service. **During Activity 1, the treatment plant and 1 MG reservoir need to be online**. Isolation may occur in the 3 MG reservoir valve vault or using the buried isolation valve outside of the vault if possible.

c. Activity 2: Complete all pipe and valve work in the 3 MG Reservoir valve vault: Remove portion of existing piping, install new vault piping to separate inlet and outlet, replace 3 existing butterfly valves with new electrically actuated valves. **During Activity 2, the treatment plant and 1 MG reservoir need to be online**. Isolation may occur using the existing buried isolation valve outside the vault if possible.

d. Activity 3: Install buried 3 MG Reservoir 33" outlet pipe between 3 MG Reservoir valve vault and tie-in point. Disinfect and test new piping.

e. Activity 4: Complete 3 MG reservoir outlet pipe tie-in to existing buried 33" pipe. Cap the existing 33" pipe south of reservoir inlet, complete outlet pipe tie-in.

f. Activity 5: Complete all 1 MG Reservoir interior work: Install baffle curtains, install and commission new washdown piping, replace ladder, recoat existing piping. Clean and disinfect reservoir and place back in service. **During Activity 5, the 3 MG reservoir needs to be online** to provide storage for the system downstream of the plant.

g. Activity 6: Complete access modification work in 3 MG reservoir valve vault. Remove existing bottom stairs, construct new landing and access ladders.

h. Activity 7: Complete installation of new sample pumps and instrumentation in 3 MG reservoir valve vault, including new sample pumps, piping, and sampling instruments mounted on panel mounted on wall above new upper landing.

i. Activity 8: Install buried washdown piping from system tie-in up to the outside of the 1 MG and 3 MG reservoir walls. This can be complete before or after the washdown pipe has been installed in the reservoirs and through the reservoir wall.

j. Activity 9: Install and commission new flow meter and check valve inside of WaterPro Meter Vault. Prior to beginning, coordinate with WaterPro to shut isolation valve and tap the existing pipe to confirm the valve seals. **This work needs to be scheduled between December 2027 and February 2028.**

k. Activity 10: Install new electrical, instrumentation, and panels for new actuated butterfly valves, and place in service. Commission new instrumentation.

l. Activity 11: Landscape Restoration.

m. Activity 12: Final site improvements and paving.

G. Essential Service and Capacity Constraints

1. Water Supply: All water mains, storage, and treatment facilities must remain in service throughout the project, with only the specified brief interruptions to complete work and make connections.

2. Shutdown Constraints: The Southeast Regional Water Treatment Plant (SERWTP) cannot be taken out of service at the same time as the Jordan Valley Water Treatment Plant (JVWTP). The JVWTP currently has the following scheduled shutdowns:
   a. January-February 2027
   b. November 2027-February 2028

END OF SECTION

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SECTION 01 20 00
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section defines the manner in which the Lump Sum Prices, Unit Prices, and the Allowances listed in the Bid Schedule will be used to determine measurement and payment for all Work and describes the required procedures for monthly progress payments to the Contractor.

B. Bid amounts will include all plant, equipment, tools materials, labor, service, and all other items required to complete the Work included in the Agreement unless specifically excluded by this section. Work required for which no separate Bid item is identified will be considered as a subsidiary obligation of the Contractor, and the cost therefore shall be included in the most applicable Bid item. Refer to 01 32 16 – Construction Progress Schedule for resource loading and progress payments. Compensation for partial completion of the Work will be determined by use of the Construction Schedule. Bid amounts for each item will be the basis for development of budget values for activities included in the Construction Schedule and in the Schedule of Values. Adjustments to Allowance Bid Item amounts will be applied to the Contract Price when Work is completed, and actual Allowance item amounts are known.

C. Payment for all items in the Bid Schedule will include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of Work being described, as necessary to complete the various items of the Work in accordance with the requirements of the Contract Documents, including all appurtenances thereto, and including but not limited to all costs of permits and cost of compliance with the regulations of public agencies having jurisdiction, including Safety and Health Requirements of the Division of Industrial Safety and the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA).

D. All costs shall be included in the prices named in the Bid Schedule for the various items of Work. Except as otherwise provided herein, no separate payment will be made for any item that is not specifically set forth in the Bid Schedule.

E. When included, all estimated quantities stipulated in the Bid or other Contract Documents are approximate and are to be used only as a basis for estimating the probable cost of the Work and for the purpose of comparing the Bids submitted for the Work. The actual amounts of Work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. Contractor agrees that it will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts thereof.

F. The unit or lump sum item of work, which involves excavation or trenching shall include all costs for such work. No direct payment will be made for excavation or trenching. All excavation and trenching will be unclassified as to materials which may be encountered; in addition, trenches will be unclassified as to depth. No additional payment will be made for

rock or caliche excavation, nor for blasting which the Contractor determines is required for rock or caliche excavations.

G. Note that the information provided in this Section is intended for use as a general description of the breakdown of work to be included in the Bid Schedule. The following descriptions are NOT intended to represent a complete listing of all Work required by the Contract Documents. It is the Bidder's responsibility to make sure that costs for all Work required in the plans and specifications is accounted for in the appropriate Bid Items, whether or not specifically described in this Measurement and Payment section. The Owner is not responsible for Contractor's failure to properly coordinate with Subcontractors and Suppliers regarding the breakdown of Work in these Contract Documents.

1.2 MEASUREMENT AND PAYMENT

A. Lump Sum Bid Items

1. All Work Required by the Contract Documents

a. The sum allowed for 1, 2, 3, 5, 6, 7, 8, 9, and 10 as set forth in the Bid Form includes all Work for and in connection with construction of the Contract in its entirety, including but not limited to all costs associated with dust control mitigation measures, permit fees and other related costs to ensure compliance with the Board of Health Air Pollution Control Regulations.

b. Payment for Work under this Bid item will be based on the breakdown of costs for each scheduled activity in the Construction Schedule and the percentage of completion for each activity in accordance with the Contract Documents.

c. Preparing the Construction Progress Schedule shall be a separate activity on the Construction Schedule and shall also be a separate activity on the Schedule of Values. Payment for the Construction Progress Schedule is not in addition to, but is incidental to the other lump-sum items included in the Work.

d. Payment for mobilization, as defined in Section 01 71 00 – Mobilization, as part of the lump sum price named in the Bid Schedule shall equal six percent (6.0%) of the total lump sum price bid for the Work. The payment for mobilization is not in addition to, but is part of the lump sum price for the Work. Include a separate activity for mobilization in the Construction Schedule and in the Schedule of Values. This activity shall include all principal items and all submittals specified in Section 01 71 00 – Mobilization, as applicable. The remaining lump sum, except as otherwise required by this Agreement, shall be appropriately distributed among the remaining work activities that make up the total lump sum price. Payment for mobilization will be approved in accordance with the status of completion of each mobilization component as defined in the approved mobilization plan required in Section 01 71 00; except that no payment for mobilization will be approved until Items 1, 2, 8, 9, 10, and 11 of paragraph 3.1.A of Section 01 71 00 are complete. No more than one-half of the payment for mobilization will be paid until all submittals required by paragraph 3.2 of Section 01 71 00 have been approved by Engineer.

e. Payment for each approved Operations & Maintenance (O & M) Manual, as defined in Section 01 33 20 – Contractor Submittals, as part of the total lump sum price named in the Bid Schedule shall equal 10% of the value of the piece

of equipment or group of like-kind pieces of equipment that it represents. The payment for each O & M Manual is not in addition to but is part of the lump sum price for the Work. A separate activity for each O & M Manual shall be included in the Construction Schedule and in the Schedule of Values. The remaining lump sum price, except as otherwise required by this Contract, shall be appropriately distributed among the remaining work activities that make up the total lump sum price.

A. Unit Price Bid Items

1. Measurement and calculation of quantities for payment to be as indicated in this section.
2. Unit prices or lump sum amounts to include full compensation for furnishing all labor, materials, products, tools, equipment, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit, and doing all work shown on the Drawings, defined in the Specifications, and/or stipulated herein.
3. Payment covers the cost of incidental work which includes: quality control; temporary facilities; removal and disposal of waste materials; dust control; site cleanup; and all other necessary work, to install the Work complete.
4. Unit Price Work required by the Contract Documents.
    a. Bid Item No. 4 – Replace Joint Sealant in 3 MG Reservoir Floor
        1) Measurement: Measured and paid for on a lineal foot basis as measured in the field by the Engineer, and based on sealant crack repair material placed to the width and thickness indicated in the Drawings and Specifications.
        2) Payment Covers: All labor, materials, tools, and equipment required to complete joint repairs, including but not limited to: Removing existing joint sealant; cleaning, grinding, blasting and preparing repair areas; patching holes; masking; furnishing and installing sealant primer and repair materials per the Drawings and Specifications; curing; cleanup; and all other work required to complete joint repairs.

1.3 GENERAL PROGRESS PAYMENT REQUIREMENTS

A. A Payment for Work performed shall be in accordance with installed quantities as assessed in comparison to the Schedule of Values and the Construction Schedule. Engineer will verify measurements and quantities. Each activity necessary to manage and complete the Work is identified on the Contract schedules. Each activity will be assigned its respective value, a portion of the Contract Price, as shown on the Schedule of Values (Roll-up), and detailed cost loaded activity schedule.

B. Payment for all lump sum costs and services incurred on this Agreement shall be based on the earned value of Work accomplished during the reporting period. Earned value is determined by the completion percentage of each activity as determined by the Schedule of Values and the Construction Schedule applied to the total value of the activity. No construction activity shall be deemed 100 percent complete until Contractor has completed the physical check out and inspection of the completed Work and has submitted the signed inspection form to Engineer.

C. Earned value is derived from the current status of Contractor Construction Schedule as determined by the monthly schedule status submittals. Each schedule status submittal is reviewed and approved by Engineer prior to Contractor obtaining approval for the Summary of Earned Values or quantities installed and the Application for Payment.

1.4 APPLICATION FOR PAYMENT

A. Submit application for payment on Owner's form and be certified by signature of an Authorized Officer of Contractor.

B. The Application for Payment shall contain all necessary references and attachments that substantiate the invoice for progress payment (e.g., certified payrolls, labor reports, progress schedule data, and Summary of Earned Values). It shall substantiate the invoice for progress payment and shall be preceded or accompanied by the schedule and status data as a condition of payment, in accordance with the Construction Schedule and the Schedule of Values.

1.5 REVIEWS/APPLICATION FOR PAYMENT

A. Review meetings between Contractor and Engineer will be held weekly and within 7 Days prior to the payment application date designated by Engineer. Three Days prior to the last review meeting of the month, submit an updated schedule and a signed application for payment showing a Summary of Earned Values for the reporting and payment period so that Engineer can compare earned values to available status data. Make any adjustments to the Master Record Documents, updated schedule, and payment applications required by Engineer. Upon completion of the adjustments, Engineer will sign the payment request and forward it to Owner. Engineer will determine payment amounts if agreement with Contractor is not reached.

1.6 PAYMENT FOR SUPPLIES AND MATERIALS

A. Payment based on the actual cost of supplies, materials and equipment on hand shall be made by Owner with or without a paid invoice. "Actual cost" of materials shall be the invoice amount, whether paid or not, and shall not include any costs associated with installation, testing, etc. Contractor shall be entitled to payment of the actual cost of supplies, materials, and equipment only if it (1) presents an invoice to Owner with the application for payment and (2) states in the application for payment that the materials have been delivered and stored in the time and manner specified in the contract between Contractor and his Supplier or Subcontractor. If Contractor fails to comply with those conditions, Owner may withhold payment in accordance with the provisions. Owner expressly reserves the right to withhold retention until Contractor presents to Owner a paid invoice, or some other proof of payment satisfactory to Owner, for Owner's use in verifying the accuracy of the actual cost of the supplies, materials or equipment. If the amount paid does not match the actual cost, Owner will adjust the amount of retention accordingly. Payment for supplies, materials or equipment on hand does not alter the responsibility of Contractor for all supplies, materials and equipment until Final Acceptance of the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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SECTION 01 25 10
PRODUCTS, MATERIALS, EQUIPMENT, AND SUBSTITUTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for delivery and storage of products and materials specified for use in the Project. It also includes requirements for handling requests for equals and substitutions made after award of the Contract.

DEFINITIONS

B. Definitions in this Article are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," “special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.

C. The word "Products," as used herein, is defined to include purchased items for incorporation into the Work, regardless of whether specifically purchased for the Project or taken from stock of previously purchased products.

D. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form units of work.

E. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items).

F. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying and erection of the Work.

1.2 QUALITY ASSURANCE

A. Source Limitations: To the greatest extent possible for each unit of work, provide products, materials, and equipment of a singular generic kind from a single source.

B. Compatibility of Options: Where more than one choice is available as options for selection of a product, material, or equipment, select an option, which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material, and equipment selections.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance
   1. Deliver and store products, materials, and equipment in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft.

2. Manage delivery schedules to minimize long-term storage of products at Site and overcrowding of construction spaces. Ensure coordination to minimize holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

B. Transportation and Handling
1. Transport products by methods to avoid damage. Deliver in undamaged condition in manufacturer's unopened containers and packaging.
2. Furnish equipment and personnel to handle products, materials, and equipment, including those provided by Owner, by methods to prevent soiling and damage.
3. Provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

C. Storage and Protection
1. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate-controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.
2. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.
3. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
4. Storage shall be arranged to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.
5. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

D. Maintenance of Storage
1. Periodically inspect stored products on a scheduled basis. Maintain a log of inspections and make the log available on request.
2. Comply with manufacturer's product storage requirements and recommendations.
3. Maintain manufacturer-required environmental conditions continually.
4. Ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.
5. For mechanical and electrical equipment, provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.
6. Service products on a regularly scheduled basis. Maintain a log of services and submit as a record document prior to acceptance by Owner in accordance with the Contract Documents.

1.4 PROPOSED SUBSTITUTIONS AND "OR EQUAL" ITEMS

A. Substitution and “or equal” determination shall be submitted and evaluated per the General Conditions included in the Contract Documents.

B. When proposing a substitution, transmit all documents to Engineer in electronic format (single PDF), via web-based construction management software as specified in Section 01 32 00 – Electronic Project Management System.

C. Unless otherwise provided by law or authorized in writing by Engineer, submit the "Substitution Request Form(s)" within 35 days after award of the Contract.

D. Whenever products, materials, or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the naming of the manufacturer is intended to establish the type, function, and quality required. The Contract Price is understood to be based upon furnishing the item specified.

E. If a named item is not available or a supplier is no longer doing business, the following shall apply:
   1. When a named supplier is no longer doing business under the name indicated, furnish the specified product from the legal successors to the named supplier.
   2. When a named product is no longer available from the named supplier due to acquisition or sale of the given product line, but the product is available from another supplier, provide the named product. In such cases, submit a substitution request form and include certification from the supplier that the product being supplied is materially and functionally identical to the product named in the Contract Documents.
   3. When the named product is no longer available from the named supplier or any other supplier, notify Owner in writing and Owner will direct Engineer to identify suitable substitute products. Provide one of the suitable substitute products.

F. The procedure for review by the Engineer will include the following:
   1. Wherever a proposed substitution has not been submitted within said 35-day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by Engineer, provide the product, material, or equipment indicated in the Contract Documents.
   2. Certify that the proposed substitution will adequately perform the functions and achieve the results called for by the general design and be similar and of equal substance to that indicated and be suited to the same use as that indicated.
   3. Engineer will evaluate each proposed substitution within a reasonable period.
   4. As applicable, do not make shop drawing submittals for a substitution without Engineer's prior written acceptance of the request for substitution. Do not order, install, or utilize any substitution item prior to written acceptance of the request for substitution.
   5. Engineer will record the time required by Engineer in evaluating substitutions and in making changes by Contractor in the Contract Documents occasioned thereby.

G. Application for substitution must contain the following statements and information, which will be considered by Engineer in evaluating the proposed substitution:
   1. Submit “Substitution Request Form,” at end of this Section, fully executed.
   2. The evaluation and acceptance of the proposed substitution shall not prejudice the achievement of substantial completion on time.
   3. Whether or not acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitution.
   4. Whether or not incorporation or use of the substitution in connection with the Work is subject to payment of any license fee or royalty.
   5. All variations of the proposed substitution from the items originally specified shall be identified.

6. Available maintenance, repair, and replacement service shall be indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.
7. Itemized estimate of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.

H. Without any increase in cost to Owner, be responsible for, and pay all costs in connection with proposed substitutions and costs of inspections and testing of equipment or materials submitted for review prior to purchase thereof for incorporation in the Work, whether or not Engineer accepts the proposed product, equipment, or material. Reimburse Owner for the charges of Engineer and other authorized representatives for evaluating each proposed substitution.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

BOWEN COLLINS & ASSOCIATES

SUBSTITUTION REQUEST FORM

To: _____ Project: _____

_____ Date: _____

_____ Owner: _____

Specified Item:

Section	Page	Paragraph	Description

The undersigned requests consideration of the following:

Proposed Substitution: _____

Attached data includes product description, specifications, drawings, photographs, performance and test data adequate for evaluation of the request. Applicable portions of the data are clearly identified.

The undersigned states that the following paragraphs, unless modified on attachments, are correct:

1. The proposed substitution does not affect dimensions shown on Drawings and will not require a change in any of the Contract Documents.
2. The undersigned will pay for changes to the design, including engineering design, detailing, and construction costs caused by the request substitution which is estimated to be $_____.
3. The proposed substitution will have no adverse effect on other contractors, the construction schedule (specifically the date of substantial completion), or specified warranty requirements.
4. Maintenance and service parts will be locally available for the proposed substitution.
5. The incorporation or use of the substitute in connection with the work is not subject to payment of any license fee or royalty.

The undersigned further states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item.

Submitted by **Contractor:**		Reviewed by **Engineer:**	
Firm:		☐ Accepted as Submitted	☐ Accepted as Noted
By:		☐ Not Accepted	☐ Received too Late
Signature:		By:	
Telephone:		Title:	
Attachments:		Date:	
Comments:		Comments:	

SECTION 01 26 13
REQUESTS FOR INTERPRETATION (RFI)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes procedures for submitting Requests for Interpretation (RFI) and limitations on use of RFI to obtain interpretation and clarification.

1.2 RELATED SECTIONS

A. Section 01 25 10 – Products, Materials, Equipment, and Substitutions.

B. Section 01 33 20 – Submittal Procedures.

1.3 DEFINITIONS

A. Request for Interpretation: A document submitted to Engineer by Contractor, requesting clarification of a portion of the Contract Documents, hereinafter referred to as an RFI.

1.4 CONTRACTOR'S REQUESTS FOR INTERPRETATION (RFI)

A. Contractor's Requests for Interpretation (RFI): Should Contractor be unable to determine from the Contract Documents, the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of Work is described differently at more than one place in the Contract Documents; request that Engineer make an interpretation of the requirements of the Contract Documents to resolve such matters. Comply with procedures specified herein to make Requests for Interpretation (RFI).

B. Submission of RFI: Prepare RFI and submit electronically utilizing the Electronic Project Management System. Refer to Section 01 33 20 – Submittal Procedures.
   1. Fill in transmittal form completely, and if supplemental drawings or other information is prepared by hand, it shall be fully legible and attached with the transmittal form.
   2. The Project Management System will automatically assign each RFI a discrete, consecutive number. Include this number in the title of the RFI. For instance, Revision #1 to RFI 029 should be noted in the title as "original title name, Rev 1".
   3. Each page of the RFI and each attachment to the RFI shall bear Owner's project name, project number, date, RFI number and a descriptive title. Merge all into a single PDF document for attachment in the system.
   4. Clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed. In the RFI, indicate presumed interpretation or understanding of the requirement along with reasons for such understanding. Include proposed solutions that may be set forth to complete the Work with associated cost and schedule impact, if any.

5. Engineer will review all RFI to determine whether they are RFI within the meaning of the term. If Engineer determines that the transmittal is not an RFI, it will be returned, unreviewed as to content, for resubmittal in the proper manner.
6. Frivolous RFI or simply passing on the RFI without first vetting the RFI will be subject to reimbursement from Contractor to Owner for fees charged by Engineer and other design professionals engaged by Owner.

C. Subcontractor-Initiated and Supplier-Initiated RFI: RFI from subcontractors and material suppliers shall be submitted through, be reviewed by, and be attached to an RFI prepared, signed, and submitted by Contractor. RFI submitted directly by subcontractors or material suppliers will be returned unanswered to Contractor.
1. Review all subcontractor- and supplier-initiated RFI and take actions to resolve issues of coordination, sequencing, and layout of the Work. Coordination of the work, sequence, and layout are not the responsibility of Owner or Engineer.
2. RFI submitted to request clarification of issues related to means, methods, techniques, and sequences of construction or for establishing trade jurisdictions and scopes of subcontracts will be returned without interpretation. Such issues are solely Contractor's responsibility.

D. Requested Interpretation: Carefully study the Contract Documents to ensure that information sufficient for interpretation of requirements of the Contract Documents is not included therein. RFI that request interpretation of requirements clearly indicated in the Contract Documents will be returned without interpretation.
1. In all cases in which RFI are issued to request clarification of issues related to means, methods, techniques and sequences of construction; for example, pipe and duct routing, clearances, specific locations of Work shown diagrammatically, apparent interferences and similar items, furnish all information required for Engineer or Owner to analyze and/or understand the circumstances causing the RFI and prepare a clarification or direction as to how to proceed.
2. If information included with this type of RFI is insufficient, the RFI will be returned unanswered.

E. Unacceptable Uses for RFI: RFI shall not be used to request the following:
1. Approval of submittals (use procedure specified in Section 01 33 20 - Submittal Procedures).
2. Approval of substitutions (refer to Section 01 25 10 – Products, Materials, Equipment and Substitutions).
3. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Contract General Conditions).
4. Different methods of performing Work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Contract General Conditions).

F. Disputed Requirements: If Engineer's response to an RFI is believed to cause a change to the requirements of the Contract Documents, immediately give written notice to Engineer stating why this is believed to be true. Failure to give such written notice immediately shall waive any right to seek additional time or compensation under the Contract.

PART 2 - PRODUCTS

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 GENERAL

A. This Section defines the process whereby the Schedule of Values shall be developed and incorporated into the cost loading function of the Construction Progress Schedule as specified in Section 01 32 16 - Construction Progress Schedule. Monthly progress payment amounts shall be determined from the weekly progress updates of the scheduled activities. The schedule of values shall, as a minimum, list the value of every activity on the schedule, and shall include such additional breakdowns as required herein. The values in the Schedule of Values do not establish a commitment by either Contractor or Owner when negotiating changes to the Contract Documents.

1.2 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values to Engineer as part of the Construction Progress Schedule submittal. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through resource loading of the schedule activities, sufficient detailed breakdown shall be provided to meet this requirement. The Schedule of Values shall have a one-to-one relationship to the work activities of the Construction Schedule even though additional detailed breakdowns for the Schedule of Values may be required. Engineer will be the sole judge of acceptable breakdowns, details, and descriptions of the values established. If, in the opinion of Engineer, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified.

B. The minimum details of a breakdown of the major Work components are indicated below. Provide greater detail when directed by Engineer.
   1. Mobilization: Six percent of Contract Price.
   2. Construction Progress Schedule shall be broken down by initial submittal and monthly updates.
   3. Break down Civil site Work into roadways, individual drainage systems, individual flood control structures, site concrete, soil cement, paving, excavation cut and fill, clearing and grubbing and any other items determined to be necessary for the establishment of pay and activity items.
   4. Break down concrete structures into excavation, subgrade preparation, and appurtenant pre-foundation Work, concrete foundation construction, slabs on grade, walls, columns, suspended slabs, etc. (provide sufficient breakdown to accommodate necessary schedule detail.
   5. Break down mechanical Work within each structure to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.
   6. Break down electrical and Instrumentation Work within each structure to identify individual systems, equipment installation by equipment name and number, and equipment testing and checkout.
      a. Break down fiber optic conduit Work into conduit installation and pullboxes.

b. Break down cathodic protection Work by ribbon anode and appurtenances, test station types, rectifiers, and insulating flanges.

7. Break down protective coating Work by system. Where specific coating Work may be critical to performing the Work to meet milestone and schedule dates, such Work shall be included as individual pay and activity items.
8. Break down utility relocation Work into individual pipelines running from and to termination points. Each pipeline shall be an individual pay item unless otherwise allowed by the Engineer.
9. Break down pipeline Work into individual items including pipe, specials, and other pipe materials, excavation, pipe installation, joint welding (including testing), joint protection, CLSM, pipe zone, backfill, surface restoration, and hydrostatic testing; pipeline crossings; pipeline interconnections; and any other items determined necessary for the establishment and pay and schedule activities.
10. Break down in-field pipeline lining by stations between access manholes.
11. Provide breakdown for disinfection, testing, and commissioning of pipelines and reservoirs.
12. Operations and Maintenance (O & M) Manuals shall be broken down into one O & M Manual per piece of equipment or one O & M Manual per group of like-kind pieces of equipment for establishment of pay and schedule activity items.
13. Break down all other Work not specifically included in the above items as necessary for establishment of pay and schedule activity items.

C. After submittal of the Schedule of Values, as part of the Construction Progress Schedule submittal, meet with Engineer and jointly review the schedules. Review the value allocations and extent of detail to determine any necessary adjustments to the values and to determine if sufficient detail has been proposed. Make adjustments deemed necessary to the value allocation or level of detail and submit a revised detailed Schedule of Values within 5 workdays from receipt of comments from Engineer.

1.3 CROSS REFERENCE LISTING

A. To assist in the correlation of the Schedule of Values and the Construction Progress Schedule, provide a cross referenced listing in two parts as follows:
1. In the first part, list each scheduled activity with the breakdown of the respective valued items making up the total cost of the activity.
2. In the second part, list the valued items with the respective scheduled activity or activities that make up the total cost indicates.
3. Where several schedule items make up the total cost for a valued item (shown in the Schedule of Values), the total cost for each scheduled item shall be indicated.

B. Update and submit the listings in conjunction with the monthly Construction Progress Schedule updates.

C. Incorporate approved Change Orders reflected in the Construction Progress Schedule into the Schedule of Values as a single unit identified by the Change Order number.

1.4 CHANGES TO SCHEDULE OF VALUES

A. Assign values, approved by Engineer, for changes to the Construction Schedule which add activities not included in the original Construction Schedule but are included in the original

Work (schedule omissions). Reduce other activity values to provide equal value adjustment increases for added activities as approved by Engineer.

B. If Contractor and Engineer agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made. Engineer may direct changes to the schedule when inequities are discovered and agreement on the reallocation cannot be achieved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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SECTION 01 31 30
SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor's safety program shall conform to the requirements specified in the General Conditions and Supplementary Conditions.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring, or construction activities could be considered a potential hazard to people.

B. A "Designated Safety Officer" or "Safety Representative" for the purposes of this Contract, means anyone who can identify the existing and predictable hazards in the areas surrounding a construction project or those working conditions at a construction project that are unsanitary or dangerous to employees. A "Designated Safety Officer" has the authority to make prompt corrective measures to eliminate those hazards.

1.3 SUBMITTALS

A. Demonstrate compliance action with the stipulations of Utah Occupational Safety and Health Administration (OSHA), Mine Safety and Health Administration (MSHA), and other applicable local, state, and federal safety requirements by submitting to Engineer a copy of all safety plans, programs, and permits. Such plans and programs shall include, but are not limited to:
   1. Hazard Analysis Prior to Major Activities (job safety analysis, JSA).
   2. Emergency Plan.
   3. Rigging and Hoisting Plans.
   4. Excavation and Trenching Plans.
   5. Respiratory Protection Program.
   6. Fire Protection Plan.
   7. Confined Space Entry Program.
   8. Explosives Handling and Storage.
   9. Confined Space Entry Program.
   10. Electrical Safety (drop cords, temporary power, GFCI's, etc.)
   11. Lock Out/Tag Out.
   12. Fall Protection.
   13. Heavy Equipment Operations.
   14. Burning and Welding Operations.
   15. Training Plan.
   16. Tunneling/Underground/Jacking/Boring Operations.
   17. Project Site Rules and Regulations (hazard protection plan).
   18. Material Handling (storage-disposal).
   19. Fuel Storage and Refueling.
   20. Hazard Communication/Right to Know.

21. Subcontractor Requirements.
22. Ventilation.
23. Personal Protective Equipment (hearing, eye, face).
24. Power Transmission/Distribution (temporary and/or permanent).
25. Traffic Control.
26. Environmental Controls.
27. Safety Meetings.
28. Spill Control Plan.
29. First Aid Facilities.

B. Engineer's receipt of safety plans or programs will not relieve Contractor in any way from the full and complete responsibility for safety and training of its personnel, and the onsite personnel of Owner, Engineer, and other visitors to areas of active construction areas. Daily, inform Engineer of changes to the boundaries of the active construction areas.

C. Be responsible for safety training all personnel who will have access to the active construction areas to meet state, federal, local and Contractor requirements. Maintain reasonable, regularly scheduled training sessions in mutually accessible facilities through entire Contract. Training costs for all personnel and visitors, except those costs associated with training personnel of Contractor, subcontractors, suppliers, and visitors will be considered incidental to other lump-sum portions of the Work and no additional compensation for such training will be provided.

D. Safety Program Requirements:
   1. Safety Representative Requirements:
      a. Assign a full-time Safety Representative as defined in the General Conditions of the Contract.
      b. The Safety Representative's duties and responsibilities will be hazard recognition, accidents prevention, new employee orientation (including subcontractors), and the maintaining and supervising of safety precautions and program. This person shall have no other duties. The Safety Representative or a qualified and approved deputy shall be onsite at all times while Work is ongoing.
      c. Qualifications of the Safety Representative and assigned deputies shall be submitted to Engineer for review. Acceptance of their qualifications by Engineer is required prior to the start of any activity on the Project. The Safety Representative will, as a minimum, meet the requirements of regulations for the Utah Occupational Safety & Health Enforcement Program.
   2. Hazardous Substances:
      a. Provide Engineer with a list of all hazardous substances anticipated to be brought on-site.
      b. Maintain on site Material Safety Data Sheets (MSDS) prior to arrival of any hazardous substances on the Project.
      c. Use storage area(s) as outlined in the spill control plan.
   3. Job Safety Analysis (JSA):
      a. Outline the sequence of the Work, equipment to be used, identify hazards that may exist or may be created and what procedures and/or safety equipment will be used to eliminate or reduce these hazards. A Scope of Work JSA shall be prepared and provided to the Engineer prior to the start of unusual,

hazardous, or have risk potential activities on the Project. The name of the competent person assigned to this activity will be included on the JSA.

b. Complete a JSA for any activity, which may be of an unusual nature or involves unique hazards.

4. Reports

a. Provide to Engineer copies of Contractor's and subcontractor's:

1) First aid, recordable, lost time and near miss, monthly logs.
2) OSHA 200 injury log (annually).
3) Safety meeting reports and topics (weekly).
4) List of competent persons as required by OSHA and the Project Health and Safety Manual for each required task and their qualification as such.
5) Injury and accident reports will be submitted to Engineer within 24 hours of any incident. **Immediate** notification to Engineer of an accident is **required**. Full cooperation with Engineer in accident investigation is required.

b. Conduct weekly safety inspections. Corrective actions shall be taken within 24 hours to address all deficiencies identified during inspections. Deficiency reports shall be prepared and submitted to Engineer within 48 hours indicating corrective actions taken. Failure to comply with required corrective measures identified in the safety inspection will result in the delayed signing of the monthly application for progress payment by Engineer.

c. Provide Engineer with a report of any periodic audit of Contractor's safety performance and/or records.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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SECTION 01 32 00
ELECTRONIC PROJECT MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements to use Engineer's web-based Electronic Project Management system (EPM).

1.2 RELATED SECTIONS

A. Section 01 33 20 – Submittal Procedures.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Contractor is required to use Engineer's (EPM) system, VPO, by The Simplex Group, Inc. for electronic construction management document control and communications between the Owner, Engineer, other project-related consultants, and Contractor. Having the system capability in place onsite is a condition precedent to processing the first payment request.

B. User Access Limitations:
   1. Engineer will control access to the EPM system by allowing access and assigning user profiles to accepted personnel.
   2. User profiles will define levels of access into the system, determine assigned function-based authorizations, and user privileges.
   3. Subcontractors and suppliers will be given access to the EPM system by and through Engineer. Entry of information exchanged and transferred between Contractor and subcontractors and suppliers will be the responsibility of Contractor.

C. Ownership and Management of Data:
   1. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the EPM system) by all parties will be owned by Engineer, but maintained and operated collaboratively by members of the Project Team.

D. Automated System Notification and Audit Log Tracking:
   1. Review comments made (or lack thereof) by Engineer or Owner on Contractor submitted documentation does not relieve Contractor from compliance with requirements of the Contract Documents.
   2. Contractor is responsible for managing, tracking, and documenting Work to comply with the requirements of the Contract Documents.
   3. Engineer's or Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of Contractor's submitted information.

E. Computer Requirements:
   1. Use computer hardware and software that meets the requirements of the EPM system. As recommendations are modified by the EPM system's authors, upgrade hardware and software system(s) to meet or exceed the recommendations.

Upgrading Contractor's computer systems will not be justification for a cost or time modification to the Contract.

2. Ensure that connectivity to the EPM system is accomplished through DSL, cable, T-1, fiber optic, or wireless communications systems. Minimum bandwidth requirements for using the system are 128 kb/s. It is recommended that a faster connection be used when uploading pictures, videos, and data files into the system.
3. Before upgrading any computer software or hardware, verify that such upgrades are compatible with the latest version of the EPM system at no additional cost to the Engineer or Owner.
4. Utilize the full version of Adobe Acrobat (or equal) so that Portable Document Format (PDF) submittals can be assembled into single files and organized appropriately. Obtaining and utilizing this software will be at no additional cost to Engineer or Owner.

F. User Connectivity:
1. Provide a list of Contractor's key EPM personnel for the Engineer's acceptance.
2. Contractor is responsible for identifying personnel to be added or removed from the system.
3. Engineer reserves the right to perform a security check on all potential users.
4. Contractor will be allowed to add additional personnel and subcontractors to the EPM system.

G. Training:
1. Engineer will provide a single training session to assist Contractor in the use of the EPM system. Time cost of the training session will be borne by the attendees.
2. Make applicable staff available for an initial 2-hour training session to be scheduled at a mutually agreeable time and place within 14 days of Notice to Proceed.
3. Training may consist of web-based seminar(s) in conjunction with a conference call.
4. Contractor may request Engineer to provide additional training and technical support for use of the EPM system. Time cost of the training session will again be borne by the attendees.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Web Based EPM User's List:
1. At the preconstruction meeting, provide a list of key EPM personnel, utilizing form at the end of this Section. Engineer will use this information for no other purpose than to establish the necessary accounts for use by each individual.
2. Specifically identify Contractor's administrator on the list.
3. Personnel shall have sufficient computer skills required to access the Internet, log on to the EPM system, and utilize the system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SYSTEM UTILIZATION

A. Utilize the EPM system to transmit all documents and for all information management required by the Contract Documents.

B. When transmitting electronic documents, use PDF format unless specifically instructed to upload native format document files. When creating PDF files, utilize the native software to produce the most efficient files directly and avoid optically scanning hard copies.

C. Unacceptable documents include faxed and/or hand-written documentation of RFI, sketches, and inspection requests/reports.
   1. Contractor is responsible for data entry via the EPM system in the generation of Project related documentation.
   2. Contractor is responsible for preparing electronic sketches and drawings necessary for the electronic submittal of necessary information related to general questions and formal RFI.
   3. Provide field personnel with the necessary computer equipment to allow entering documentation electronically.

3.2 SYSTEM CONTENTS

A. The EPM system will contain the following information available to Contractor and the Project team in general.

B. Administrative Documents
   1. Submit all general correspondence and pre-construction submittals using the EPM system. Examples include:
      a. Permits
      b. Requests for Substitution per Section 01 25 10 – Products, Materials, Equipment, and Substitutions.
      c. Transmit Construction Schedules in both the native software format and as a PDF file in the format specified herein.
      d. General information requests.
      e. Contractor's Quality Control Plan and associated reports.
      f. Meeting minutes from Project meetings.

C. Requests for Interpretation (RFI): Submit RFI and maintain logs through the EPM system and in accordance with Section 01 26 13 – Requests for Interpretation (RFI).

D. Compliance Submittals
   1. Submit material test reports, inspection requests and reports, certificates, and manufacturer field reports through the EPM system as PDF files.

E. Project Photographs and Videos.
   1. Include dates on photographs and videos.
   2. Use JPEG or JPEG2000 format for photos

3. Use WMV file format for videos.

F. Inspection requests and reports.

G. Record and Closeout Submittals
1. Submit operation and maintenance data and closeout submittals through the EPM system as PDF documents during the approval and review of such, as specified in Section 01 33 20 – Submittal Procedures. Hard copy submittal is required only for final approved documents.

H. Financial Submittals
1. Submit required Schedule of Values, Pay Estimates, and Change Request Proposals through the EPM system.

3.3 OFFICIAL RECORD

A. The documentation and records maintained in the EPM system will be the "Official Records" for the Project. This documentation shall be the records for adjudication of all Project disputes.

END OF SECTION

EPM System User List

Name	Project Role	E-mail Address	Company	Primary Phone	Address	City	State	Zip Code

Attach additional pages as needed

SECTION 01 32 21
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

A. The project management scheduling tool, "Critical Path Method", commonly called CPM, shall be employed for the planning and scheduling of all Work required under the Contract Documents. Because preparation, submittal, acceptance and updating of a CPM Construction Schedule is considered of vital importance to the success of the Project for both Owner and Contractor, Owner agrees to pay for a completed Construction Progress Schedule and for acceptable updates thereto, as described in Section 01 20 00 - Measurement and Payment.

B. In addition to the scheduling aspect under the CPM method, the Construction Progress Schedule shall show an "S" curve for scheduled dollar expenditures versus time and a progress curve showing physical progress expected over time. Resource curves for manpower and equipment shall also be provided with the Construction Progress Schedule and monthly updates.

C. In preparing the baseline schedule and monthly updates, consult with all key subcontractors and suppliers to assure concurrence with the feasibility and achievability of planned start dates, sequencing, durations, and completion dates.

1.2 RELATED SECTIONS

A. Section 01 20 00 – Measurement and Payment

1.3 QUALIFICATIONS

A. Demonstrate competence in the use of CPM scheduling through the submission of a fully compliant CPM Construction Schedule with the initial CPM submission. Upon failure to so demonstrate competence in the CPM scheduling, Engineer may direct Contractor to employ the services of a scheduler that can demonstrate competence. Comply with such directive.

B. The Contractor shall use the services of scheduler who has verifiable training and credentials in preparing and maintaining a computerized CPM Construction Schedule using Primavera software as specified herein. The scheduler must qualify within the planning period.
   1. Required Experience: Performed CPM scheduling on at least 2 completed construction projects of value at least 75 percent as large as this one and having at least 75 percent as many schedule items as this one. Scheduling of both projects shall have been done using Primavera software (P3 for Windows) or equal.
   2. Submit the following:
      a. Descriptions of at least 2 projects of the value and complexity above.
      b. Copy of a CPM schedule from one of the previous projects.
      c. Names and telephone numbers of facility owner representative, design engineer, and Engineer for each project.
   3. Evidence supporting the above qualifications shall be submitted to the Engineer.

1.4 CPM CONSTRUCTION SCHEDULE SUBMITTAL PROCEDURES

A. The Contractor shall submit the following:
   1. A CPM time-scaled logic network, computer generated using Primavera P3 scheduling software.
   2. Computerized Tabular Reports.
      a. Activity sort by activity ID, organized by facility or area.
      b. Activity sort by early start, organized by facility or area.
      c. Activity sort by float, organized by facility or area.
      d. Predecessor/successor listing.
      e. Activity code dictionary.
      f. Resource code dictionary.
   3. Basis of schedule narrative describing the logic and reasoning of the schedule.
   4. Resource value allocation by activity.
   5. Breakdown of specific cost amount for each component of multi-component activities in the CPM Schedule in spreadsheet format (using Microsoft Excel) showing component unit quantities as well as costs. Such breakdown, when accepted by Engineer shall constitute the Schedule of Values for the Project.
   6. Compact Disk (CD-ROM) copy of entire schedule, resources, and spreadsheet.
   7. A look-ahead schedule for the weekly progress meetings in a format approved by Engineer.

B. CPM Standards
   1. Definition: CPM, as required by this Section, shall comply with the standards outlined in the Associated General Contractors' publication, "Construction Planning and Scheduling" unless specifically changed by this Section.
   2. CPM Construction Schedule: The Contractor's CPM Construction Progress Schedule shall include a graphic time scaled logic network, computerized tabular reports and resource loading as described below. To be acceptable, the schedule must demonstrate the following:
      a. A logical succession of Work from start to finish. This logical succession, when accepted, is the Contractor's work plan.
      b. Clear definition of each activity including cost, manpower, equipment, and material quantities as resources. The assigned dollar value (cost loading) of each activity shall cumulatively equal the Contract Price.
      c. Proper interfacing of related activities including submittals, major material and equipment deliveries, procurement, required permits and other constraints such as equipment or manpower/crew availability. Submittal dates must include review periods and permit schedules must include agency review and issue dates. The narrative shall explain the rationale for all constraints, lags and unusual relationships.
      d. Agreement with the interim milestones, schedule coordination requirements, and completion dates indicated in the Contract Documents.
   3. CPM Graphic Logic Network
      a. The CPM graphic logic network or diagram shall be in the form of a time-scaled diagram of the customary precedence diagram and may be divided into several separate pages with suitable notation relating the interface points among the pages. Individual pages shall not exceed 24-inch by 36-inch. Notation on each activity line shall include activity descriptions, total float, and durations as a minimum.

b. All construction activities and procurement shall be indicated in a time-scaled format, and a calendar shall be shown on all sheets along the entire sheet length. Each activity shall be plotted so the beginning and completion dates of said activity can be determined graphically by comparison with the calendar scale. A legend shall be included clearly distinguishing between critical and non-critical path activities and progress to date.

4. Duration: The duration indicated for each activity shall be in units of whole working days and shall represent the single best time considering the scope of the Work and resources planned for the activity including time for holidays and inclement weather. The calendar for the network shall be in calendar days. Except for certain non-labor activities, such as curing concrete or delivering materials, activity durations shall not exceed 14 Days, be less than one Day, nor exceed $50,000 in value unless otherwise accepted by Engineer.
5. Computerized Tabular Reports: Reports shall include the following for each activity depicted in the schedule.
   a. Activity ID
   b. Activity Description
   c. Duration (original and remaining)
   d. Early Start Date
   e. Early Finish Date
   f. Total Float
   g. Percent Complete
   h. Activity Cost and Resources
   i. Actual Start Date
   j. Actual Finish Date
6. Project Information: Each report shall be prefaced with the following summary data.
   a. Project Name
   b. Contractor
   c. Type of Tabulation (Initial or Updated)
   d. Project Duration
   e. Project Scheduled Completion Date
   f. Projected Completion Date

C. Time of Submittals
1. Submit the items listed in paragraph 1.3.A above, within 45 days of the Notice to Proceed for Engineer to review. Engineer will review the schedule submittals within 15 Days and state acceptance or rejection of the proposed CPM Construction Progress Schedule.
2. Within 15 Days after receipt of Engineer's review comments, revise and resubmit the CPM Construction Progress Schedule as required. The revised CPM Construction Progress Schedule will be reviewed and accepted or rejected by Engineer within 10 Days after receipt.
3. Submit a CPM Construction Progress Schedule update, as provided in Paragraph 1.5 of this Section along with each Application for Payment, or monthly, whichever is shorter.

D. Acceptance
1. The finalized CPM Construction Schedule will be acceptable to Engineer when it provides an orderly progression of the Work from Notice to Proceed to Final Completion in accordance with the Contract requirements, adequately defines the

Contractor's Work plan, provides a workable arrangement for processing submittals in accordance with the requirements, and properly allocates resource values for manpower, major materials, equipment and costs to each activity (free of unbalances in resources) as determined by Engineer. Manpower may be represented as composite crews in the CPM Construction Progress Schedule. The network diagram and tabular reports when accepted by Engineer shall constitute the CPM Construction Progress Schedule until revised or updated as provided herein. When the CPM Construction Schedule has been accepted, submit to Engineer three (3) copies of the CPM graphic logic network, three (3) copies of a computerized, tabular report in which the activities have been sequenced by activity numbers, three (3) copies of a computerized, tabular report in which activities have been sequenced by early starting date, and three (3) copies of a computerized, tabular report in which activities have been sequenced by total float.

2. Owner's review and acceptance of the CPM Construction Progress Schedule is for conformance to the requirements of the Contract Documents only. Review and acceptance by Owner do not relieve Contractor of any of its responsibility whatsoever for the accuracy or feasibility of the CPM Construction Progress Schedule, or of Contractor's ability to meet interim milestone dates and the Contract completion date, nor does such review and acceptance expressly or impliedly warrant, acknowledge, or admit the reasonableness of the logic, durations, and resource value loading of the CPM Construction Progress Schedule.

1.5 CHANGE OF CONTRACT TIMES

A. If a change of Contract Times is made pursuant to Article 12 of the General Conditions, the approved change shall be reflected in the next schedule update as an integrated fragment for the changed work item(s).

1.6 SCHEDULE UPDATES

A. The CPM Construction Schedule shall be updated to reflect the as-built conditions of the Work and to accurately forecast the status of incomplete activities. Progress reports shall be given at each weekly progress meeting, stating actual percent earned versus percent planned. CPM Construction Progress Schedule updates shall be submitted to Engineer with each payment request. Updates shall include approved changes in the Work and shall accurately depict the status and sequence of all activities.

B. The updated CPM Construction Schedule shall be submitted in the form, sequence, and number of copies requested for the initial schedule.

C. The Engineer will review each CPM Construction Progress Schedule update and comments within seven (7) days of the submittal. Revise and resubmit the schedule within five (5) days of receipt of comments from Engineer. Engineer will review the re-submittal within five (5) days and provide comments if the schedule update is still unacceptable. Revise and resubmit the schedule within five (5) days of receipt of comments from Engineer.

1.7 PROGRESS MEETINGS AND LOOK-AHEAD SCHEDULES

A. For the weekly progress meetings, submit a look-ahead schedule. This schedule will cover four weeks: the immediate past week, the current week, and the forthcoming two weeks. This

schedule will include all activities, which are complete, started, are incomplete or underway, or scheduled to be worked during this four-week time frame. This schedule shall list all activities from the accepted CPM Construction Progress Schedule, which are complete, are scheduled for Work during the period, are currently planned to be worked, even if out of sequence, and Work which is unfinished but scheduled to be finished. Actual start and completion dates shall be provided for the Work that has been completed the prior week; forecast early start and early finish dates shall be provided for the Work that is in-process or upcoming.

B. Each activity noted above shall be identified by activity number corresponding to the accepted CPM Construction Progress Schedule and detailed description of the activity.

C. Deliver the look-ahead schedule to Engineer 24 hours prior to the weekly progress meeting in a format approved by Engineer.

D. Provide tabular reports for manpower and equipment resources with each look-ahead schedule.

1.8 CPM CONSTRUCTION SCHEDULE REVISIONS

A. If Engineer directs, propose revisions to the CPM Construction Progress Schedule upon occurrence of any of the following instances:
   1. The actual physical progress of the Work falls more than five percent (5%) behind the accepted CPM Construction Progress Schedule, as demonstrated by comparison to the accepted CPM Construction Progress Schedule updates or as determined by Engineer if a current accepted CPM Construction Progress Schedule does not exist.
   2. Engineer considers milestone or completion dates to be in jeopardy because of "activities behind schedule". "Activities behind schedule" are all activities that have not or cannot be started or completed by the dates shown in the CPM Construction Progress Schedule, regardless of the existence of positive float on the activity.
   3. A Change Order has been issued that changes, adds, or deletes scheduled activities or affects the time for completion of scheduled activities.

B. When the instances requiring revision to the CPM Construction Progress Schedule occur, submit the proposed revised CPM Construction Progress Schedule within ten (10) working days after receiving direction from Engineer to provide such Schedule. No additional payment will be made to Contractor for preparation and submittal of proposed revised CPM Construction Progress Schedules. However, if Engineer accepts the proposed revised CPM Construction Progress Schedule, it shall replace and supersede all previous CPM Construction Progress Schedules and substitute for the next CPM Construction Progress Schedule update that would otherwise be required and shall qualify for payment of the CPM Construction Schedule update. Failure to submit required CPM Construction Progress Schedule revision proposals in a form acceptable to Engineer shall result in forfeiture and deduction of payments for CPM Construction Schedule updates.

C. Revisions to the CPM Construction Progress Schedule shall comply with all of the same requirements applicable to the original schedule.

1.9 SCHEDULE RECOVERY

A. If a revised CPM Construction Progress Schedule accepted by Engineer requires additional manpower, equipment, hours of work or work shifts, or to accelerate procurement of materials or equipment, or any combination thereof, as schedule recovery measures to meet Contract milestones, implement such schedule recovery measures without additional charge to Owner.

1.10 TIME IMPACT ANALYSIS REQUIREMENT

A. When delays are experienced and a time extension is requested, submit to Engineer a written time impact analysis illustrating the influence of all changes or all delays on the current Project completion date. The time impact analysis shall be constructed on an as-built schedule analysis approach. The as-built schedule that is created will incorporate all actual start and finish dates, actual durations of activities, actual sequences of construction (referred to as the as-built logic) current as of the time the time impact analysis is performed. This time impact analysis shall incorporate all delays (including Owner, Contractor and third-party delays without exception) in the time frame that they actually occurred with actual logic ties. The as-built schedule data shall be obtained from the most recent approved monthly schedule update. The as-built schedule shall be created as an early start schedule with the actual start and finish dates coinciding with the early start and finish dates from the most recent approved monthly schedule update. The as-built schedule shall show the original activity durations equal to the actual duration and the actual logic driving all activities. This as-built schedule will be validated by Engineer. All requests for time extension shall be based upon an analysis of this as-built schedule. The critical path will be established and all Owner-caused delays on the critical path will be identified. The time extension will be based solely upon the cumulative duration of all Owner and third party caused delays, which are on the critical path. Any time extensions to the Project's interim milestone dates, if any, shall be non-compensable time extensions only.

B. Each time impact analysis shall demonstrate the estimated time impact based on the events of delay, the status of construction at that point in time, and the event time computation of all activities affected by the change or delay. The event times used in the analysis shall be those included in the latest approved update of the project schedule, in effect at the time the change or delay was encountered.

1.11 EARLY COMPLETION SCHEDULES

A. Early completion schedules are generally not acceptable to Owner but may be accepted as a convenience to Contractor and under the following conditions.
   1. Submit a specific written request outlining the specific reasons for using the early completion schedule.
   2. Acknowledge and agree in writing that the proposed reduction in time represents Project time already paid for by Owner as part of the Bid Price, and available to both Contractor and Owner for the mitigation of impacts to the Project from any source. Contractor is not entitled to any increase in Contract Price for failure to achieve the early completion and waives all claim to same.
   3. Early completion schedules shall not be based upon or rely on expedited approvals by Owner or Engineer.
   4. Early completion schedules must meet all other requirements of the Contract.

B. Revise early completion schedules, which have activities behind schedule, when and as requested by Engineer.

C. When completion occurs early, any remaining future schedule updates shall be considered complete and earned and shall be paid as part of the final payment.

1.12 BASIS OF SCHEDULE NARRATIVES

A. Furnish a basis of schedule narrative to Engineer with each Application for Payment. If the Work falls behind schedule, submit additional narrative at such intervals as Engineer may request.

B. In each narrative, include a summary of progress for the month, description of any current and anticipated delaying factors, a variance analysis for varying activities, impacts on the construction schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to Engineer, must be substantiated with satisfactory evidence.

C. In each narrative, include a list of the activities completed during the preceding month and a list of the activities started during the month but not yet completed.

1.13 FLOAT

A. Total Float is the number of days by which a part of the Work in the CPM Construction Progress Schedule may be delayed from its early start and finish dates without necessarily extending the Contract Times. The difference in time between the Project's scheduled early completion date, as submitted, and the required Contract completion date shall be considered as float, slack time, or contingency. Float, slack time, or contingency within the schedule, and total float within the overall schedule, is not for the exclusive use of either Owner or Contractor, but is jointly owned by both parties and is a resource available to and shared by both parties as needed to meet Contract milestones and the Contract completion date.

B. Do not sequester shared float through such strategies as extending activity duration estimates to consume available float, using preferential logic, using extensive crew/resource sequencing, etc. Since float time within the schedule is jointly owned, no time extensions will be granted nor delay damages paid until a delay occurs which extends the work beyond the Contract completion date. Since float time within the Construction Progress Schedule is jointly owned, it is acknowledged that Owner-caused delays on the project may be offset by Owner-caused time savings (i.e. critical path submittals returned in less time than allowed by the Contract, approval of substitution requests which result in a savings of time to the Contractor, etc.). In such an event, no time extension or delay damages will be granted until all Owner-caused time savings are exceeded, and the Contract completion date is also exceeded.

1.14 PAYMENTS

A. Payment for CPM Construction Schedule shall be as described in Section 01 20 00 - Measurement and Payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 20
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for submittals required in performance of the Work, including shop drawings, schedules, surveys, reports, samples, plans, lists, drawings, documents, warranties, certifications, findings, programs, manuals, data sheets, or any other item of information required by the Contract Documents to be submitted in accomplishing the Work.

1.2 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval for inclusion in the Work.

B. Deferred Submittal: Information in accordance with the applicable Building Code, submitted by Contractor for portions of the design that are to be submitted to permitting agency after the time of permit application and prior to installation of that portion of Work. Deferred Submittals must include Engineer's review documentation stating that submittal has been found to be in general conformance with overall Project design.

C. Informational Submittal: Information submitted by Contractor to represent compliance with Contract Requirements included in the Work, but which are not part of the Work itself. Informational Submittals must be submitted to Engineer for information and for determination that submitted information is in accordance with Contract requirements.

D. Shop Drawing: The term "Shop Drawing" as used herein shall be understood to include detail design calculations, shop drawings, fabrication and installation drawings, erection drawings, lists, graphs, and similar items.

E. PDF: Abbreviation for "Portable Document Format", used for transmittal of electronic documents.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Whenever submittals are required hereunder, transmit all documents to Engineer in electronic format, via web-based construction management software as specified in Section 00 73 00 – Supplementary Conditions. Contact information for the web-based project management software is as follows:

Josh Curtis, P.E.
Bowen Collins & Associates
154 E 14075 S
Draper, UT 84020
Email: jcurtis@bowencollins.com
Office: (801) 495-2224

B. Be responsible for the accuracy, completeness, and coordination of all submittals. Do not delegate this responsibility in whole or in part to any subcontractor. Submittals may be prepared by Contractor, subcontractor, or supplier, but Contractor shall ascertain that each submittal meets the requirements of the Contract and the Project. Ensure that there is no conflict with other submittals and notify Engineer in each case where a submittal may affect the work of another contractor or Owner.

C. Coordination
   1. Ensure coordination of submittals of related crafts and subcontractors.
   2. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently ahead of performance of related construction activities to avoid delay.
   3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
   4. Carefully review all submittals prior to submission. Sign and date each transmittal with a direct statement acknowledging that the equipment or material in the submittal meets all the requirements specified or shown in the Contract Documents without exception. No consideration or review of any submittals will be made for any items, which have not been so certified. All non-certified submittals will be returned without action taken, and any delays caused thereby shall be the total responsibility of Contractor. Submittals which cannot bear this certification because they contain an exception or deviation to the Contract Documents shall be so noted in the electronic transmittal and shall only be submitted in accordance with Section 01 25 10 – Products, Materials, Equipment and Substitutions.

D. Processing: Allow sufficient review time so that installation will not be delayed because of the time required to process submittals, including time for resubmittals.
   1. Except as may otherwise be indicated herein, Engineer will return each submittal, with comments noted thereon, within 14 calendar days following receipt by Engineer.
   2. For resubmittal, Engineer will be allowed the same review period as for the original submittal.
   3. It is considered reasonable that Contractor will make a complete and acceptable submittal to Engineer by the second submission of an item. Owner reserves the right to withhold monies due Contractor to cover additional costs of any review beyond the second submittal.
   4. Allow additional time if processing must be delayed for coordination with subsequent submittals. Engineer will promptly advise Contractor when a submittal being processed must be delayed for coordination.
   5. If an intermediate submittal is necessary, process the same as the initial submittal.
   6. No extension of Contract Time will be authorized resulting from non-compliant submittals or failure to transmit submittals to Engineer sufficiently in advance of the Work to permit processing.
   7. If an incomplete submittal is made, the submittal may be returned without review. A complete submittal will contain sufficient data to demonstrate that the items contained therein comply with the Contract Documents, meet the minimum requirements for submittals as described in the Contract Documents, and include all corrections as required from previous submittals.

E. Submittal Schedule
   1. Within 30 days of the Notice to Proceed, submit a complete list of anticipated submittals, which includes Specification and Drawing references.
      a. Coordinate submittal schedule with any subcontracts, schedule of values, the list of products, and Contractor's construction schedule.
      b. Prepare schedule in chronological order.
      c. Update the list with "early start" submittal dates within 15 days of submittal of the Construction Progress Schedule.
      d. Update submittal dates whenever the schedule is updated and include any additional submittals identified after the initial submittal in the updates.

F. Unsolicited Submittals: Unsolicited submittals may be returned without being reviewed.

G. Changes in Work: Changes in the Work will not be authorized by submittal review actions. No review action, implicit or explicit, will be interpreted to authorize changes in the Work. Changes will only be authorized by separate written direction from Owner, in accordance with the General Conditions.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data:
   1. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Where Product Data must be specially prepared because standard published data is not suitable for use, submit as "Shop Drawings."
   2. Mark each data sheet to show applicable choices and options pertinent to the Project. Where printed Product Data includes information on several products, some of which are not required for the Project, mark the data sheets to indicate the applicable information. Include the following information:
      a. Manufacturer's printed recommendations.
      b. Compliance with recognized trade association standards.
      c. Compliance with recognized testing agency standards.
      d. Application of testing agency labels and seals.
      e. Notation of dimensions verified by field measurement.
      f. Notation of coordination requirements.
   3. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

B. Samples
   1. Whenever in the Specifications, samples are required, submit not less than 3 samples of each item or material to Engineer for acceptance at no additional cost to Owner.
   2. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
   3. Submit samples for acceptance, a minimum of 21 days prior to ordering such material for delivery to the jobsite. Submit in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work.

4. Transmit a submittal as a single PDF document with list of samples via the web-based project management software.
5. Individually and indelibly label and tag all samples to indicate all specified physical characteristics and Manufacturer's name for identification. Upon receiving acceptance by Engineer, one set of the samples will be stamped, dated, and returned. One set of samples will be retained by Engineer, and one set of samples will remain at the Project site until completion of the Work.
6. Unless indicated otherwise, all colors and textures of specified items presented in sample submittals shall be from the manufacturer's standard colors and standard materials, products, or equipment lines. If the samples represent non-standard colors, materials, products, or equipment lines and their selection will require an increase in Contract time or Price, clearly indicate this information in the submittal.

C. Shop Drawings
1. Wherever called for in the Contract Documents, or where required by Engineer, transmit an electronic Shop Drawing Submittal to Engineer for review, using the web-based project management software. Whenever required to submit design calculations as part of a Submittal, such calculations shall bear the signature and seal of a professional engineer registered in the appropriate discipline in the state of Utah unless otherwise directed.
2. Organization
    a. Prepare a single shop drawing submittal for each item or class of material or equipment for which submittal is required. At a minimum, separate submittals are required for different Specification Sections except as follows. A single submittal covering multiple sections will not be accepted unless the primary specification references other sections for components. Example: If a pump section references other sections for the motor, protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be accepted; a single submittal covering vertical turbine pumps and horizontal split case pumps would not be acceptable.
    b. Index the components for the submittal and reference the specification sections and paragraph numbers for all components in the description field of the electronic submittal. Relate the submittal components to drawing number, detail number, schedule title, or room number and building name, as applicable.
    c. Unless indicated otherwise, terminology and equipment names and numbers used in submittals shall match the Contract Documents.
    d. Engineer will assign a single review action to each submittal, which action shall pertain to every part of the submittal as a whole.
    e. Disorganized submittals, which do not meet the requirements specified herein will be returned without review.
3. Format
    a. Assemble submittals into a single PDF file for each transmittal. Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on PDF sheets at least 8-1/2" x 11" and no larger than 36" X 48"
    b. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with all pertinent data, capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Present sufficient level of detail for assessment of compliance with the Contract Documents.

c. Assign each Submittal a unique number, including the specification section under which it is submitted. Number all submittals sequentially within the applicable specification section. Original submittals will be assigned a numeric submittal number. Resubmittals shall be numbered with a revision number in addition to the original submittal number.

D. Engineer's Action

1. If submittal is returned to Contractor marked "NO ACTION TAKEN", indicating that the submittal has been received and is being retained for record-keeping purposes. Formal revision and resubmission of said submittal will not be required.
2. If submittal is returned to Contractor marked "NO EXCEPTIONS TAKEN", formal revision and resubmission of said Submittal will not be required and construction may proceed.
3. If submittal is returned to the Contractor marked "MAKE CORRECTIONS NOTED", formal revision and resubmission of said submittal will not be required but construction must proceed according to the review comments included with the submittal.
4. If submittal is returned marked "REVISE AND RESUBMIT", revise said submittal and resubmit. Construction may not proceed.
5. If submittal is returned marked "REJECTED-RESUBMIT", revise said submittal and resubmit. Construction may not proceed.
6. Resubmittal of portions of multi-page or multi-drawing submittals will not be allowed. For example, if a Shop Drawing Submittal that consists of ten drawings contains only one drawing that needs to be amended and resubmitted, the submittal as a whole is deemed as "REVISE AND RESUBMIT", and all ten drawings included in the submittal are required to be resubmitted.
7. On resubmittals, flag any changes made, other than those made or requested by Owner or Engineer.

E. Commence fabrication of an item only after Engineer has reviewed the pertinent submittals and Engineer has assigned action as either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED". Corrections indicated on submittals are considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis for changes to the Contract requirements.

F. Owner's and/or Engineer's review of shop drawing submittals does not relieve Contractor of the responsibility for correctness of details and dimensions and for compliance with the Contract Documents. Assume responsibility and risk for misfits due to errors in submittals. Be responsible for dimensions and design of adequate connections and details.

G. Deferred Design Submittals: Items noted on the Contract Documents as "Deferred Submittals" must be submitted to Engineer, who will review them and forward them to the building official with a notation indicating that the deferred submittal documents have been reviewed and found to be in general conformance with the design of the Project. Do not install Deferred Submittal items until the deferred submittal documents have been approved by the permitting agency.

H. Test and Evaluation Reports: Submit technical data, test reports, calculations, surveys, and certifications based on field tests and inspections by independent inspection and testing agency and by authorities having jurisdiction.

1. Reports of results of inspections and tests will not be considered Contract Documents.
2. Refer to Section 01 45 00 - Quality Control for additional requirements.

1.5 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference referred to in Section 01 11 00 - Summary of Work, submit the following items to Engineer for review:
1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitute ("Or-Equal") submittals listed in the Bid.
2. A list of all permits and licenses to be obtained, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.
3. A preliminary Schedule of Values in accordance with Section 01 29 73 – Schedule of Values.
4. A preliminary Construction Project Schedule in accordance with requirements of Section 01 32 16 – Construction Progress Schedule.
5. The name and qualifications of the Designated Safety Representative in accordance with requirements of Section 01 31 30 - Safety.

1.6 SITE CONDITION SURVEYS

A. Submit the site conditions survey data as required in Section 01 71 30 – Site Conditions Surveys.

1.7 CONSTRUCTION PROGRESS REPORTS

A. Transmit a progress report to Engineer with each Application for Payment. If the Work falls behind schedule, submit additional progress reports at such intervals as Engineer may request.

B. In each progress report, include sufficient narrative to describe any current and anticipated delaying factors, effect on the construction schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to Engineer, must be substantiated with satisfactory evidence.

C. In each progress report, include a list of the activities completed with their actual start and completion dates, a list of the activities currently in progress, and the number of working days required to complete each.

1.8 SURVEY DATA

A. Make available for examination throughout the construction period, all field books, notes, and other data developed while performing the surveys required by the Work and submit all such data to Engineer with documentation required for final acceptance of the Work.

1.9 UTILITY INVESTIGATION

A. Transmit the findings of the utility investigation in accordance with Section 01 71 50 – Protection and Restoration of Existing Facilities.

1.10 QUALITY ASSURANCE/QUALITY CONTROL PLAN

A. Prepare and submit a Quality Assurance/Quality Control Plan for the Work contained in the Contract in accordance with Section 01 45 00 – Quality Control.

1.11 CONTRACTOR DAILY REPORT

A. Submit to Engineer, or designee, a daily report. Upload report not later than 9:00 A.M. of the workday following the report date and include the following:
   1. Day of week, date, Contractor name and Report number.
   2. Summary of work in process (segregated by Contractor and Subcontractor).
   3. Details of work accomplished including quantities of Work installed.
   4. Summary of equipment working and where working.
   5. Summary of manpower by work element and Subcontractor.
   6. Receipt of major equipment or materials.
   7. All required testing performed and, if available, documented results.
   8. Notification of percent of Work delayed by abnormal weather conditions.
   9. Notification of percent of Work delayed by other utility conflicts or conditions.

1.12 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manual
   1. Submit technical operation and maintenance information for each item of mechanical, electrical and instrumentation equipment in an organized manner in the *Operations and Maintenance Manual*, written so that it can be used and understood by the Owner's operation and maintenance staff.
   2. Furnish initial submittal of the *Operations and Maintenance Manual* to Engineer upon delivery of the respective equipment.
   3. Subdivide the *Operations and Maintenance Manual* first by Specification Section number; second, by equipment item; and last, by "Part." Conform "Parts" to the following (as applicable):
      a. Part 1 – Equipment Summary:
         1) Summary: In a summary table, indicate the equipment name, equipment number, and process area in which the equipment is installed.
         2) Form: Furnish an Equipment Summary Form for each item of mechanical, electrical and instrumentation equipment in the Work. Fill in the relevant information on the form and include it in Part 1.
      b. Part 2 – Operational Procedures:
         1) Procedures: Include manufacturer-recommended procedures on the following in Part 2:
            a) Installation
            b) Adjustment
            c) Startup
            d) Location of controls, special tools, equipment required, or related instrumentation needed for operation
            e) Operation procedures
            f) Load changes
            g) Calibration
            h) Shutdown

i) Troubleshooting
j) Disassembly
k) Reassembly
l) Realignment
m) Testing to determine performance efficiency
n) Tabulation of proper settings for all pressure relief valves, low and high- pressure switches, and other protection devices
o) List of all electrical relay settings including alarm and contact settings
p) Lubrication.

c. Part 3 – Preventive Maintenance Procedures:
1) Procedures: Preventive maintenance procedures shall include all manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by leaving the equipment in place.
2) Schedules: Include recommended frequency of preventive maintenance procedures. Cover lubrication schedules, including lubricant SAE grade, type, and temperature ranges.

d. Part 4 – Parts List:
1) Parts List: Furnish a complete parts list, including a generic description and manufacturer's identification number for each part. Include addresses and telephone numbers of the nearest supplier and parts warehouse.
2) Drawings: Include cross-sectional or exploded view drawings with the parts list.

e. Part 5 – Wiring Diagrams:
1) Diagrams: In this part, include complete internal and connection wiring diagrams for electrical equipment items.

f. Part 6 – Shop Drawings:
1) Drawings: In this part, include approved shop or fabrication drawings, complete with dimensions.

g. Part 7 – Safety:
1) Procedures: This part describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Part 8 – Documentation:
1) Place all equipment warranties, affidavits, and certifications required by the Technical Specifications in this part.

4. Transmit to Engineer, one copy of the *Operations and Maintenance Manual* in digital format. In addition to the digital copy, furnish Engineer with four identical hard copies of the *Operations and Maintenance Manual*. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. Prepare a table of contents indicating all equipment in the manuals. Display the title of each volume on the cover and spine.
5. Submit *Operations and Maintenance Manuals* in final form, not later than the 75 percent of construction completion date. Correct all discrepancies found by Owner or Engineer in the *Operations and Maintenance Manual* within 30 days from the date of written notification.
6. Incomplete or unacceptable *Operations and Maintenance Manuals* at the 75 percent construction completion point constitute sufficient justification to withhold the

amount stipulated in paragraph "*Operations and Maintenance Manual* Submittals" of Section 01 77 00 – Project Closeout, from any monies due.

B. Certificates
   1. When specified in individual specification sections, submit manufacturers' certificates to Engineer for review as specified.
   2. Submit in form of letter or company standard forms, signed by officer of manufacturer.
   3. Include the following with each certification
      a. Project name and location.
      b. Contractor's name and address.
      c. Quantity and date or dates of shipment or delivery to which certificate applies.
      d. Manufacturer's name.
      e. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
      f. Certificates may be recent or previous test results on material or product but must be acceptable to Engineer.

C. Record Documents
   1. Prepare and maintain one set of record documents at the Project Site per the requirements of Section 01 78 39 – Project Record Documents. Submit to Engineer at close of Project.

1.13 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Submit list of spare parts information for all mechanical, electrical, and instrumentation equipment. Include the current list price of each spare part. Limit the spare parts list to those spare parts which each manufacturer recommends be maintained by Owner in inventory at the plant site. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to facilitate Owner in ordering. Cross-reference all spare parts lists to the equipment numbers designated in the Contract Documents. In addition to electronic submittal, bind the spare parts lists in standard size, 3-ring, loose-leaf, vinyl plastic hard cover binders suitable for bookshelf storage. Binder ring size not to exceed 2.5 inches.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 35 53
SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Protect the active construction areas of the Work, including all material, equipment, field office trailers, and their contents from theft, vandalism, and unauthorized entry.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring, or construction activities could be considered a potential hazard to people.

1.3 RELATED SECTIONS

A. Section 01 57 19 – Temporary Environmental Controls

1.4 SUBMITTALS

A. Prior to performance of any work at the Project Site, submit to Engineer for record only, two copies of the security plan commensurate with the needs of the Project, signed by officer of Contractor. Be solely responsible for adequacy of the security plan.

B. Provide Engineer with drawing and data showing temporary fencing and gate locations, along with materials to be used.

C. Provide Engineer with a list of 24-hour emergency phone numbers for Contractor personnel.

D. Submit to Engineer an updated progressive inventory of materials and equipment received on-site.

E. Submit log of workmen and visitors to Project Site.

1.5 SECURITY PROGRAM

A. Protect Work and existing premises, including the field office trailers and their contents, from theft, vandalism, and unauthorized entry during working and non-working hours.

B. Accept sole responsibility for Project Site security and protection of the Work.

C. Initiate the security program at job mobilization and maintain the security program throughout construction period.

D. Limit lighting to basic safety and security requirements, and shield when possible.

E. Be responsible for the security of storage compound and lay down area, and for all plant material, equipment, and tools always.

F. Prohibit firearms for the Project Site.

G. Prohibit dogs from the Project Site, except for those clearly used for security purposes within fenced areas.

H. Erect and maintain temporary security fencing as required to protect the Work, the Project Site, and existing facilities on the Project Site. The location of all temporary security fencing shall be approved in advance by Engineer.
   1. Fence Height: 6 feet
   2. Fence Material: Galvanized chain link, including barbed wire, equal in function to permanent site security fence.

1.6 ENTRY CONTROL

A. Entry control shall not unreasonably limit the personnel of Owner, Engineer, and their operations and maintenance groups from performing assigned duties. Temporary access limitations will be identified to Engineer and the operations and maintenance groups at least 24 hours prior to such limitation.

B. Restrict entry of unauthorized persons and vehicles into Project Site.

C. Allow entry only to authorized persons with proper identification.

D. When requested by Owner, implement a security badge system for the Project Site, approved by Owner.

E. Maintain a log of workmen and visitors and make log available to Owner on request. This log shall be submitted to Engineer biweekly or as necessary.

F. Require all visitors to sign the visitor log acknowledgment of the project rules included in this Section. A copy of the project rules shall be given to each visitor. Submit copies of these forms to Engineer biweekly.

G. Contractor has the right to refuse access to the Project Site or require that a person or vehicle be removed from the Project Site if found violating any of the project rules.

H. Give jobsite security orientation training to all affected employees, including subcontractor employees. Employee participation in the security orientation shall be acknowledged by their respective individual signatures affixed to an orientation roster.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 41 26
PERMITS

PART 1 - GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

A. Obtain permits required for the execution of Work in accordance with the Contract Documents. Provide copies of these permits to Owner.

B. The intent of this Section is to furnish the known list of required permits for the Work under the Contract Documents. Owner does not guarantee that this list is complete. Be responsible for determining and verifying the extent of all permits required and for obtaining such permits.

C. In the Bid Price, include costs for obtaining all necessary permits, including application fees and other costs, and the costs of complying with the conditions of all permits. Any fees listed in this section are estimates and are for information only. Verify and pay all actual fees.

D. Within 30 Days of the Limited Notice to Proceed, submit a list of all permits and licenses to be obtained, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

1.2 SUMMARY OF PERMITS TO BE OBTAINED BY CONTRACTOR

A. Obtain the following permits. Submit copies of these permits to Engineer and maintain copies on-site. Comply with all conditions of the permits.
   1. Salt Lake Valley Health Department Bureau of Air Pollution Control Dust Control:
      a. Dust Permit: The dust permit application requires a description of proposed dust control measures. The permit will include several conditions, including agreement to suspend all or part of the permitted activities if satisfactory control of airborne particulates cannot be obtained, attendance at a dust control class, and possibly posting of a bond to assure performance of permit conditions. Under all circumstances, comply with all mitigation requirements for dust control indemnify Owner against all liability arising out of this responsibility and for any and all Salt Lake Valley Health Department Bureau of Air Pollution imposed fines which may be assessed to the Project for violating the Dust Control Permit.
         1) Agency: Bureau of Air Pollution Control, Salt Lake Valley Health Department
         2) Contact Person: Joshua Greer - Environmental Health Specialist
         3) Telephone No.: (801) 313-6724
         4) Fax No.: (801) 313-6676
   2. Utah Occupational Safety and Health Administration:
      a. Construction Permit: Covers worker safety and health for all project features.
   3. Utah Department of Environmental Quality, Division of Water Quality:
      a. UPDES General Permit for Construction Dewatering/Hydrostatic Testing of Pipelines: Covers discharge waters associated with dewatering operations and hydrostatic testing of pipelines.

1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
2) Contact Person: Harry Campbell
3) Telephone No.: (801) 538-6923
4) Email: hcampbell@utah.gov

b. Notification of Chlorinated Water Discharge: This notification provides 30 days' notice prior to disinfection of pipeline and discharge of pipeline and discharge of chlorinated water.

4. Utah Division of Environmental Protection, General Storm Water Permit for Construction Activities:
   a. As a condition of contract award, sign a certification of agreement to comply with the terms and conditions of the permit. Permit not required if area of disturbance is less than one acre.
   b. Agency and Contact Person:
      1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
      2) Contact Person: Jeanne Riley
      3) Address: 288 North 1460 West (Cannon Building) 3rd Floor, PO Box 144870, Salt Lake City, Utah 84114-4870
      4) Telephone No.: (801) 536-4369
      5) Email: jriley@utah.gov
      6) Website: https://deq.utah.gov/water-quality/general-construction-storm-water-updes-permits
5. Utah State Division of Health:
   a. Letter of Approval to Construct: Letter and Certificate are required for construction and operations of a water supply system.

1.3 SUMMARY OF PERMITS OBTAINED BY OWNER

1. Utah Department of Environmental Quality, Division of Drinking Water
   a. Project Notification Form and Plan Review/Construction Approval
      1) Agency: Utah Department of Environmental Quality, Division of Drinking Water
      2) Contact Person: Robert Hart
      3) Telephone No.: (801) 536-0054
      4) Email: bhart@utah.gov

PART 2 - MATERIALS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 13
ABBREVIATIONS OF INSTITUTIONS

PART 1 - GENERAL

1.1 GENERAL

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

1.2 ABBREVIATIONS

AAMA	Architectural Aluminum Manufacturer's Association
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturer's Association, Inc.
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National 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
ASLE	American Society of Lubricating Engineers
ASME	American Society of Mechanical Engineers
ASQC	American Society for Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CLSI	Clinical and Laboratory Standards Institute
CRSI	Concrete Reinforcing Steel Institute
EIA	Electronic Industries Association
ETL	Electrical Test Laboratories
EPA	Environmental Protection Agency
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Power Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers

IES	Illuminating Engineering Society
IP	Institute of Petroleum (London)
IPC	Institute of Printed Circuits
ISA	Instrument Society of America
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
MBMA	Metal Building Manufacturer's Association
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
MTI	Marine Testing Institute
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NLGI	National Lubricating Grease Institute
NSF	NSF International
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PPI	Plastics Pipe Institute
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers

SAMA	Scientific Apparatus Makers Association
SMACCNA	Sheet Metal and Air Conditioning Contractors National Association
SPI	Society of the Plastics Industry, Inc.
SPR	Simplified Practice Recommendation
SSPC	Society for Protective Coatings
SSPWC	Standard Specifications for Public Works Construction
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories, Inc.
WEF	Water Environment Federation
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association
WWPA	Western Wood Products Association (WWPA)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 19
REFERENCE STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Titles of Sections and Paragraphs: Captions accompanying Specification Sections and Paragraphs are for convenience of reference only, and do not form a part of the Specifications.

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, Specification text 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 with no choice or option. These requirements 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, accept the final responsibility for fulfillment of the entire set of contract requirements.

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 applicable codes and the applicable requirements of the following documents.

B. References herein to "Building Code", “Plumbing Code”, “Mechanical Code”, “Fuel Gas Code”, or “Fire Code” shall mean the latest adopted version of the International Building Code (IBC), the International Plumbing Code (IPC), the International Mechanical Code (IMC), the International Fuel Gas Code (IFGC), and the International Fire Code (IFC) as published by the International Code Council (ICC). Similarly, references to the "Uniform Mechanical Code" or the "Uniform Plumbing Code" shall mean the Uniform Mechanical Code or the Uniform Plumbing Code as published by the International Association of Plumbing and Mechanical Officials (IAPMO) References to the "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of any “building” code as approved by the Municipal Code and adopted by the authority 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 Documents, the most stringent requirements shall govern. Bring all conflicts to the attention of Engineer for clarification and directions prior to ordering or providing any materials or furnishing labor. Bid the most stringent requirements.

D. Construct the Work indicated herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards, and specifications listed herein.

E. Applicable Standard Specifications: References in the Contract Documents to the "Standard Specifications" shall mean the *Manual of Standard Specifications* (APWA), latest version.

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 all changes and amendments thereto.

H. References herein to "UDOT Standards" shall mean *Standard Specifications for Road and Bridge Construction*.

I. References herein to "MSHA Standards" shall mean *Mine Safety and Health Administration Standards*, latest version.

1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. Be responsible that all Work included in the Contract Documents, whether shown or not, complies with all EPA, OSHA, RCRA, NFPA, and any other Federal, State, and Local Regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist, all chemical, hazardous, and petroleum product piping and storage in underground locations must be installed with double containment piping and tanks, or in separate concrete trenches and vaults, or with an approved lining which cannot be penetrated by the chemicals, unless waived in writing by Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. The requirements of this Section apply to, and are a component part of, each Section of the Specifications.

A. The Contractor is fully responsible for quality control.

B. If any inspection demonstrates non-compliance with the Contract Documents, the Owner will provide for one re-inspection of this work at no cost to the Contractor. Subsequent re-inspections will be done at the Contractor's expense.

C. The Owner, at the Owner's expense, may provide for supplemental materials quality assurance testing for earthfill and concrete materials. Owner inspection and testing are for the sole benefit of the Owner and do not:
   1. Relieve the Contractor of responsibility for providing adequate quality control measures;
   2. Relieve the Contractor of responsibility for damage to or loss of the material before acceptance;
   3. Constitute or imply acceptance; or
   4. Affect the continuing rights of the Owner after acceptance of the completed work.

D. The Engineer retains right to direct more control testing, if in Engineer's opinion work is not being adequately controlled.

E. The Engineer also retains right to accept or reject material or work based upon Contractor's control testing or the Owner's control testing.

F. All material shall be new and of the specified quality and equal to the accepted samples, if samples have been submitted. All work shall be done and completed in a thorough, workmanlike manner, notwithstanding any omission from these Contract Documents; and it shall be the duty of the Contractor to call the Engineer's attention to apparent errors or omissions and request instructions before proceeding with the work. The Engineer may, by appropriate instructions, correct errors and supply omissions, which instructions shall be as binding upon the Contractor as though contained in the original Contract Documents.

G. At the option of the Engineer, 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. Give the Engineer written notification well in advance of actual readiness of materials to be tested and/or inspected at point of origin. 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 re-inspection at the site of the work.

H. Materials which will require testing and inspection at the place of origin shall not be shipped prior to such testing and inspection.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D3740	Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit Quality Control Plan.

C. Submit credentials for field Quality Control Representative showing experience acceptable to Engineer.

D. Submit credentials for testing laboratory showing compliance with Specifications and acceptable to Engineer.

E. Submit results of testing as specified below.

1.4 SITE INVESTIGATION AND CONTROL

A. Check and verify all dimensions and conditions in the field continuously during construction. Be solely responsible for any inaccuracies built into the Work due to Contractor's (including Subcontractor's) failure to comply with this requirement.

B. Inspect related and appurtenant Work and report in writing to Engineer, any conditions which will prevent proper completion of the Work. Failure to report any such conditions constitutes acceptance of all Site conditions. Required removal, repair, or replacement caused by unsuitable conditions shall be performed at no additional cost to Owner.

1.5 INSPECTION OF THE WORK

A. Inspect all Work performed by both Contractor and Subcontractors. Nonconforming Work and any safety hazards in the work area shall be noted and promptly corrected. Be responsible for the Work to be performed safely and in conformance with the Contract Documents.

B. The Work shall be conducted under the general observation of Engineer and is subject to inspection by representatives of Owner acting on behalf of Owner to ensure strict compliance with the requirements of the Contract Documents. Such inspection may include mill, plant, shop, or field inspection, as required. Owner, Engineer, or any inspector(s) shall be permitted

access to all parts of the Work, including plants where materials or equipment are manufactured or fabricated.

C. The presence of Engineer, or any inspector(s), shall not relieve Contractor of responsibility for the proper execution of the Work in accordance with all requirements of the Contract Documents. Compliance is the responsibility of Contractor. No act or omission on the part of Engineer, or any inspector(s) shall be construed as relieving Contractor of this responsibility. Inspection of Work later determined to be nonconforming shall not be cause or excuse for acceptance of the nonconforming Work. Owner may accept nonconforming Work when adequate compensation is offered, and it is in Owner's best interest as determined solely by Owner.

D. All materials and articles furnished shall be subject to rigid documented inspection by qualified personnel. No materials or articles shall be used in the Work until they have been inspected and accepted by Contractor's Quality Control Representative and Engineer or other designated representative. No Work shall be backfilled, buried, cast in concrete, covered, or otherwise hidden until it has been inspected. Any Work covered in the absence of inspection shall be subject to uncovering. Where uninspected Work cannot be easily uncovered, such as in concrete cast over reinforcing steel, all such Work shall be subject to demolition, removal, and reconstruction under proper inspection.

E. All Owner furnished materials and articles shall be subject to rigid inspection by Contractor's Quality Control Representative before being used or placed in the Work. Inform Engineer, in writing, of the results of said inspections within one working day after completion of inspection. If any material or articles provided by Owner are considered to be of insufficient quality for use in the Work, immediately notify Engineer.

1.6 TIME OF INSPECTION AND TESTS

A. Furnish and prepare samples and test specimens required under these Specifications and for testing in ample time for the completion of the necessary tests and analyses before said articles or materials are to be used. Furnish and prepare all required test specimens without additional expense to Owner. As provided in the Contract Documents, performance of certain tests will be by Owner, and all costs therefore will be borne by Owner, except that the costs of any test, which shows unsatisfactory results shall be back charged to Contractor.

B. Notify Engineer at least three Workdays before being ready to backfill, bury, cast in concrete, hide, or otherwise cover any Work under this Contract and request inspection before beginning any such Work of covering. Failure to notify Engineer at least three Workdays in advance of any such inspections shall be reasonable cause for Engineer to order a sufficient delay in scheduled operations to allow time for such inspection. Be responsible for costs of any remedial or corrective work required, and all costs of such delays, including its impact on other portions of the Work.

1.7 SAMPLING AND TESTING

A. Unless otherwise specified, all sampling and testing shall be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered. However, Engineer reserves the right to use any generally-

accepted system of inspection which, in the opinion of Engineer, will ensure Engineer that the quality of the workmanship is in full accord with the Contract Documents.

B. Owner reserves the right to waive tests or quality control measures. However, waiver of any specific testing or other quality control measure, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the specified testing or other quality control requirements as originally specified, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial work, shall not be construed as a waiver of any technical or qualitative requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, Owner reserves the right to make independent investigations and tests as specified in the following paragraph and failure of any portion of the Work to meet qualitative requirements of the Contract Documents shall be reasonable cause for Owner to require the removal or correction and reconstruction of any such Work.

D. In addition to any other inspection or quality control provisions that may be specified, Owner reserves the right to independently select, test, and analyze, at the expense of Owner, additional test specimens of any or all the materials to be used. Results of such additional tests and analyses shall be considered along with the tests or analyses made by the Contractor to determine compliance with the applicable specifications for the materials so tested or analyzed provided that wherever any portion of the Work is discovered, as a result of such independent testing or investigation by Engineer, which fails to meet the requirements of the Contract Documents, all costs of such independent inspection and investigation and all costs of removal, correction, reconstruction, or repair of any such Work shall be borne by Contractor.

1.8 RIGHT OF REJECTION

A. Engineer or designated representative, acting for Owner, always reserves the right to reject any articles or materials furnished hereunder which, in any respect, fail to meet the requirements of the Contract Documents, regardless of whether the defects in such articles or materials are detected at the point of manufacture or after completion of the Work at the Site. If Engineer or designated representative, through an oversight or otherwise, has accepted materials or Work which are defective or in any way contrary to the Contract Documents, such materials, no matter in what stage or condition of manufacture, delivery, or erection, may be rejected.

B. Promptly remove or replace rejected articles or materials from the Site of the Work after notification of rejection.

C. Bear all costs of removal and replacement of rejected articles or materials.

D. Failure to promptly remove and replace rejected Work shall be considered a breach of this Contract and Owner may, after 7 days' notice, terminate Contractor's right to proceed with the affected Work and remove and replace the Work and issue a back charge to cover the cost of the Work.

1.9 QUALITY CONTROL REQUIREMENTS

A. Establish and execute a Quality Control program for the services, which are being provided. The program shall provide adequate measures for verification and conformance to defined requirements of all personnel, including lower-tier subcontractors (including fabricators, suppliers, and sub-subcontractors). Prepare and submit a plan responsive to this Section for review by Engineer.

B. Furnish Engineer with a project specific Quality Control Plan. The plan shall contain a comprehensive account of quality control procedures applicable to this Project. The detailed requirements for this Plan are delineated in the following paragraphs. No progress payments will be made until the Quality Control Plan is fully accepted by Engineer.

C. Using the Quality Control Plan, describe and define the personnel requirements described herein. Provide personnel with assigned quality control functions reporting to a field Quality Control Representative. The field Quality Control Representative shall report to a senior manager of Contractor and shall not have supervisory or managerial responsibility over the work force. Persons performing quality control functions shall have sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions. Contractor's Quality Control representative(s) shall be on-site as often as necessary (but not less than the daily hours specified in the Contract Documents) to remedy and demonstrate that Work is being performed properly and to make multiple observations of all Work in progress. The Quality Control Plan shall include a statement by the senior manager designating the Quality Control Representative and specifying authorities delegated to the Quality Control Representative to direct cessation or removal and replacement of defective Work.

D. The Quality Control Plan shall ensure the achievement of adequate quality throughout all applicable areas of the contract. In the Quality Control Plan, describe the program and include procedures, work instructions and records. In addition, describe methods relating to areas that require special testing and procedures as noted in the Specifications.

E. Identification and Control of Items and Materials: Describe procedures in the Quality Control Plan to ensure that items or materials that have been accepted at the site are properly used and installed. Provide procedures for proper identification and storage, and to prevent the use of incorrect or defective materials.

F. Inspection and Tests: Provide written procedures defining a program for control of inspections performed. These procedures shall be described in the Quality Control Plan.
   1. Inspections and tests shall be performed and documented by qualified individuals. At a minimum, "qualified" shall mean having performed similar quality control functions on similar type projects. Records of personnel experience, training and qualifications shall be maintained and made available for review by Engineer upon request.
   2. Maintain and provide to Engineer, within two working days of completion of each inspection and test, adequate records of all such inspections and tests. Inspection and test results shall be documented and evaluated to ensure that requirements have been satisfied.
   3. Procedures shall include:

a. Specific instructions defining procedures for observing all Work in process and comparing this Work with the Contract requirements (organized by specification section).
b. Maintaining and providing Daily Inspection Reports. Such reports shall, at a minimum, include the following:
    1) Item(s) inspected
    2) Quality characteristics in compliance
    3) Quality characteristics not in compliance
    4) Corrective/remedial actions taken
    5) Statement of certification
    6) QC Manager's signature
c. Specific instructions for recording all observations and requirements for demonstrating through the reports that the Work observed complied, or a deficiency was noted and action to be taken.
d. Procedures to preclude the covering of deficient or rejected Work.
e. Procedures for halting or rejecting Work.
f. Procedures for resolution of differences between the Quality Control Representative(s) and the production representative(s).

4. The Quality Control Plan shall identify all contractual hold/inspection points as well as any Contractor imposed hold/inspections points.
5. The Quality Control Plan shall include procedures to provide verification and control of all testing provided, including:
    a. Maintaining and providing to Engineer Daily Testing Records. Such records shall, at a minimum, contain the following:
        1) Item(s) tested
        2) Quality characteristics in compliance
        3) Statement of correctness & certification
        4) Quality characteristics not in compliance
        5) Corrective/remedial actions taken
        6) QC Manager's signature
    b. Individual test records will contain the following information:
        1) Item tested –item number and description
        2) Test results
        3) Test designation
        4) Test work sheet including location sample was obtained
        5) Acceptance or rejection
        6) Date sample was obtained
        7) Retest information, if applicable
        8) Control requirements
        9) Tester signature
        10) Testing QC staff initials
    c. Providing for location maps for all tests performed or location of Work covered by the tests.
    d. Maintaining copies of all test results.
    e. Ensuring Engineer receives independent copy of all tests.
    f. Ensuring testing lab(s) are functioning independently and in accordance with the specifications.
    g. Ensuring re-tests are properly taken and documented.

G. Control of Measuring and Test Equipment: Measuring and/or testing instruments shall be adequately maintained, calibrated, and adjusted to maintain accuracy within prescribed limits. Perform calibration at specified periods against valid standards traceable to nationally recognized standards and documented.

H. Supplier Quality Assurance: The Quality Control Plan shall include procedures to ensure that procured products and services conform to the requirements of the Contract Documents. Requirements of these procedures shall be applied, as appropriate, to lower-tier suppliers and/or Subcontractors.

I. Deficient and Nonconforming Work and Corrective Action: The Quality Control Plan shall include procedures for handling of deficiencies and non-conformances. Deficiencies and non-conformances are defined as documentation, drawings, material, equipment, and Work not conforming to the specified requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent recurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documented and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:
   1. Personnel responsible for identifying deficient and non-complying items within the work.
   2. How and by whom deficient and non-compliant items are documented “in the field”.
   3. The personnel and process utilized for logging deficient and non-compliant work at the end of each day onto a Deficiency Log.
   4. Tracking processes and tracking documentation for deficient and non-compliant items.
   5. Personnel responsible for achieving resolution of outstanding deficiencies.
   6. Once resolved, how are the resolutions documented and by whom.

J. Special Processes and Personnel Qualifications
   1. The Quality Control Plan shall include detailed procedures for the performance and control of special process (e.g., welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).
   2. Personnel performing special process tasks shall have the experience, training, and certifications commensurate with the scope, complexity, or nature of the activity. They shall be approved by Engineer before the start of Work on the Project.

K. Audits: The Quality Control Plan shall provide for documented audits to verify that quality control procedures are being fully implemented by Contractor as well as its subcontractors. Audit records shall be made available to Engineer upon request.

L. Documented Control/Quality Records
   1. Establish methods for control of Contract Documents, which describe how Drawings and Specifications are received and distributed to assure the correct issue of the document being used. The methods shall also describe how as-built data are documented and furnished to Engineer.
   2. Maintain evidence of activities affecting quality, including operating logs, records of inspections and tests, audit reports, material analyses, personnel qualification and certification records, procedures, and document review records.

3. Quality records shall be maintained in a manner that provides for timely retrieval, and traceability. Quality records shall be protected from deterioration, damage, and destruction.
4. Provide a list with specific records as specified in the Contract Documents, which will be furnished to Engineer at the completion of activities.

M. Acceptance of Quality Control Plan: Engineer's review and acceptance of the Quality Control Plan shall not relieve Contractor from any of its obligations for the performance of the Work. Contractor's quality control staffing is subject to Engineer's review and continued acceptance. Owner, at its sole option, without cause, may direct Contractor to remove and replace the Quality Control Representative. No Work covered by the Quality Control Plan shall start until Engineer's acceptance of the Quality Control Plan has been obtained.

N. Engineer may perform independent quality assurance audits to verify that actions specified in the Quality Control Plan have been implemented. No Engineer audit finding or report shall in any way remove any requirements of this Contract.

1.10 TESTING SERVICES

A. All tests which require the services of a laboratory to determine compliance with the Contract Documents shall be performed by an independent commercial testing firm acceptable to Engineer. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped and fully qualified to perform the tests in accordance with the specified standards.

B. Independent testing laboratory shall be accredited by the American Association of State Highway and Transportation Officials (AASHTO) for the tests they will perform and as appropriate for the Work being performed. The laboratory shall also be accredited under ASTM C1077, ASTM D3740, and ASTM D3666.

C. Engineer shall have the right to inspect work performed by the independent testing laboratory both at the project and at the laboratory. This shall include inspection of the independent testing laboratory's internal quality assurance records (quality assurance manual, equipment calibrations, proficiency sample performance, etc.).

D. Obtain Engineer's acceptance of the testing firm before having services performed. Pay all costs for these testing services.

E. Testing services provided by Owner, if any, are for the sole benefit of Owner. However, test results shall be available to Contractor. Testing necessary to satisfy Contractor's internal quality control procedures shall be the sole responsibility of Contractor.

F. Testing Services furnished by Contractor: Unless otherwise specified, and in addition to all other specified testing requirements, provide all testing services in connection with the following materials as required for Engineer's review:
1. Concrete materials and mix designs.
2. Embankment, fill, and backfill materials.
3. Quality control testing of all precast concrete.
4. All other tests and engineering data required for Engineer's review of materials and equipment proposed to be used in the Work.

5. In addition, the following quality control tests shall be performed by Contractor:
    a. Holiday testing of pipeline coatings.
    b. Air testing of field-welded joints for steel pipe or pipe cylinders and fabricated specials.
    c. All testing and inspection of welding work including, but not limited to, welding procedure qualifications, welder operator qualifications, all work performed by the certified welding inspector, all appropriate nondestructive testing of welds and all repair and retest of weld defects.

G. Field Testing Services furnished by Contractor: Unless otherwise specified, Contractor will provide quality control testing services in connection with the following materials and equipment incorporated in the Work.
1. Concrete strength tests.
2. Moisture-density and relative density tests on embankment, fill, and backfill materials.
3. In-place field density test on embankments, fills, and backfill.
4. Other materials and equipment as specified herein.
5. Testing, including sampling, shall be performed by Engineer or testing firm's laboratory personnel, in general manner and frequency indicated in the Specifications.
6. Furnish all sample materials and cooperate in the testing activities, including sampling. Interrupt the Work when necessary to allow testing, including sampling to be performed. There shall be no claim for an increase in Contract Price or Contract Times due to such interruption. When testing activities, including sampling, are performed in the field by the testing firm's laboratory personnel, furnish personnel and facilities to assist in the activities.
7. The testing firm’s laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and will furnish a written report of each test. Distribution of the reports shall be as directed by Engineer.

H. Transmittal of Test Reports: Written reports of tests and engineering data furnished for Engineer's review of materials and equipment proposed to be used in the Work shall be submitted per Section 01 33 20 - Submittal Procedures.

I. The testing firm retained for material field testing shall furnish a minimum of five copies of written report of each test. Three copies of each test report will be transmitted to Engineer within three Workdays after each test is completed. Consecutively number each report for each type of test.

J. Testing firm shall furnish one copy of each field and laboratory quality control test to Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 50 10
SITE ACCESS AND STORAGE

PART 1 - GENERAL

1.1 REFERENCES

A. U.S. Dept. of Transportation, Federal Highway Administration (FHWA) standards.

MUTCD	Manual of Uniform Traffic Control Devices

B. U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA) standards.

Subpart G, Part 1926	Safety and Health Standards for Construction

1.2 SUBMITTALS

A. Provide design and engineering calculations for custom temporary bridges or steel plates to be employed.

B. Submit hazardous materials storage plan.

C. Submit the EPA issued number for wastes generated at the site.

1.1 CONSTRUCTION SITE ACCESS

A. Construction access to the site shall be via the two proposed access points shown on Drawing C-01. Access the 1 MG Reservoir through the main SERWTP site access gate. Access the 3 MG Reservoir and valve vault using the access gate east of the pretreatment building. For work inside the WaterPro Meter Vault, there is a vehicle access gate from Wasatch Blvd south of the vault that can be utilized. These are the only permitted access points to the site.

1.3 ROADWAY AND TRAFFIC LIMITATIONS

A. Investigate the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work. Comply with the provisions specified in the Traffic Management Plan. Accept responsibility to construct and maintain any haul roads required for construction operations.

B. Maintain a maximum speed limit of 15 mph while on the Project Site.

C. Confine all vehicles to the designated construction area. Cross-country travel is prohibited.

1.4 TEMPORARY CROSSINGS

A. General: Provide continuous, unobstructed, safe, and adequate pedestrian and vehicular access to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Provide safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300

feet. Cooperate with parties involved in the delivery of mail and removal of trash and garbage to maintain existing schedules for such services. Maintain vehicular access to residential driveways to the property line except when required construction precludes such access for reasonable periods of time.

B. Temporary Bridges: Wherever necessary, provide suitable temporary bridges or steel plates over unfilled excavations, except where written consent of the individuals or authorities concerned to omit such temporary bridges or steel plates has been secured. Any such obtained written consent shall be delivered to Engineer prior to excavation. Maintain all such bridges or steel plates in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case. Adopt designs furnished by said authority for such bridges or steel plates, or submit designs to said authority for approval, as may be required. New designs shall be stamped and signed by a professional engineer, licensed to practice in Utah.

C. Street Use: Nothing herein shall be construed to entitle Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work hereunder. Conduct operations so as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of Engineer and proper governmental authority. Where excavation is being performed in primary streets or highways, always maintain one lane in each direction open to traffic unless otherwise indicated. Provide toe boards to retain excavated material if required by Engineer or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the Work shall always BE kept accessible to fire-fighting equipment. Temporary provisions shall be made to assure the use of sidewalks and the proper functioning of all gutters, storm drain inlets, and other drainage facilities.

D. Traffic Control: For the protection of traffic in public or private streets and ways, provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the MUTCD, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations."

E. Take all necessary precautions for the protection of the Work and the safety of the public. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. Station such guards or flaggers and conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. All signs, signals, and barricades shall conform to OSHA Safety and Health Standards for Construction.

F. Temporary Street Closure: If closure of any street is required during construction, apply in writing to the authority having jurisdiction at least 30 days in advance of the required closure for signage and detour requirements.

G. Temporary Driveway Closure: Notify property owner or occupant (if not owner-occupied) of the closure of the driveways to be closed more than one eight-hour workday at least three working days prior to the closure. Minimize the inconvenience and minimize the time that the driveways will be closed. Fully explain to the owner/occupant how long the work will take and when closure is to start.

1.5 WORK AND STORAGE AREA

A. Owner will designate as indicated in the Contract Documents, and arrange for the Contractor's use, a portion of the property shown on Drawing C-01 for use during the term of the Contract as a storage and shop area for construction operations on the Work. Provide a plot plan of intended storage/work area use to Engineer.

B. Make independent arrangements for any necessary off-site storage or shop areas necessary for the proper execution of the Work.

C. Lands to be furnished by Owner for construction operation and other purposes are indicated. Should it be necessary to use any additional land for staging or for other purposes during the construction of the Work, independently arrange for the use of such lands and pay any required rental or use fees. Unless otherwise shown, specified, or agreed, all sites shall be returned to their original condition or better upon completion of the Work.

D. Nothing herein shall imply granting an exclusive use of roadways or public and/or private land employed to perform the Work.

E. Temporary Storage Buildings and Enclosures
   1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials to be stored therein.
   2. Arrange and partition to provide security of contents and ready access for inspection and inventory.

F. Construct and use a separate storage area with adequate spill containment for hazardous materials used in constructing the Work.
   1. For the purpose of this paragraph, hazardous materials to be stored in the separate area are all products labeled with any of the following terms: Warning, Caution, Poisonous, Toxic, flammable, Corrosive, Reactive, or Explosive. In addition, whether or not so labeled, the following materials shall be stored in the separate area: diesel fuel, gasoline, new and used motor oil, hydraulic fluid, cement, paints and paint thinners, two-part epoxy coatings, sealants, asphaltic products, glues, solvents, wood preservatives, sand blast materials, and spill absorbent.
   2. Hazardous materials shall be stored in groupings according to the Material Safety Data Sheets.
   3. Develop and submit to Engineer a plan for storing and disposing of the materials above.
   4. The separate storage area shall meet the requirements of authorities having jurisdiction over the storage of hazardous materials.
   5. Hazardous materials which are delivered in containers, shall be stored in the original containers until use. Hazardous materials which are delivered in bulk, shall be stored in containers which meet the requirements of authorities having jurisdiction.
   6. Obtain and submit to Engineer a single EPA number for wastes generated at the site.
   7. The separate storage area shall be inspected by the proper authorities prior to construction of the area, upon completion of construction of the area, and upon cleanup and removal of the area.

G. In the event machinery and equipment need servicing on site, be responsible to clean environmentally hazardous materials from the site immediately.

1.6 PARKING/CONSTRUCTION TRAILER

A. Provide a level pad sufficient for parking of minimum 7 vehicles. This work will be done within three days of mobilization at the jobsite.

B. Parking of construction vehicles is limited to the Owner's property shown on Drawing C-01.

B. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. Repair breaks, potholes, low areas, which collect standing water, and other deficiencies.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 51 00
TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. Provide temporary utilities as required to provide the Work and perform the services, complete, in accordance with the Contract Documents.

B. The types of utility services required for general temporary use at the project site include the following:

Water service (potable for certain uses)

Sanitary sewer

Electric power service

1.2 JOB CONDITIONS

A. Scheduled Uses: In conjunction with establishment of the job progress schedule, establish a schedule for implementation and termination of service for each temporary utility or facility; at earliest feasible time, and when acceptable to Owner, change over from use of temporary utility service to permanent service.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide either new or used materials and equipment, which are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry, by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided for Contractor by Owner or another utility company, provide the remainder with matching and compatible materials and equipment that comply with applicable standards and codes and requirements of Owner and that company.

PART 3 - EXECUTION

3.1 INSTALLATION OF TEMPORARY UTILITY SERVICES

A. General: Wherever feasible, engage the utility company to install temporary service to project, or as a minimum, to make connection to existing utility service; locate services where they will not interfere with total project construction Work, including installation of permanent utility services; and maintain temporary services as installed for required period

of use; and relocate, modify or extend as necessary from time to time during that period as required to accommodate total project construction Work.

3.2 INSTALLATION OF POWER DISTRIBUTION SYSTEM

A. Power: Provide all necessary power required for its operations under the Contract, and provide and maintain all temporary power equipment and lines required to perform the Work in a safe and satisfactory manner.

B. Temporary Power Distribution: Provide a weatherproof, grounded, temporary power distribution system sufficient to accommodate performance of entire Work of project, including temporary electrical heating where needed, operation of test equipment and test operation of equipment and systems, temporary operation of other temporary facilities, including permanent equipment and systems which must be placed in operation prior to use of permanent power connections (pumps, valves, HVAC equipment, and similar equipment), and power for temporary operation of existing facilities (if any) at the site. All temporary construction power wiring shall be on a Ground Fault Interruption System.

3.3 INSTALLATION OF LIGHTING

A. Construction Lighting: All Work conducted at night or under conditions of deficient daylight shall be suitably lighted to insure proper Work and to afford adequate facilities for inspection and safe working conditions. All construction lighting shall be hooded and directed downward away from residences.

B. Temporary Lighting: Provide a weatherproof, grounded temporary lighting system in every area of construction work, as soon as overhead floor/roof deck structure has been installed; and provide sufficient illumination for safe work and traffic conditions; and run circuit wiring generally overhead, and rise vertically in locations where it will be least exposed to possible damage from construction operations on grade, floors, decks, or other recognized areas of possible damage or abuse.

3.4 WATER SUPPLY

A. General: Be responsible to provide an adequate supply of water of a quality suitable for all domestic, construction, and testing purposes. This includes obtaining the necessary water meter from the governing agency and paying the appropriate use fees.

B. Water Connections: Do not make connection to, or draw water from, any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the affected water system. For each such connection made, first attach to the fire hydrant or pipeline a valve and a meter, if required by the said authority, of a size and type acceptable to said authority and agency. Pay all permit charges.

3.5 COMMUNICATIONS

A. Telephone Services: Provide and maintain at all times during the progress of the Work a cellular telephone system which will allow the Owner or Engineer telephone access to the Contractor and staff.

3.6 INSTALLATION OF SANITARY FACILITIES

A. Toilet Facilities: Fixed or portable chemical toilets shall be provided whenever needed for use on the site. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 2926.51 of the OSHA Standards for Construction.

B. Sanitary and Other Organic Wastes: Establish a regular daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities or organic material wastes from any other source related to the operations shall be disposed of away from the site in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto.

3.7 OPERATIONS AND TERMINATIONS

A. Inspections: Prior to placing temporary utility services into use, inspect and test each service and arrange for governing authorities' required inspection and tests and obtain required certifications and permits for use thereof.

B. Protection: Maintain distinct markers for underground lines and protect from damage during excavating operations.

C. Termination and Removal: When need for a temporary utility service or a substantial portion thereof has ended, or when its service has been replaced by use of permanent services, or not later than time of substantial completion, promptly remove installation unless requested by Engineer to retain it for a longer period. Complete and restore Work which may have been delayed or affected by installation and use of temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces.

D. Removal of Water Connections: Before final acceptance of the Work on the project, all temporary connections and piping installed shall be entirely removed, and all affected improvements shall be restored to original condition or better, to the satisfaction of the Engineer and to the agency owning the affected utility.

END OF SECTION

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SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 EXPLOSIVES AND BLASTING

A. The use of explosives on the Work will not be permitted.

1.2 DUST ABATEMENT

A. Furnish all labor, equipment, and methods required to prevent, control, and mitigate fugitive dust from the construction activities. In complying with this requirement, conform to all local requirements in all circumstances. Be responsible for damage resulting from dust generated by its activities. Dust abatement measures shall be continued until Engineer directs otherwise.
   1. Unpaved Roads: Apply liquid dust palliative as appropriate for traffic areas as approved by Engineer.
   2. All other Non-Paved Work Areas: Apply a liquid dust palliative (soil stabilizer type) derived from natural organic plant sources and containing no growth – or germination – inhibiting materials as approved by Engineer. Application shall be effective for dust suppression according to applicable County Health District Air Pollution Control Division dust regulations. Do not allow movement of vehicles or storage of materials on treated areas.

1.3 RUBBISH CONTROL

A. Prepare a trash abatement program and submit to Engineer for review. The program shall include placing all litter, trash, garbage, construction debris, and refuse in scavenger-proof, resealable containers. Trash includes, but is not limited to, cigarettes, cigars, gum wrappers, tissue, cans, paper, and bags. During the progress of the Work, keep the Project Site and other areas used by it in a neat and clean condition, and free from any accumulation of rubbish. Dispose of all rubbish and waste materials of any nature occurring at the Project Site, establish regular intervals of collection and disposal of such materials and waste. Keep haul roads free from dirt, rubbish, and unnecessary obstructions resulting from construction operations. Disposal of all rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal, and in conformance with all applicable safety laws, and to the requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

B. Clean up and properly dispose of any oil, fuel, and other equipment leaks at the time of occurrence. Service and maintenance vehicles shall carry a bucket and pads to absorb leaks and spills. Notify Engineer of any spills or leaks at the time of occurrence.

1.4 SANITATION

A. Toilet Facilities: Provide fixed or portable chemical toilets wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.

B. Sanitary and Other Organic Wastes: Establish a regular collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities or organic material wastes from any other source related to the construction operations shall be disposed of away from the Site in a manner satisfactory to Engineer and in accordance with all laws and regulations pertaining thereto.

1.5 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether soil sterilant, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer.

1.6 CULTURAL RESOURCES

A. Direct attention to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800, which provide for the preservation of potential historical architectural, archaeological, or cultural resources (hereinafter called "cultural resources").

B. Conform to the applicable requirements of the National Historic Preservation Act of 1966 as it relates to the preservation of cultural resources.

C. In the event potential cultural resources are discovered during subsurface excavations at the Site of construction, institute the following procedures:
   1. Engineer will issue a Field Order directing the cessation all construction operations at the location of such potential cultural resources find. Mark the area in an appropriate manner to ensure that all construction equipment, activities, and personnel remain clear of the area until further notice.
   2. Field Order shall be effective until such time as a qualified archaeologist can be called to assess the value of these potential cultural resources and make recommendations to the State Historic Preservation Office.

D. If the archaeologist determines that the potential find is a bona fide cultural resource, at the direction of the State Historic Preservation Office, suspend work at the location of the find under the provisions for changes contained in Articles 10, 11, and 12 of the General Conditions.

1.7 AIR QUALITY

A. Maintain all vehicles and equipment in proper tune.

B. Use Best Available Control Technology on construction equipment, including a timing retardation.

C. Use natural-gas powered construction equipment where possible.

D. Encourage employee car-pooling.

1.8 NOISE

A. Comply with the hours of work as allowed by the local jurisdiction or land management agency.

B. Noise limits on construction equipment will comply with the noise limits of the local jurisdiction or land management agency. All construction equipment shall be equipped with manufacturer's standard noise control devices (i.e., mufflers, acoustical lagging, and/or engineer enclosures). Take special care not to throttle the engine excessively and keep engine speed as low as possible. Do not leave the equipment running or idling needlessly, especially when near noise-sensitive land uses. Noise-sensitive land uses include, but are not limited to, residences, schools, hospitals, libraries, retirement and elderly care centers, religious and worship facilities, courts of law, certain noise-sensitive professional offices, and quiet recreational areas such as campgrounds and hiking trails.

C. Use newer equipment whenever possible. Inspect all construction equipment at periodic intervals to ensure proper maintenance and the presence of noise control devices (i.e., mufflers and shrouding, etc.)

D. Keep heavy, noisier equipment a minimum of 100 feet away from the property line of any noise-sensitive land use for any length of time. Avoid coming closer than 200 feet if multiple pieces of equipment are operating simultaneously. If such cases are unavoidable, avoid throttling the engine excessively or leaving the equipment running needlessly. Heavy equipment shall be operated in a manner to comply with the jurisdiction's noise ordinance and vibration performance standard. To comply with these requirements, it may be necessary to operate heavy equipment only 30 minutes out of each one-hour period at distances closer than 200 feet from an occupied property. During the remaining 30 minutes, the equipment should move further away or be shut down, but may resume 30 minutes later.

E. Locate stationary noisy equipment away from construction boundaries that are near noise-sensitive uses.

F. Concrete trucks shall perform initial mixing and other activities that require high revving of the truck engine a minimum of 600 feet from noise-sensitive land uses. Keep engine revolutions per minute as low as possible at closer distances.

G. Whenever possible, use electric hand tools rather than gas-powered tools.

H. If operation of dewatering pumps and generators is required between the hours of 6 p.m. and 7 a.m. and within 600 feet of a noise-sensitive land use, they shall be treated with acoustical noise control measures (e.g., mufflers, shrouding, and/or enclosures) so as not to exceed 56 dba at 50 feet or other appropriate requirements of the local jurisdiction.

I. If requested by the Engineer, install temporary noise barriers for construction activities, including staging areas that occur closer than 100 feet from noise-sensitive land uses. Noise barriers can be made of plywood, heavy vinyl curtain material, natural or temporary earth berms, or stockpiles of construction material.

1.9 CONTROL OF SURFACE WATER

A. Be advised that portions of the Work site are subject to flooding from surface waters. Many portions of the site are located directly in washes or drainage ways. Other portions of the Work are located outside major drainage ways but are still subject to minor channelized flows and overland sheet flow during some rainfall events.

B. Be responsible for protecting the Work and temporary facilities from damage due to flooding, runoff, surface water flows, and related subsurface flows until final Project closeout. Provide protection for all aspects of the Work whether temporary or permanent. Provide all materials and equipment required to protect the Work. No additional payment will be made by Owner for providing protective measures or for any damage resulting from said flows. All damage from said flows shall be completely replaced in accordance with the Contract Documents at no additional cost to Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 00
MOBILIZATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Organization and mobilization of the forces.

B. Transporting construction plant and equipment to the jobsite and setting up of same.

C. Transporting various tools, materials, and equipment to the jobsite.

D. Erection of temporary buildings and facilities as required for field offices, staging, storage, and construction operations.

1.2 PAYMENT FOR MOBILIZATION

A. Payment for mobilization shall be as described in Section 01 20 00 – Measurement and Payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Mobilization shall include the following principal items:
1. Provide all required insurance certificates and bonds.
2. Move onto the site, or portion of site as available, of all plant and equipment required for first month's operations including office and storage trailers.
3. Install temporary construction power, wiring, and lighting facilities.
4. Develop construction water supply.
5. Provide all on-site communication facilities, including telephones, cordless phone antenna, and radio pagers.
6. Provide on-site sanitary facilities and potable water facilities.
7. Arrange for and erection of work and storage yard.
8. Construct and implement security features and requirements complying with Section 01 31 30 – Safety.
9. Obtain all required permits.
10. Post all OSHA required notices and establish safety programs.
11. Provide Superintendent at the job site full time.

3.2 SUBMITTAL REQUIREMENTS

A. The following submittals are due by the day indicated and must be approved by Owner as a condition precedent to completion of mobilization.

No.	Submittal	Specification Section
1.	Quality Assurance / Control Plan	01 45 00
2.	Mobilization Plan	01 71 00
3.	Safety Program	01 31 30
4.	Concrete Mix Designs	03 30 00
5.	List of Permits and Licenses	01 41 26
6.	Schedule of Submittals	01 33 20

3.3 MOBILIZATION PLAN

A. Within 15 Days after receipt of the Notice to Proceed, submit a mobilization plan to Engineer for approval, which shall include a breakdown showing the estimated value of each component of mobilization as described in paragraphs 3.1 and 3.2 herein.

B. Include a bar chart schedule showing each item of mobilization listed in paragraphs 3.1 and 3.2 herein and include scheduled start date, finish dates, and total duration. The plan shall also list each activity to be initiated in the first 90 Days following Notice to Proceed, complete, with scheduled start date, finish date, and total duration.

END OF SECTION

SECTION 01 71 30
SITE CONDITIONS SURVEYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements to document conditions of the Project Site and adjacent properties before construction begins and after completion of the Work. Methods include still photographs, digital video recordings, and topographic surveys.

1.2 SUBMITTALS

A. Submit all photographs, digital videos, and topographic survey data of the preconstruction conditions to Engineer for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

1.3 CLOSEOUT SUBMITTALS

A. Complete and submit all digital videos, still photographs, mapping, and survey data of the postconstruction conditions to Engineer prior to final inspection by Owner and Engineer.

B. Provide postconstruction survey data to Engineer as follows:
   1. Submit topographic mapping for each site hereinbefore identified for topographic mapping and surveys as a separate electronic map (drawing) in AutoCAD Release 2018, or later.
   2. Also submit each AutoCAD site map in hard copy plot format (six copies).
   3. Engineer will review hardcopy plots for accuracy relative to the specified requirements.
   4. Amend mapping files, as required, based on review of the hardcopy plots by Engineer.
   5. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of 1"=20' horizontal and 2-foot contour intervals as specified for National Map Accuracy Standards.
   6. All electronic mapping files shall be three-dimensional.
   7. Submit lists of survey points for all topographic surveys in ASCII text file format.
   8. Provide mapping and points files on one or more compact discs in a format acceptable to Engineer.

C. Submit six copies of the disk media.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Conduct thorough preconstruction and postconstruction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs, digital video recordings, and topographic mapping. Provide and submit sufficient photographs, supplemented by digital video, to Engineer to resolve any damage claims, which may arise due to the construction of this Project. Develop topographic mapping using the Project coordinates and referenced to the Project base lines and benchmarks. Mapping shall be adequate to ascertain preconstruction and postconstruction conditions (including elevations) of all public and private property within and adjacent to the construction limits.

B. Digital video or photographic surveys shall include, but not be limited to, all access roads used to transport material or equipment to and from the Site and elevation of roadways, drives, walks, and buildings. Use spot elevation surveys to document the elevation on abutting roadways, drives, and walks, taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the Work. In addition, take elevations of all building slabs along the Project route. Provide topographic mapping as specified herein.

C. Digital video recordings required as part of this Section and by Section 31 10 00 – Site Preparation and Restoration and Section 31 23 00 - Earthwork may be combined into a single set of media provided the requirements for videos specified in both Sections are met.

D. As a minimum, note preconstruction and postconstruction conditions and perform digital video surveys of the following:
   1. Areas used to access the Site or haul materials and equipment to the Site.
   2. The access road, both original and relocated locations and ultimately to the Site.
   3. All Work areas, including, but not limited to, access corridors, disposal areas, and staging areas.
   4. Any work completed by other contractors at the Site that will be impacted or otherwise affected by Work of this Project.

E. Supplement digital video surveys with still photographs and spot elevation surveys as required to document the original condition and location of existing features and facilities.

F. Provide digital video records in DVD-R format.

END OF SECTION

SECTION 01 71 50
PROTECTION AND RESTORATION OF EXISTING FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Protect all existing utilities and improvements not designated for removal and restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than they were prior to such damage or temporary relocation, in accordance with the Contract Documents.

B. Call Blue Stakes before commencing any digging for location of underground utility lines and cable locations. The number is 811 or (801) 208-2100.

C. Provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations except for unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches and shall remain in place during all non-working hours.

D. Provide temporary caps over all large diameter pipe during non-working hours to prevent unauthorized access.

1.2 RIGHTS-OF-WAY

A. Do not perform any work that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure. Do not enter upon the rights-of-way involved until notified by Engineer that Owner has secured authority therefore from the proper party.

B. After authority has been obtained, give said party due notice of intention to begin work, if required by said party, and remove, shore, support or otherwise protect such pipeline, transmission line, ditch, fence, or structure or replace same.

C. When two or more contracts are being executed at one time on the same or adjacent land in such manner that work on one contract may interfere with that on another, Owner will determine the sequence and order of the Work. When the territory of one contract is the necessary or convenient means of access for the execution of another contract, such privilege of access or any other reasonable privilege may be granted by Owner to Contractor so desiring, to the extent, amount, in the manner, and at the times permitted and in full conformance with the conditions of the Contract Documents.

D. No such decision as to the method or time of conducting the Work or the use of territory shall be made the basis of any claim for delay or damage, except as provided for temporary suspension of the Work in the General Conditions of the Contract.

1.3 PROTECTION OF STREET OR ROADWAY MARKERS

A. Do not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. Do not begin pavement breaking or excavation until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Accurately replace survey markers or points disturbed after all street or roadway resurfacing has been completed.

1.4 RESTORATION OF PAVEMENT

A. General: Replace all paved areas cut or damaged during construction with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing a permit. The pavement restoration requirement to match existing sections applies to all components of existing sections, including sub-base, base and pavement. Conform temporary and permanent pavement to the requirements of the affected jurisdictional agency. Neatly saw cut pavements, which are subject to partial removal, in straight lines. Refer to Division 32 for specific pavement restoration requirements.

B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction, place temporary surfacing promptly after backfilling and maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.

C. Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, saw cut back and trim the edge to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement. Refer to plans for minimum dimension of T-patch replacement width over disturbed pipeline trenches in paved areas.

D. Pavement Crown: In areas where pipeline trenching impacts an existing crown of asphalt, survey, and submit to Engineer documentation showing the pre-construction location of the crown prior to trenching. Replace the crown of asphalt to its pre-construction location to the satisfaction of the governing agency and Engineer.

E. Restoration of Sidewalks or Private Driveways: Wherever sidewalks or private roads have been removed for purposes of construction, place suitable temporary sidewalks or roadways promptly after backfilling and maintain them in satisfactory condition for the period fixed by the authorities having jurisdiction over the affected portions before proceeding with the final restoration. If no such period of time is so fixed, maintain said temporary sidewalks or roadways until the final restoration thereof has been made.

F. Restoration of Curb and Gutter: Wherever curb and gutter, including driveway and sidewalk approaches, have been removed for purposes of construction, replace these improvements following construction to the specific dimension and requirements of the authority having jurisdiction. Replace improvements, including required ADA access details to the latest version of the authoritative standard regardless of their preconstruction condition.

1.5 EXISTING UTILITIES AND IMPROVEMENTS

A. General. Protect underground utilities and other improvements, which may be impaired during construction operations, regardless of whether the utilities are indicated on the Drawings. Take all possible precautions for the protection of unforeseen utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.

B. Except for utilities specifically located on the Drawings, be responsible for exploratory excavations (potholing) as deemed necessary to determine the exact locations and depths of utilities, which may interfere with the Work. Perform all such exploratory excavations as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Work's progress. When such exploratory excavations show the utility locations as shown on the Drawings to be in error, so notify Engineer. Refer to plans for minimum advance distance that potholing must be performed prior to pipeline trenching work.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility.

D. Utilities to be Moved: In case it becomes 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 removed are encountered within the area of operations, notify Engineer a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

E. Utilities to be Removed: Where the proper completion of the Work requires temporary or permanent removal and/or relocation of an existing utility or other improvement which is indicated, remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to Engineer and the owner of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished 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 as found prior to removal.

F. Owner's Right of Access: Owner and owners of public utilities and franchises reserve right to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.

G. Underground Utilities Indicated: Existing utility lines that are indicated or the locations of which are made known prior to excavation and that are to be retained, and all utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced unless otherwise repaired by the owner of the damaged utility. If the owner of the damaged facility performs its own repairs, reimburse said owner for the costs of repair.

H. Underground Utilities Not Indicated: In the event of damage to existing utility lines that are not indicated or the locations of which are not made known prior to excavation, make a verbal report of such damage immediately to Engineer and a written report thereof promptly thereafter. Notify the utility owner of the damage. If directed by Engineer, repairs shall be made under the provisions for changes and extra work contained in the General Conditions.

I. Damages. Costs of locating and/or repairing damage not due to failure to exercise reasonable care, and removing or relocating such utility facilities not indicated in the Contract Documents with reasonable accuracy, and for equipment on the project which was actually working on that portion of the Work which was interrupted or idled by removal or relocation of such utility facilities, and which was necessarily idled during such Work will be paid for as extra Work in accordance with the provisions of the General Conditions.

J. Approval of Repairs: All repairs to a damaged utility or improvement are subject to inspection and approval by an authorized representative of the utility or improvement owner before being concealed by backfill or other work.

K. Fire Hydrants: Keep all fire hydrants and water control valves free from obstruction and available for use at all times.

L. Maintaining in Service: Unless indicated otherwise, all oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. Be responsible for and repair all damage due to construction operations. The provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

M. Utility Service Laterals: Utility service laterals are not shown on the plans. Anticipate that there are no less service laterals than there are homes where project trenches are located in the vicinity of a street between a home and the utility main. Protect in place, or remove and replace to the satisfaction of the utility owner, all utility service laterals encountered during construction. Duration of utility service outages and public notification procedures shall conform to the standards of the controlling agency and these Contract documents.

1.6 TREES OR SHRUBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS

A. General: Except where trees or shrubs are indicated to be removed, 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. Do not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or Owner. Trim or replace existing trees and shrubs which are damaged during construction using the services of a certified tree company under permit from the jurisdictional agency and/or Owner.

B. Trimming; 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. Do not use spikes 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 kerosene, coal tar, creosote, or other material injurious to the life of the tree.

C. Replacement: Immediately notify the jurisdictional agency and/or Owner if any tree or shrub is damaged by construction operations. If, in the opinion of said agency or Owner, the damage is such that replacement is necessary, replace the tree or shrub at no additional expense to Owner. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a

small size, the pay to the 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 not be less than 1-inch diameter nor less than 6 feet in height. Planting of replacement trees and shrubs shall be in accordance with the recommendations of the nursery furnishing the plants. Unless otherwise indicated, water and maintain the replacement trees and shrubs for 6 months after planting.

1.7 LAWN AREAS

A. Repair lawn or landscaped areas damaged during construction to match the pre-construction condition to the satisfaction of the landowner and Owner. Use high quality sod to restore all lawn areas. Location and quality of irrigation system equipment shall be confirmed prior to construction. Where lawn irrigation systems have been removed or damaged during construction, be responsible for replacement of systems in kind to the satisfaction of the landowner. Anticipate that pressurized irrigation systems are present in all maintained lawn areas that will be impacted by construction. Verify proper operation of the irrigation system with landowner as required for maintenance of newly installed sod prior to transferring of watering responsibilities.

1.8 UNIMPROVED AREAS

A. Remove and stockpile topsoil prior to construction in accordance with Division 31 specifications. Replace topsoil prior to restoration of unimproved areas.

B. Unimproved areas, including unclassified open spaces, fields, and unimproved rights-of-way, damaged during construction shall be repaired to match pre-construction conditions to the satisfaction of the land owner and Owner. At a minimum, unimproved areas shall be smoothed and finished graded with topsoil to match preconstruction topography, and reseeded using a native seed mix acceptable to the land owner and Owner.

C. All slopes greater than 2H : 1V shall be protected with erosion control matting prior to reseeding.

1.9 OTHER SURFACE IMPROVEMENTS

A. Conduct a pre-construction survey of all properties that will be impacted by construction operations. All improvements that have the potential to be impacted by construction, including but not limited to fencing, landscaping, boulders, retaining walls, irrigation systems, and other public and/or private improvements, shall be protected in place, or if necessary, removed and replaced with like kind or better quality following construction.

1.10 NOTIFICATION BY CONTRACTOR

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, notify the owners or agencies responsible for such facilities not less than three days nor more than seven days prior to excavation so that a representative of said owner or agencies can be present during such Work if they so desire.

B. When it is necessary to temporarily deny access to property, or when any utility service connection must be interrupted, give notices sufficiently in advance to enable the affected persons to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

C. Contact, cooperate with, and provide written notice (including Contractor's phone number) at least seven days prior to beginning Work on each street. The written notice shall include the approximate schedule and explanation of Work and shall be given to each homeowner, business, all emergency agencies, schools, and residents, which will be affected by the project; particularly in reference to temporary interruptions to vehicular access. At least twenty-four hours prior to initiation of Work, provide a second notice to confirm the scope of scheduled Work. Submit a copy of the notifications to Engineer, for approval, prior to the start of construction. Make verbal door-to-door communication prior to construction to remind all affected parties of the construction to take place. In addition, be responsible to answer and resolve any conflicts that may arise between a homeowner or business owner and the construction personnel.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 74 19
DISPOSAL OF WATER

PART 1 - GENERAL

1.1 SUMMARY

A. Prepare a detailed listing of all discharges and overflows that will occur during the disinfection procedure.

B. All water used in hydrostatic testing shall be disposed of in accordance with water quality regulations. Note that all chlorinated water from pipeline draining and testing, reservoir draining and testing, and all other construction activities shall be dechlorinated prior to discharge to the local drainage.

1.2 REFERENCES

A. American Water Works Association (AWWA) standards, latest edition.

AWWA C651	Disinfection Water Mains
AWWA C652	Disinfection of Water Storage Facilities

1.3 SUBMITTALS

A. Submit a listing of every significant discharge from a drain valve, pump well, overflow, drain piping, and from all related appurtenances. "Significant discharge" is defined as a volume that is greater than that required to exercise or fill piping with chlorinated water and briefly flush. The listing shall be utilized as input for the Construction Progress Schedule to identify the volume and duration for every discharge that must be accounted for. Very minor discharges for air-release piping or drains that are exercised briefly to ensure disinfection do not need to be identified on the Construction Progress Schedule for dechlorination or discharge.

B. Include the proposed method and equipment for dechlorination, including type of agent, temporary feed pumps, and appurtenant feed equipment.

C. Final Report: Submit to Engineer a final report of each significant discharge, its locations, dates sampled for effectiveness of dechlorination, and the test results.

PART 2 - PRODUCTS

2.1 MATERIALS FOR DECHLORINATION

A. Where dechlorination of water released back to the environment is required, use a sodium bisulfate or equivalent dechlorinator. Sodium bisulfite, if used, shall be applied at a ratio of at least 1.47 parts per every part of chlorine to be removed. This is to remove all the free active chlorine. Since the reaction produces a byproduct of hydrochloric acid, it will also tend to lower the pH of the water and remove calcium carbonate from the water. If the pH drops

below 6.0, add calcium carbonate back into the water during the dechlorination process to restore the pH to an acceptable level of at least 6.0.

B. The process of dechlorination consists of utilizing a chemical metering pump to inject a 44 percent (or less) solution of sodium bisulfite into a temporary discharge pipe with a static mixer and after a few seconds (plus or minus three) withdrawing sample for a chlorine residual analyzer. Based on the results, the analyzer shall send a signal to adjust the chemical feed rate.

PART 3 - EXECUTION

3.1 MAJOR DISCHARGES, PUMP WELLS, OVERFLOWS

A. General: List each drain valve, pump well, and overflow, along with proposed volume and duration of discharge during the disinfection procedure. Locations requiring dechlorination shall be indicated. Refer to Drawings to obtain detailed information on size, location, and layout of facilities and access conditions. Review the site of each proposed discharge for the conditions at the proposed discharge.

END OF SECTION

SECTION 01 77 00
PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Contract closeout, including final cleaning, preparation, and submittal of closeout documents, warranties and bonds, and final completion certification.

B. Closeout submittals and submittal forms in both hard copy and electronic format.

1.2 SUBMITTALS

A. Closeout Documents: Submit the following closeout documents prior to making a written request for Final Completion.
   1. Project record drawings and documents per Section 01 78 39 – Project Record Documents.
   2. Shop drawings.
   3. Keys and keying schedule.
   4. Post construction survey record documents, where required.
   5. Quality Control reports per Section 01 45 00 – Quality Control.
   6. Final Operation and Maintenance Manuals.
   7. Maintenance stock items; spare parts and special tools.
   8. Written warranties and bonds where required.
   9. Bonds for roofing or maintenance, if indicated.
   10. Access Badges and Parking Permits.
   11. Release of liens or release of claims forms submitted by all subcontractors and suppliers, if requested by Owner

B. Evidence of Compliance With Inspections and Other Requirements of Governing Authorities: Submit the following:
   1. Special Inspection Reports.
   2. Certificate of Occupancy, if applicable.
   3. Release from each affected property owner or agency indicating final acceptance.

C. Operation and Maintenance Manuals
   1. One percent of the contract price will be withheld from any monies due as progress payments, if at the 75 percent construction completion point, the approved *Operations and Maintenance Manual* complying with Section 01 33 20 - Submittal Procedures has not been submitted. The aforementioned amount will be withheld by Owner as the agreed, estimated value of the approved *Operations and Maintenance Manuals.* Any such retention of money for failure to submit the approved *Operations and Maintenance Manuals* on or before the 75 percent construction completion point shall be in addition to the retention of any payments due under General Conditions of the Contract.

D. Final Change Order: A final Change Order shall be submitted and processed if required. Final payment and close-out procedures shall comply with requirements of the Contract Documents.

1.3 CLOSEOUT TIMETABLE

A. Establish dates for equipment testing, acceptance periods, and on-site instructional periods as required under the Contract Documents. Such dates shall be established not less than one week prior to beginning any of the required activities, to allow Owner, Engineer, and their authorized representatives sufficient time to schedule attendance at such activities.

1.4 COMPLETION PROCEDURES

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Prior to making such request, the following must be complete:
   1. Work necessary for the safe, proper, and complete use or operation of the facility as intended.
   2. Punch list of items remaining to be completed, for submission with the request for issuance of a Certificate of Substantial Completion.
   3. Submit and receive acceptance of accurate record drawings for all work completed to date.
   4. Submit and receive acceptance of all specified warranties, bonds, guarantees and operation and *Operations and Maintenance Manuals*.
   5. Complete all required vendor training, testing, and where required, start-up.
   6. Deliver all required spare parts, maintenance stock items, and special tools.
   7. Complete equipment and communications system testing successfully.

B. Upon receipt of the request, Engineer and designated representatives will review the request, the Work, and the above requirements to determine whether Substantial Completion has been achieved. If this review fails to support Substantial Completion, Engineer will notify Contractor in writing citing the reasons for rejection. If Engineer determines that Substantial Completion has been achieved, the following procedures will be followed:
   1. Engineer, his/her representative, and user representatives will review the Work and the punch list to assure all deficiencies are noted on a final punch list.
   2. Engineer will schedule and conduct a pre-final walk-through of the facility with representatives of Owner, Engineer, Contractor, and others, for the purpose of formally reviewing the Work, the final punch list, and the readiness of the Work for use. A copy of the final punch list will be furnished to all participants and any additional items noted during the walk-through will be added to the list.
   3. Upon completion of the pre-final walk-through, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion as the date of the walk-through, provided the walk-through has verified that the Work is in fact ready for use and occupancy by Owner for its intended purpose. Engineer will attach to the certificate a punch list of items to be completed or corrected before final payment. In accordance with the General Conditions of the Contract, upon approval of this request by Owner, the facility will be considered Substantially Complete.

C. When Contractor deems that the entire Work or an agreed portion thereof is complete, Contractor shall notify Engineer and Owner in writing that the entire Work is complete. Final Completion will be deemed to have occurred when Work is completed including the following:
   1. All final punch list items have been corrected, signed off by Contractor and Engineer, and demonstrated to Owner during a final walk-through.
   2. All updates to record drawings, and *Operations and Maintenance Manuals* have been made.
   3. Demobilization and site cleanup are complete.
   4. Facilities and/or equipment have been properly demonstrated to be functioning as required.
   5. Owner has received releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.
   6. New permanent cylinders and key blanks for all locks have been provided to Owner.

D. Certificate of Final Completion
   1. When all items have been completed or corrected, submit written documentation to Engineer that the entire Work is complete in accordance with the Contract Documents and request final inspection.
   2. Upon completion of final inspection by Owner and Engineer, Owner will either prepare a Certificate of Final Completion of the entire Work or advise all parties of Work not satisfactorily complete. If necessary, repair or replacement and inspection procedures will be repeated until Owner accepts the Work and issues a Certificate of Final Completion.

E. Partial Utilization may be desired at Owner's option, as described in the General Conditions. If Partial Utilization is requested, the same procedure for completion of that portion of the Work as indicated in paragraphs A and B above, will be used.

1.5 CLOSE-OUT PROCEDURE

A. Engineer and Contractor shall meet and resolve all outstanding issues including, but not limited to:
   1. Claims and adjustments for time or costs
   2. Outstanding, unused allowances
   3. Procedures for handling warranty issues.

B. A Final Change Order shall be processed if required. Final payment and close out procedures shall comply with all requirements of the Contract Documents.

1.6 MAINTENANCE AND GUARANTEE

A. Comply with the maintenance and guarantee requirements contained in General Conditions of the Contract.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless Contractor has obtained a statement in writing from the

affected private authority or public agency releasing Owner from further responsibility in connection with such repair or resurfacing. Submit such release(s) to Engineer.

C. Make all repairs and replacements promptly upon receipt of written order from Owner. If Contractor fails to make such repairs or replacements promptly, Owner reserves the right to do the Work and Contractor, and his surety shall be liable to Owner for the cost thereof.

1.7 BOND

A. Furnish a Performance Bond as required by General Conditions of the Contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. Certificate of Final Completion of the Work by Owner will be withheld until requirements for final cleanup of the Project Site are complete as follows:
   1. Perform final cleaning prior to inspections for final acceptance.
   2. Employ skilled workers who are experienced in cleaning operations.
   3. Use cleaning materials that are recommended by manufacturers of surfaces to be cleaned.
   4. Avoid scratching, discoloring, and otherwise damaging surfaces being cleaned.
   5. Clean roofs.
   6. Broom clean and power wash exterior paved surfaces and rake clean other surfaces of sitework. Police yards and grounds to keep clean.
   7. Remove dust, cobwebs, and traces of insects and dirt.
   8. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, fixtures, and Equipment.
   9. Remove nonpermanent protection and labels.
   10. Polish finish hardware.
   11. Wash and shine mirrors.
   12. Polish glossy surfaces to clear shine.
   13. Clean ducts, blowers, and coils when units were operated without filters during construction.
   14. Clean light fixtures and replace burned-out or dim lamps.

3.2 WASTE DISPOSAL

A. Remove temporary structures and facilities and arrange for and dispose of surplus materials, waste products, and debris as follows:
   1. Prior to making disposal on private property, obtain written permission from owner of such private property.
   2. Do not fill ditches, washes, or drainage ways which may create drainage problems.
   3. Do not create unsightly or unsanitary nuisances during disposal operations.
   4. Maintain disposal site in safe condition and good appearance.

5. Complete leveling and clean-up prior to final acceptance of the Work.

3.3 TOUCH-UP AND REPAIR

A. Touch up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for final acceptance.

B. Refinish or replace entire surfaces that cannot be touched-up or repaired satisfactorily.

3.4 DEMOBILIZATION

A. Demobilization shall include moving plant and equipment, field trailers, construction materials, debris, and so forth from the Site as well as performing final cleanup.
   1. Disturbed areas shall be restored to their original state or better.
   2. Permanent improvements damaged during construction operations shall be repaired or replaced at no additional cost to Owner.
   3. Remove all equipment, materials, waste, and debris from the site and restore site to original condition upon completion of construction.
   4. The work area shall be restored to its original or better condition and shall be inspected and approved by Engineer.

END OF SECTION

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SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Maintain at the Site for Owner, one record copy of the Drawings, Specifications, Operation and Maintenance manuals, coordination drawings, and Shop Drawings that are clearly marked with a red pen to indicate all changes and or revisions resulting from, but not limited to, the following:
   1. Actual Project as constructed.
   2. Addenda.
   3. Change Orders and other modifications.
   4. Engineer's instructions.
   5. Field revisions.
   6. Requests for Interpretation (RFI).
   7. All other changes.

B. Give special attention to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings.

C. Record drawings shall be supplemented by any detailed sketches as necessary or directed to fully indicate the Work, as actually constructed.

D. Section Includes:
   1. Maintenance of Documents and Samples
   2. Marking Devices.
   3. Recording.
   4. Close-out Submittal Delivery.

1.2 MAINTENANCE OF DOCUMENTS AND SAMPLES

B. Store documents and samples in field office apart from documents used for construction.

C. Provide files and racks for storage of documents.

D. Provide locked cabinet or secure storage space for storage of samples.

E. Maintain documents in clean, dry, legible condition and in good order. Keep record documents separate from those used for construction.

F. Always make documents and samples available for reference by Engineer and Owner.

G. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final shop drawings, and by including appropriate reference information

describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.

H. During progress meetings, record documents may be reviewed to ascertain that changes have been recorded.

I. Updated Drawings, when provided by Engineer, will be substituted for the hand markups provided Contractor prints the applicable Drawings and inserts them into the record set each month.

J. Copies of the record drawings will be audited regularly by Engineer after the month in which the Notice to Proceed is given as well as on completion of the Work. Failure to properly maintain record drawings in a up-to-date condition may result in the withholding of payments due at the sole discretion of Owner.

1.3 MARKING DEVICES

A. Use a red color pen for recording all information to all documents defined herein.

1.4 RECORDING

A. Label each document "CONFORMING TO CONSTRUCTION RECORD" in neat large red printed letters.

B. Record information concurrently with construction progress, at the time the material or equipment is installed. Do not conceal any work until required information is recorded.

C. Drawings shall be legibly marked or PDFs edited to record actual construction per the following:
   1. Record actual depths of various elements of foundations in relation to finish first floor datum.
   2. Record actual as-built depths, horizontal and vertical location, (at every direction change and a maximum of 100 feet intervals on straight runs), of underground pipes, duct banks, and other buried utilities. Reference horizontal location to Project coordinate system and vertical elevations to Project datum.
   3. Identify and record specific details of pipe connections, location of existing buried features and utilities located during excavation, and the final locations of piping, equipment electrical conduits, manholes, and pull boxes (horizontal coordinates and vertical elevation).
   4. Identify and record location of spare conduits including beginning, ending, and routing through pull boxes, and manholes. Record spare conductors, including number and size, within spare conduits, and filled conduits.
   5. Record actual schedules, lists, layout drawings, and wiring diagrams.
   6. Record field changes of dimension and detail.
   7. Record changes made by instruction from Engineer or by Change Order.
   8. Record details not on original Contract Drawings.

D. Specifications and Addenda shall be legibly marked to record:
   1. Manufacturer, trade name, catalog number, and supplier for each product and item of equipment installed.

2. Changes made by instruction from Engineer or by Change Order.

E. Record potholing data and installation of marker balls.

F. All surveying for record documents shall be performed by a licensed surveyor.

1.5 CLOSEOUT SUBMITTALS

A. At Contract closeout, deliver complete record documents to Engineer as required in Section 01 77 00 - Project Closeout. Final payment will not be acted upon until the record drawings have been prepared and delivered to Engineer.

B. The information submitted will be incorporated by Engineer into final drawings to be provided to Owner. Be responsible for the accuracy of submitted construction information. Engineer will assume that the information provided by Contractor is correct and faithfully represents actual construction.

C. This submittal shall include the record paper set along with 2 portable drives. Each portable drive shall contain .pdf files and .dwg files of each drawing.

D. Prepare submittal with transmittal letter containing:
1. Date.
2. Project title and number.
3. Contractor's name and address.
4. Title and number of each record as-built document.
5. Signature of Contractor's authorized representative and a statement that certifies that the record documents are accurate and reflect what was installed during construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 81 10
SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This section Includes seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment and piping.
   2. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

A. International Code Council (ICC) documents as follows:

IBC	International Building Code, 2024 Edition with Utah state amendments

B. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7	Minimum Design Loads for Buildings and Other Structures, 2022 Edition

1.3 SUBMITTALS

A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 01 33 20 - Submittal Procedures. All drawings and calculations shall be signed and sealed by a licensed Civil or Structural engineer as required below under "Qualifications".

B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Licensed Professionals: Design of items required by this Section and other items not specifically shown in the Contract Documents shall be performed by a Civil or Structural Engineer licensed to practice in the state of Utah.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Criteria: Design in accordance with the requirements of the International Building Code and ASCE 7.
   1. Seismic acceleration variables to be used in design are as follows:
      a. The design 5 percent damped spectral response acceleration at short periods, S_{DS} = 1.03g.

b. The design 5 percent damped spectral response acceleration at a period of 1 second, S_{D1} = 0.8g.
c. The mapped maximum considered earthquake, 5 percent damped, spectral response acceleration at short periods, S_S = 1.53g.
d. The mapped maximum considered earthquake, 5 percent damped, spectral response acceleration at a period of 1 second, S_1 = 0.54g.
e. Soil Site Class = D.
f. Seismic Design Category = D.

2. Seismic Importance Factor for Anchorage of Mechanical and Electrical Equipment: 1.00.
3. Do not use friction to resist sliding due to seismic forces.
4. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting seismic forces. Embedded anchor bolts used to resist seismic forces shall have a standard hex bolt head.
   a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet IBC requirements when installed in cracked substrates.
   b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by Engineer.
   c. Seismic forces must be resisted by direct bearing on the fasteners used to resist seismic forces. Do not use connections which use friction to resist seismic forces.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 82 11
WIND DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This section Includes design criteria for the following when exposed to wind forces:
   1. Anchorage of mechanical and electrical equipment and piping.
   2. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

A. International Code Council (ICC) documents as follows:

IBC	International Building Code, 2024 Edition with Utah state amendments

B. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7	Minimum Design Loads for Buildings and Other Structures, 2022 Edition

1.3 SUBMITTALS

A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 01 33 20 - Submittal Procedures. All drawings and calculations shall be signed and sealed by a licensed Civil or Structural engineer as required below under "Qualifications".

B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Licensed Professionals: Design of items not specifically shown in the Contract Documents shall be performed by a professional Civil or Structural Engineer licensed to practice in the state of Utah.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Criteria: Design in accordance with the requirements of the International Building Code and ASCE 7.
   1. Basic Wind Speed: 109 miles per hour
   2. Risk Category: III
   3. Exposure: C
   4. Topographic Factor: As calculated per ASCE 7.

5. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting wind forces. Embedded anchor bolts used to resist seismic forces shall have a standard hex bolt head.
    a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet IBC requirements.
    b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by the Engineer.
    c. Wind forces must be resisted by direct bearing on the fasteners used to resist wind forces.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND STARTUP

PART 1 - GENERAL

1.1 SUMMARY

A. Equipment testing and startup are required for satisfactory completion of the Contract and, therefore, shall be completed within the Contract Time.

B. Section Includes:
1. Startup Plan
2. Certificates of Installation and Startup Services
3. Record Keeping
4. Factory Performance Testing
5. Field Performance Testing
6. Special Tools and Lubricating Equipment
7. Startup
8. Lubrication

1.2 DEFINITIONS

A. Component Test and Check Out is the verification that each component of the Work complies with the Contract Documents and is ready to perform its intended function.

B. Subsystem Test and Startup is the verification that a discrete group of related components is functioning as intended within itself and is ready to perform its intended function in the overall system.

C. System End-To-End Test and Startup is the operation and verification that all related components and subsystems are functioning as intended and are ready for final commissioning and operation.

D. Commissioning is placing a complete system or project into service.

1.3 SUBMITTALS

A. Submit startup plan a minimum of 90 days prior to beginning startup procedures.
1. Submit and have an approved detailed and coordinated startup plan for each piece of equipment, subsystem, and the entire system.
2. The Plan and Progress Schedule shall include the following activities:
   a. Manufacturer's services and startup dates.
   b. Submittal dates for certificates of installation and startup services.
   c. Operator training dates for each phase.
   d. Submittal of operation and Maintenance manuals.
   e. Functional test dates.
   f. Operational performance test dates.
   g. Post operational performance test dates.

3. The plan shall include test logs for each item of equipment and each system. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
4. Provide summary of shutdown requirements for existing systems which are necessary to complete startup of new equipment and systems.
5. Revise and update startup plan based upon review comments, actual progress, and to accommodate changes in the sequence of activities.
6. System startup plan shall be coordinated with Owner's operations staff and Engineer to ensure operational intent is achieved.

B. Submit certified copies of factory test reports.

C. Startup Records:
1. Maintain and submit the following records generated during each phase of startup defined above in article titled Definitions:
   a. Daily logs of equipment testing identifying all tests conducted and outcome.
   b. Logs of time spent by manufacturer's representatives performing services on the Site.
   c. Equipment lubrication records.
   d. Electrical phase, voltage, and amperage measurements.
   e. Insulation resistance measurements.
   f. Data sheets of control loop testing, including testing and calibration of instrumentation devices and setpoints.
   g. Detailed, point-by-point, sensor/controlled device/field device to PLC to HMI screen witnessed validation checklist for all telemetry and SCADA tags utilizing a fully functional network or other telemetry system available at the Owner's plant or other Owner-designated facility.

D. Certificates of Installation and Startup Services
1. At completion of installation and functional testing, furnish Certificate of Installation and Startup Services, signed by manufacturer, Contractor, and Owner's authorized representatives. Each form shall be completed for individual pieces of equipment in a timely manner as construction proceeds.
2. Submit 3 original copies of each completed form to Engineer.
3. Certify that:
   a. Equipment has been properly installed, adjusted, aligned, and lubricated.
   b. Equipment is free of any stresses imposed by connecting piping or anchor bolts.
   c. Equipment is suitable for satisfactory full-time operation under full load conditions.
   d. Equipment operates within the allowable limits for vibration.
   e. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
   f. Control logic for startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly functioning.
   g. For remotely monitored and controlled devices, functionality shall not be certified until indication and controls are tested using local and remote SCADA based indications.

4. Sign and submit for acceptance the forms and field manufacturer reports along with the manufacturer's representative prior to proceeding with System End-To-End Test and Startup.

PART 2 - PRODUCTS

2.1 FACTORY PERFORMANCE TESTING

A. Test equipment for proper performance at the point of manufacture or assembly.

B. Demonstrate equipment meets specified performance requirements.

C. Submit certified copies of factory test results to Engineer for review and approval.

D. Do not ship equipment until certified copies of factory test reports have been approved by Engineer. Written acceptance of factory test results does not constitute final acceptance.

2.2 FIELD PERFORMANCE TESTING

A. Furnish the services of an experienced and authorized representative of the manufacturer of each item of equipment indicated in the equipment schedules (excluding manually-operated valves smaller than 24 inches in size, injectors, tanks, batch-type disc meters, and rotameters, and any other minor items of equipment specifically exempted by Engineer in writing), who shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, arrange to have the manufacturer's representative revisit the job site as often as necessary until all trouble is corrected, and the equipment installation and operation are satisfactory to Engineer.

B. Require that each manufacturer's representative furnish to Engineer a written report addressed to Owner certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts and has been operated satisfactorily under full-load conditions.

C. Be responsible for scheduling all operations testing, including the End-To-End Testing performed with other contractors associated with the RTU controls and communications. Be advised that Engineer and Owner's operating personnel will witness operations testing and that the manufacturer's representative shall be required to instruct Owner's operating personnel in correct operation and maintenance procedures. Such instruction shall be scheduled at a time arranged with Owner at least two weeks in advance and shall be performed while the respective manufacturer's equipment is fully operational. On-site instruction shall be given by qualified persons who have been made familiar in advance with the equipment and systems. Prior to scheduling any operations testing, furnish *Operations and Maintenance Manuals* required by the Contract Documents.

D. Notify the Engineer at least three Workdays in advance of each equipment test.

E. Furnish all personnel, power, water, chemicals, fuel, oil, grease, and all other necessary equipment, facilities, and services required for conducting the tests.

2.3 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. Furnish, according to manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics, including valve keys and stems.

B. Time of Delivery: Submit special tools and lubricating equipment to Engineer when unit is placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.

C. Quality: Provide tools and lubricating equipment of a quality comparable to what the equipment manufacturer uses.

PART 3 - EXECUTION

3.1 STARTUP

A. Startup is a highly complex operation requiring the combined technical expertise of Contractor, manufacturers, subcontractors, Engineer, and Owner. Coordinate all parties necessary for the successful plant startup.

B. Be responsible for the complete test, check out, startup, and commissioning of all elements of the Project. Verify these activities through daily inspection reports, test records, on-site vendor certifications, and by other appropriate means. The test and startup requirements specified in this Section are complementary to those indicated elsewhere in the Contract Documents.

C. Conduct all test, check out, and startup requirements indicated in the Contract Documents and provide documentation of same to Engineer prior to commissioning. Where vendor on-site inspections are required prior to or during startup, require vendor to provide a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup and/or commissioning.

D. It is not the intent of Engineer to instruct Contractor in the startup; however, Engineer will be available prior to and during startup to provide technical support to the Contractor.

E. Perform a 7-day functional test of the facility. The intent of the 7-day functional test is to demonstrate that all the components and systems that have been constructed and installed function individually and collectively in accordance with the Contract Documents. The 7-day functional test shall demonstrate the ability of the entire facility to operate continuously for 7-days without failure. In the event of a failure of any of the facility components, the cause of the failure shall be determined and repaired, and the 7-day functional test shall be restarted from time zero.
    1. Prepare a plan that details the procedures of the 7-day functional test. The plan shall indicate start and stop times of each of the pumping units, capacity to be pumped during each period, the number of pumps to be operated during each period, auxiliary systems that will be needed during each period, and starting and stopping sequences

of each facility subsystem to be operated during each period. Provide adequate detail in the plan to determine personnel needed to operate and monitor all components to be evaluated during each period but the increments of the schedule shall not be greater than 2 hours. In the plan, identify by name all personnel needed to complete the 7-day functional test and identify the shift that each person will work during the test.

2. As part of the plan for the 7-day test, define, subject to Engineer's approval, what will constitute a failing test. At a minimum, a test shall be considered to have failed if any of the following events occur at any time during the 7-day functional test.
    a. Failure of a pumping unit or motor.
    b. Performance of a pumping unit (including pump and motor) outside of its specified acceptable ranges for vibration, noise, temperature, cavitation, efficiency, and capacity.
    c. A failure of any ancillary component or system that cannot be returned to service within 30 minutes of failure.
    d. Three failures of an ancillary component or system regardless of the amount of time it takes to return it to service and regardless of whether or not the failures are due to the same cause.
    e. Three failures of equipment of the same model, regardless of the amount of time it takes to return each to service and regardless of whether or not the failures are due to the same cause.
3. During the performance of the 7-day functional test, it shall not be acceptable to bypass, deactivate, or in any way disable a protective device, alarm, or control to facilitate completion of the test.
4. If variable speed pumps are provided as part of the construction, each pump shall be run under automatic control during the 7-day functional test to verify the ability to operate as required by the Contract Documents provided the communications system is available. If the communication is not available, Engineer will prescribe the method and flow rates at which the 7-day functional test will be performed.
5. Provide adequate staff on Site to operate the facility and make factory personnel available to assist in resolving problems as needed at no additional cost to Owner.
6. Take readings every hour of the 7-day functional test to record equipment operation, operating speeds, flow rates, temperature of equipment components, system pressures, operating voltage, current, power draw of each operating unit, and any problems encountered during the previous hour. Provide readings to Engineer each morning for the previous day's run for evaluation and acceptance of the preceding day as being satisfactorily completed for the 7-day functional test.

F. Furnish operating personnel for the duration of the startup. Additionally, furnish all water, power, chemicals, and other consumables required for the test.

G. Facility startup shall not be commenced until Component Test and Check Out, Subsystem Tests, and System End-To-End Tests, with associated control systems in place and functioning, all have been completed to the satisfaction of Engineer.

H. All defects in materials or workmanship, which appear during this test period, shall be immediately corrected. Time lost for equipment repairs, wiring corrections, control point settings, or other reasons, which interrupt the startup may, at the discretion of Engineer, be justifiable cause for extending startup test duration.

I. During startup, furnish the services of authorized representatives of the manufacturers, in addition to those services required under operations testing, as necessary, to correct faulty equipment operation.

J. During startup, keep records of the operations in accordance with the instructions of Engineer.

3.2 LUBRICATION

A. Where lubrication is required for proper operation of equipment, incorporate the necessary provisions in accordance with the manufacturer's requirements. Where possible, make lubrication automated and positive.

B. Upon completion System End-To-End Tests and Startup, a qualified manufacturer's representative shall perform preventive maintenance, such as change break-in lubrication, complying with manufacturer's recommendations.

C. Oil Reservoirs: Where oil is used, provide a reservoir of sufficient capacity to lubricate the unit for a 7-day period.

END OF SECTION

DIVISION 03
CONCRETE

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including forms, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 117	Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 315	Details of Concrete Reinforcement
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Formwork For Concrete

B. American Welding Society (AWS):

D1.4	Structural Welding Code – Reinforcing Steel

C. ASTM International (ASTM) standards, most recent editions:

ASTM A82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A185	Standard Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A497	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Standard Specification for Low Alloy Steel Deformed Bars for Concrete Reinforcement

ASTM A775	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM C31	Standard Specification Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specifications for Concrete Aggregates
ASTM C39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C156	Standard Test Method for Water Loss [from a Mortar Specimen] Through Liquid Membrane-Forming Curing Compounds for Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM C1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

ASTM D1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 4397	Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E1745	Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

D. Concrete Reinforcing Steel Institute (CRSI) standards, most recent editions:

Manual of Standard Practice

1.3 SYSTEM DESCRIPTION

A. The Contractor shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements specified herein.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit details of the concrete reinforcement steel and concrete inserts as soon as possible after receipt of the Notice to Proceed.

C. Include, but not limit to, the following:
1. Complete bar schedule, bar details and erection drawings to conform to ACI 315.
2. Each type of bar marked with identification corresponding to identification tag on bar.
3. Length, type, and location of all splices.
4. Erection drawings shall be clear, easily legible and to a minimum scale of:
   a. 1/4 inch = 1 foot.
   b. 1/8 inch = 1 foot if bars in each face are shown in separate views.
5. Size and location of openings.

D. Do not use Contract Documents as erection drawings.

1.5 QUALITY ASSURANCE

A. Ready mix concrete manufacturer qualifications: Concrete producer shall be a firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.

B. Perform work in accordance with ACI 301 and the applicable referenced documents.

C. Welders' Certificates: When welding of reinforcing steel is proposed, submit welders' certificates certifying welders employed on the Work and verifying AWS qualification within the previous 12 months. All welding to be performed in accordance with AWS D1.4.

D. Conform to ACI 305R and/or ACI 306R when concreting during hot or cold weather as appropriate.

PART 2 - PRODUCTS

2.1 FORMWORK

A. Conform to ACI 301, ACI 318, and ACI 347, using plywood or metal forms.

B. Plywood forms: Douglas Fir or Southern Yellow Pine species; solid one side or high density overlaid one side; sound, undamaged sheets designed to support weight of concrete with minimum deflection.

C. Steel forms: Stiffened to support weight of concrete with minimum deflection.

D. Glass fiber reinforced resin type: Preformed shape, stiffened to support weight of concrete with minimum deflection.

E. Form ties: Removable or snap-off metal of fixed length, leaving no metal within 1 inch of finished surface.

F. Form release agent: Colorless mineral oil that will not stain concrete or absorb moisture.

2.2 STEEL REINFORCEMENT

A. Reinforcing steel: ASTM A615, Grade 60, deformed billet steel bars, uncoated finish.
   1. When shown on Drawings, supply epoxy coated bars in accordance with ASTM A775.
   2. Plain-steel wire: ASTM A82 as drawn.
   3. Plain steel welded wire reinforcement: ASTM A185, fabricated from as-drawn steel wire into flat sheets.
   4. Deformed-steel welded wire reinforcement: ASTM A497, flat sheet.
   5. Tie wire: Minimum 16 gage annealed type.
   6. Chairs, bolsters, bar supports and spacers: Sized and shaped for strength and support of reinforcement during concrete placement.

B. Welding reinforcing steel: When welded reinforcing steel is called for on the Drawings or in these Specifications, provide per ASTM A706.

2.3 CONCRETE MATERIALS

A. Blended Hydraulic Cement: Comply with ASTM C595, Type IL (10) (MS), grey color.
   1. Cement shall not contain more than 0.60 percent equivalent alkalis.
   2. Limestone content is limited to 10 percent.
   3. Single brand of cement used throughout Work; brand approved by Engineer.

B. Fly ash: ASTM C618, Class F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.
   1. Maximum of 25 percent replacement at 1.0 pounds of fly ash per pound of cement replaced.

C. Coarse aggregate: ASTM C33,
   1. Graded Size No. 67.
   2. Obtain coarse aggregates from sources approved by Engineer.

D. Fine aggregate: ASTM C33
   1. Fineness Modulus: Not over 3.00.
   2. Obtain fine aggregates from sources approved by Engineer.

E. Lightweight aggregates: Not permitted unless specifically allowed by Engineer.

F. Water
   1. Clean and not detrimental to concrete; potable.
   2. Conform to ASTM C94.

2.4 ADMIXTURES

A. Air entrainment: ASTM C260.

B. Water reducing: ASTM C494, Type A.

C. Water reducing and retarding: ASTM C494, Type D.

D. Water reducing and accelerating: ASTM C494, Type E.

E. Water reducing, high range plasticizer: ASTM C494, Type F.

F. Do not use calcium chloride.

G. Pigments for underground conduit banks: Pigment shall be added to concrete encasing electrical duct banks as required by Rocky Mountain Power Company.

2.5 RELATED MATERIALS

A. Bonding agent: Polymer resin emulsion acceptable to Engineer.

B. Bond breaker: VOC compliant, water or solvent based membrane forming, reactive bond breaker.

C. Vapor barrier: Multi-ply reinforced polyethylene sheet, ASTM E1745, Class C, not less than 7.8 mils thick or polyethylene sheet, ASTM D4397, not less than 15 mils thick.

D. Grout: Premixed compound with non-metallic aggregate, cement, water reducing and plasticizing agents, capable of minimum compressive strength of 2500 psi in 3 days and 6000 psi in 28 days.

E. Construction joints: Locate and install construction joints that are not shown on Drawings so as not to impair strength of concrete, and as acceptable to the Engineer.

F. Premolded joint filler:
   1. Provide expansion joints in concrete construction in locations shown on Contract Drawings.
   2. Expansion Joint Filler: Preformed, non-extruding, resilient type, constructed of cellular neoprene sponge rubber, extending full thickness of slab, in accordance with ASTM D1751 or ASTM D1752, Type I.

G. Expansion joints: Locate and install where shown on the Drawings.

H. Joint sealant: 2-component polyurethane conforming to ASTM C920.

2.6 CURING MATERIALS

A. Water: Clean and potable.

B. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C156 shall not exceed 0.055 grams per square centimeter of surface.

C. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (1) (2). The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.

D. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.

E. Membrane Curing Compound: ASTM C309, Type 1, Class B. Sodium silicate compounds shall not be allowed.

F. Evaporation retardant to provide thin continuous film over freshly placed flatwork concrete to prevent rapid moisture loss before finishing.

2.7 CONCRETE MIXTURES

A. Normal-weight concrete: Select proportions for normal-weight concrete in accordance with ACI 301 using either the “statistical method” or the “trial batch method”.
   1. “Statistical method” is preferred with a minimum of 30 tests acceptable to the Engineer.
   2. If “trial batches” are used to verify the mix design strength, the proposed mix design shall achieve an average compressive strength of 1200 psi more than strengths given in table below.

B. Concrete strength, cement content and slump per the following table:

Type of Construction	Compressive Strength (psi)	Aggregate Gradation (ASTM C33)	Slump in Inches (Max.)	Max W/C Ratio (by Weight)
Site Slabs; Curb and gutter; thrust blocks	4,000	#57 (1")	4	0.50

1. Slump as shown above shall be plus or minus 1 inch.
2. Minimum cement content:
   a. Reinforced Concrete: Six sacks of Portland Cement per cubic yard.
   b. Unreinforced Concrete: Five sacks of Portland Cement per cubic yard.
3. Air content: Provide air entrainment resulting in a total air content of 5 to 7 percent for all types of construction.
   a. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.
   b. Air may be omitted from interior slabs to be trowel finished.

2.8 CONCRETE MIXING

A. Measure, batch, mix, and deliver concrete according to ASTM C94 and furnish batch ticket for each truck delivered.
   1. Deliver and place concrete within 90 minutes from the time the water is added to the mix.
   2. When ambient air temperature is above 90 degrees F, reduce delivery and placement time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

A. Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. Surface shall be free from standing water, mud and debris at the time of placing concrete.

B. Unless otherwise indicated, provide exterior corners in concrete members with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

3.2 FORMWORK

A. Verify lines, levels, and measurement before proceeding with formwork.

B. Hand trim sides and bottom of earth forms. Remove all loose soil.

C. Align form joints.

D. Do not apply form release agent where concrete surfaces will receive special finishes or applied coatings that may be affected by the agent.

E. Coordinate work of other trades in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

3.3 STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   1. Do not cut or puncture vapor barrier if used.

3.4 CONCRETE PLACEMENT

A. Notify Engineer a minimum of 24 hours prior to commencement of concreting operations.

B. Before placing new concrete on or against concrete which has set, existing surfaces shall be roughened and cleaned free from all laitance, foreign matter, and loose particles.

C. Place concrete in accordance with ACI 301.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301. In no case shall water be added to exceed the specified water-cement ratio of the mix.

E. Conform to ACI 305R when concreting during hot weather.

F. Conform to ACI 306R when concreting during cold weather.

3.5 FLOOR SLABS

A. Install control joints in slab by forming or cutting within 4 hours of placement using an early entry saw.

B. Separate slabs-on-grade from vertical surfaces using full-depth joint filler. Apply joint sealant when shown on Drawings.

3.6 FINISHING FORMED SURFACES

A. Rough-formed finish: As-cast concrete texture imparted by form facing material with tie holes and defective areas repaired and patched.
   1. Remove fins and other projections exceeding 1/2 inch.
   2. Apply to concrete surfaces not exposed to view after final grading.

B. Smooth-formed finish: As-cast concrete texture imparted by form facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
   1. Repair and patch tie holes and defective areas.
   2. Remove fins and other projections exceeding 1/8 inch.
   3. Apply to concrete surfaces exposed to view or to be covered with a coating or covering material applied directly to concrete.

3.7 FINISHING UNFORMED SURFACES

A. Broom finish at exterior concrete slabs, paving, and steps.

3.8 CONCRETE CURING AND PROTECTION

A. Evaporation retarder.
   1. Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. per hour before and during finishing operations.
   2. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

B. Cure concrete for not less than 14 days after placing.

C. Leave forms in place at least 14 days, or until concrete has attained specified 28-day strength, unless otherwise approved by Engineer. If forms are allowed to be removed within 14 days of placing concrete, continue curing in accordance with other methods specified herein or as directed by Engineer.

D. Strictly follow careful procedures for the removal of forms and perform with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.

E. Keep encasement concrete, concrete cradles and anchor blocks moist until covered. The surface shall be covered with moist earth not less than 4 hours, or more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

F. Concrete slabs may be cured by either of the following two methods:
   1. Method 1:
      a. After finishing slab, wet surface with a fine spray of water and cover with polyethylene-bonded waterproof paper sheeting.
      b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
      c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
      d. Repair or replace sheets immediately if damage occurs.
   2. Method 2:
      a. Cover concrete with water-saturated polyethylene-coated burlap curing mats and keep continuously wet for curing period.
      b. Lap sheets 4 inches at sides and ends and seal with adhesive tape to form a continuous watertight joint.
      c. Weigh sheeting down with wood planks to keep sheeting in contact with concrete.
      d. Repair or replace sheets immediately if damage occurs.

G. As an alternate to above referenced curing methods for formed and slab concrete, spray surface with liquid curing compound that does not affect bond of paint to concrete surface.
   1. Apply curing compound in accordance with manufacturer's instructions as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and

within 2 hours after completion of finish or stripping of forms, if stripped in less than 14 days.

a. Maximum coverage rate of 200 square feet per gallon, applied in such a manner as to cover surface with a uniform film to seal thoroughly.

2. Curing vertical surfaces with a curing compound:
   a. Cover vertical surfaces with a minimum of two coats of the curing compound.
   b. Apply the first coat of curing compound immediately after form removal. Vertical surface at the time of receiving the first coat shall be damp with no free water on the surface.
   c. Allow the preceding coat to completely dry prior to applying the next coat.
   d. Vertical surface is defined as any surface steeper than 1 vertical to 4 horizontal.
3. Curing Compound: As specified herein.
4. Take care to avoid damage to seal during curing period.
5. Repair broken or damaged seals occurring before expiration of curing period by application of additional curing compound over damaged portion.
6. Do not use curing film method where construction joints are to be made.
7. In hot weather, follow curing procedures outlined in ACI 305R.
8. In Cold Weather, following curing procedures outlined in ACI 306R.

3.9 TOLERANCES

A. Construction Tolerances: Set and maintain concrete forms and perform finishing operations so as to ensure that the completed Work is within the tolerances specified in ACI 117. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown.

3.10 FIELD QUALITY CONTROL

A. General
   1. Tests on component materials and for slump, temperature, air content, and compressive strength will be performed as specified herein.
   2. The cost of all laboratory tests for qualification of mix designs on cement, aggregates, and concrete, including strength testing will be borne by the Contractor. The cost of all field-testing during construction, including slump, temperature, air, and strength will also be borne by the Contractor. Contractor's testing laboratory shall meet or exceed the requirements of ASTM C1077.
   3. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall assist Engineer in obtaining samples, and disposal and cleanup of excess material.
   4. Composite samples of concrete placed in the Work shall be taken in accordance with ASTM C172 from the first placement of each class of concrete and at the following minimum frequency for each class:
      a. Not less than one sample per day on which concrete it placed.
      b. Not less than one sample for each 50 cubic yards of concrete placed.
      c. Not less than one sample for each 5,000 square feet of surface area for slabs or walls.
      d. Not less than 5 samples from randomly selected batches for the Work.

B. Slump Tests

1. Perform in accordance with requirements of ASTM C143 at frequency indicated for sampling above.

C. Temperature Tests
1. Test concrete temperature per ASTM C1064 at frequency indicated for sampling above.

D. Air Content Tests
1. Test air content per ASTM C231 at frequency indicated for sampling above.

E. Field Compression Tests
1. Field compression test specimens will be made at the frequency indicated for sampling above.
2. Each set of test specimens will be a minimum of five cylinders.
3. Compression test specimens for concrete shall be made in accordance with ASTM C31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
4. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and two at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete
1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318 and as specified herein.
2. All concrete which fails to meet the ACI requirements and these Specifications, is subject to removal and replacement at no increase in cost to the Owner.

END OF SECTION

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SECTION 03 60 00
GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes various types of cementitious grout to be provided and installed per the Contract Documents

B. Section includes the following types of grout:
   1. Nonshrink grout.
   2. Grout for repair of concrete.

1.2 RELATED SECTIONS

A. Section 01 33 20 – Submittal Procedures.

B. Section 01 25 10 - Products, Materials, Equipment and Substitutions.

1.3 REFERENCES

A. American Concrete Institute (ACI) standards, most recent editions:

ACI 318	Building Code Requirements for Reinforced Concrete
ACI 308	Standard Practice for Curing Concrete

B. American Society for Testing and Materials (ASTM) standards, most recent editions:

ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C348	Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars
ASTM C469	Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear

ASTM C939	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C1090	Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
ASTM C1107	Packaged Dry, Hydraulic Cement Grout (Nonshrink)
ASTM C1202	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

C. International Concrete Repair Institute (ICRI) standards, latest editions:

Guideline No 310.1R	Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
Guideline No 320.2R	Guide for selecting and specifying Materials for repair of Concrete Surfaces

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data:
1. Submit certified test results verifying the compressive strength, shrinkage, and expansion requirements indicated herein.
2. Submit manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of nonshrink and epoxy grout used in the Work.

C. Certification:
1. Provide manufacturer’s independent certification of compliance with ASTM C1107 without modification to the standard methods certifying that the Class B or C grout's post-hardening non-shrink properties are not based on gas expansion.
2. Provide Manufacturer's certification that grouts have strengths of 3500 psi at 1 day, 6500 psi at 3 days and 7500 psi at 28 days when cured at 72 degrees F as well as meeting the 3, 7, and 28-day strengths when tested and cured at the 45 deg F and 95 degree F limits and all other requirements of ASTM C1107.
3. The Contractor shall engage an independent testing laboratory to run a 24-hour grout evaluation in accordance with ASTM C1107 of each grout submitted for approval showing compliance with all aspects of the evaluation. Submit results to the Engineer for review.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Maintain all materials clean, dry and protected against dampness, freezing and foreign matter.
   1. Store non-shrink grout materials in temperature controlled environments above 40 degrees F and below 90 degrees F.
   2. Store epoxy grout components in temperature controlled environments above 60 degrees F and below 90 degrees F.

C. Deliver epoxy resin, hardener, and aggregate in sealed pre-measured containers, palletized, and shrink-wrapped to prevent shipping damage.

D. Immediately remove from the Project site any cement-based grout material which becomes damp or otherwise defective.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Nonshrink, nonmetallic grout:
      a. 5 Star Grout, Five Star Products, Inc.
      b. Masterflow 928, BASF Building Systems, Inc.
      c. NS Grout, Euclid Chemical Company.
      d. Sika Grout 212, Sika Corporation.
      e. Engineer approved equal.

2.2 NONSHRINK GROUT

A. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water.

B. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

C. 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 herein shall be that recommended by the manufacturer for the particular application. All grouts (Grade B or C) shall be tested for height change of the hardened grout at 1, 3, 14, and 28 days in accordance with ASTM C1090 and shall be tested for compression at 1, 3, 7, and 28 days in accordance with the modified ASTM C109 testing procedure.

D. Class A non-shrink grouts: Not used.

E. Class B or C high precision, fluid, extended working time, non-shrink grouts:
   1. Minimum 28-day compressive strength of 7500 PSI.
   2. No shrinkage (0.0 percent) and a maximum of 4.0 percent expansion in the plastic state when tested in accordance with ASTM C827.
   3. No shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state

4. When mixed to a fluid consistency of 20 to 30 seconds per ASTM C939 at temperature extremes of 45 to 90 degrees F shall have an extended working time of 30 minutes when tested in accordance with ASTM C1107.

F. Application:
1. Class B or C non-shrink grout shall be used for grouting under all base plates for structural steel members, grouting under all equipment base plates except for pumps and motors, and at all locations where grout is required by the Contract Documents except where epoxy grout or grout for pumps and motors is specifically required. Class B or C non-shrink grout shall be used in place of Class A non-shrink grout for all applications. Class B or C non-shrink grout shall not be used for dry packing applications or repair of concrete.

2.3 GROUT FOR REPAIR OF CONCRETE

A. Vertical, overhead, and shotcrete applications:
1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement based, shrinkage compensated, non-expansive, gray concrete product.
3. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.
4. Free of chlorides and other chemicals causing corrosion with the following properties:
a. Minimum Slant Shear Bond Strength: 2500 PSI at 28 days when tested in accordance with ASTM C882.
b. Minimum Compressive strength: 6,500 PSI at 28 days when tested in accordance with ASTM C109.
c. Minimum Tensile Bond Strength: 200 PSI at 28 days per ASTM C307.
d. Minimum Flexural Strength: 1,200 PSI when tested in accordance with ASTM C348.
e. Modulus of Elasticity: 3.6E6 PSI when tested in accordance with ASTM C469.
f. Maximum Rapid Chloride Permeability: 772 coulombs when tested in accordance with ASTM C1202.

B. Horizontal and formed applications:
1. Shall not produce a vapor barrier.
2. One component, reoplastic, cement-based, shrinkage compensated, non-expansive, gray concrete product.
3. Flowable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.
4. Free of chlorides and other chemicals causing corrosion with the following properties:
a. Minimum Shear Bond Strength: 2150 PSI at 7 days.
b. Minimum Compressive Strength: 6000 PSI at 7 days when tested in accordance with ASTM C109.
c. Minimum Flexural Strength: 770 PSI at 28 days when tested in accordance with ASTM C78.
d. Maximum Chloride Permeability: 1,000 coulombs when tested in accordance with ASTM C1202.
e. Modulus of Elasticity: 4.8E6 PSI when tested in accordance with ASTM C469.

2.4 CURING MATERIALS

A. Curing materials shall be as recommended by the grout manufacturer for prepackaged grouts.

2.5 CONSISTENCY

A. Use grouts with the consistency necessary to completely fill space to be grouted for the particular application. Where "dry pack" is called for in the Contract Documents, use grout with a consistency such that the grout is plastic and moldable but will not flow.

B. Regardless of consistency called for on the Contract Documents, the type of grout to be used shall be as indicated herein for the particular application.

2.6 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement will not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the grout manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Do not place grout on concrete or masonry substrates until those substrate materials have attained 28-day design strength unless authorized by Engineer.

3.2 MANUFACTURER'S SERVICES

A. The manufacturer of nonshrink grout and epoxy grout shall provide onsite technical assistance upon request.

B. Coordinate with the manufacturer all demonstrations, training sessions, and applicable site visits. The grout manufacturer shall conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurements, cube testing, application, and curing for each category and type of grout.

C. Training by the manufacturer is required for all types of grout installations. Grout manufacturer’s representative shall train Contractor to perform the grout Work including mixing of grouts to required consistency, testing, placing, and curing on actual project base plates, tie holes, rock pockets, and other applications.

3.3 GROUTING PROCEDURES

A. Prepackage Grouts: All 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. Base Plate Grouting:

1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a 1 inch thickness of grout or a thickness as indicated on the Contract Drawings.
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. The mixture shall be of a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. Where this method of placement is not practical or where required by Engineer, alternate grouting methods shall be submitted for acceptance by Engineer.

C. Grout for Repair of Concrete

1. All repairs shall be performed in accordance with the manufacturer's recommendations and with ICRI Guideline No 310.1R and Guideline No 320.2R. These guidelines shall be followed for removal geometry, exposing and undercutting of reinforcing steel, cleaning and repair of reinforcing steel, and edge and surface condition of concrete and shall be followed regardless of the amount of corrosion present or not present in the reinforcing steel.
2. Remove unsound deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16-inch. Remove to provide for minimum thickness specified for mortar. If reinforcing is exposed in this process, then additional concrete shall be removed until the surface is a minimum of 1-inch or 1 bar diameter behind the exposed reinforcing.
3. Clean exposed reinforcing bars of rust and other deleterious materials which may prevent bonding of the repair product.
4. Keep surface at saturated surface dry (SSD) condition for a minimum of 24-hours prior to placement of repair material.
5. Place material in accordance with Manufacturer's written recommendations.
6. Cure material continuously for 7-days with water fog nozzles or other applications which provide a continuous wet curing of the repaired area in accordance with ACI 308.

D. CONSOLIDATION

1. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

END OF SECTION

DIVISION 05
METALS

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SECTION 05 14 00
STRUCTURAL ALUMINUM FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide structural aluminum framing and appurtenant metal parts required for permanent connection of structural aluminum, complete, in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 03 60 00 – Grouting

B. Section 05 50 00 – Metal Fabrications

1.3 REFERENCES

A. Aluminum Association (AA) standards, most recent editions:

ADM 1	Aluminum Design Manual, Part 1-A Aluminum Structures, Allowable Stress Design
ASD 1	Aluminum Standards and Data

B. ASTM International (ASTM) standards, most recent editions:

ASTM B209	Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
ASTM B211	Specification for Structural Steel.
ASTM B221	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
ASTM B308	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM B429	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

C. American Welding Society (AWS) standards, most recent editions:

A5.10	Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods
D1.2	Structural Welding Code-Aluminum

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop drawings:
   1. Conform to AA recommendations and specifications.
   2. Show all holes required for other Work.
   3. Submit drawings detailing fabrication and erection of each aluminum fabrication indicated. Include plans, elevations, sections, and details of aluminum fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
   4. Fabricator's drawings shall not include reproductions from Contract Drawings.

C. Test reports:
   1. Mill Test Reports: Submit mill test reports indicating structural strength, destructive and nondestructive test analysis and chemical analyses from the aluminum used in the Work.

D. Certificates:
   1. Welders' Certificates: Documentation certifying welders employed by the Subcontractor meet AWS qualifications.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Welders: Use welders with current certifications (previous 12 months at time of bid) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to AWS D1.2, Structural Welding Code – Aluminum.
      a. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.
      b. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by Engineer

B. Shop inspection may be required by Owner at Owner's own expense.
   1. Furnish ample notice to Engineer prior to the beginning of fabrication work so that inspection may be provided if Owner desires.
   2. Furnish all facilities for the inspection of materials and workmanship in the shop and allow inspectors free access to the necessary parts of the Work.
   3. Inspectors shall have the authority to reject materials and Work that does not meet Specifications.
   4. Inspection at the shop is intended to facilitate the Work and avoid errors but will in no way relieve Contractor from the responsibility for providing proper materials and workmanship under this Specification.

C. Owner may engage inspectors to inspect welded and bolted connections and to perform tests and prepare test reports.
   1. Bolted connections and welds required by Engineer to be corrected shall be corrected or redone and retested as directed at no additional cost to Owner.

D. Costs for initial testing will be paid by Owner. Pay costs for additional testing and investigation on Work that does not meet Specifications.
   1. Supply material for testing at no additional cost to Owner.
   2. Assist Engineer in obtaining material for test samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Load structural members in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

C. Protect structural aluminum members and packaged materials from corrosion and deterioration.

D. Store material in a dry area and do not place in direct contact with the ground.
   1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
   2. Repair or replace damaged materials or structures as directed by Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Aluminum: Alloy 6061 – T6 conforming to the following specifications:
   1. Sheet and plate: ASTM B209.
   2. Rolled Bars and Rods: ASTM B211.
   3. Extruded bars, rods, shapes, and tubes: ASTM B221.
   4. Rolled or extruded structural shapes: ASTM B308.
   5. Extruded structural pipe and tube: ASTM B429.

B. Bolts and nuts for fastening aluminum: Stainless steel bolts, nuts, and washers conforming to Section 05 50 00 – Metal Fabrications.

C. Welding filler metal:
   1. Aluminum alloys conforming to the requirements of AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556 as applicable.
   2. For welding of structures which are to be anodized, use filler alloys which will not discolor when anodized; AWS ER 5654, ER5554, ER 5183, ER 5356, or ER 5556.

D. Non-shrink grout: Refer to 03 60 00 – Grouting.

E. Concrete anchors: Refer to Section 05 50 00 – Metal Fabrications.

2.2 FABRICATION

A. Fabricate structural aluminum in accordance with Contract Drawings, AA Specifications, and as indicated on shop drawings.

B. Minimize the amount of field welding. Shop assemble components into largest size practical commensurate with transportation and handling limitations.

C. Connections: Provide connections as indicated. Where not specifically indicated, design and provide connections in accordance with requirements of this Section. One sided or other types of eccentric connections are not acceptable unless indicated on Contract Documents or approved shop drawings.
   1. Drill and punch holes at right angles to surface of metal. Do not make or enlarge holes by burning. Provide holes clean and free of torn or ragged edges. Use tools which will make a 1/16-inch bevel to remove outside burrs resulting from drilling or punching operations.
   2. Cope corners of stiffener plates at 45 degrees at junction of member flanges and webs.

D. Accurately mill bearing surfaces to true plane.

E. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

F. Materials shall be properly marked and match marked for field assembly.

G. Furnish structural members full length without splices unless otherwise indicated.

H. Where finishing is required, complete assembly, including bolting and welding of units, before start of finishing operations.

I. Protect aluminum members in contact with dissimilar metals from galvanic action by coating contact areas in accordance with Section 05 50 00 – Metal Fabrications, unless indicated otherwise.

2.3 WELDING

A. Requirements of this paragraph apply to both shop welding and field welding.

B. Perform all welding in accordance with AWS D1.2 and the following:
   1. Preparation:
      a. Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
      b. Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
      c. Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
      d. Suitably prepare edges to assure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
   2. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
   3. Do not use welding processes that require use of a welding flux.
   4. Neatly make welded closures.
   5. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
   6. Make welds full penetration welds unless otherwise indicated on Contract Drawings.

C. Do not perform welding when ambient temperature is lower than 0 degrees F or where surfaces are wet and exposed to rain, snow, or high wind, or where operators are exposed to inclement conditions.

PART 3 - EXECUTION

3.1 GENERAL

A. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing are installed.

B. Plumb, align, and set structural aluminum members to tolerances listed in the AA ADM 1 for the type of Work being installed. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and level and in proper alignment until permanent connections are made, the succeeding Work is in place, and temporary measures are no longer necessary. Use temporary guys, bracing, shoring, and other work to prevent damage to adjacent work and existing structures or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind. Remove and dispose of all temporary Work and facilities off-site.

3.2 EXAMINATION

A. Verify dimensions and elevations, make field measurements necessary, and be fully responsible for accuracy and layout of Work.
   1. Specifically check the elevations of all finished footings, walls, or foundations to receive aluminum framing and the alignment of all anchor bolts before starting erection. Notify Engineer of any deviations found by such checking.

B. Review Drawings and report discrepancies to Engineer for clarification prior to starting fabrication.

3.3 ERECTION

A. Rigidly support or brace structural aluminum products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

B. To the maximum extent possible, weld connections to members in the shop and bolt connections in the field.

3.4 FIELD CONNECTIONS

A. Bolting:
   1. Unless otherwise shown on Contract Drawings, connect aluminum members to other aluminum members using 3/4-inch stainless steel bolts. Connect aluminum members to concrete using 3/4-inch stainless steel epoxy anchors per Section 05 50 00 Metal Fabrications.

2. Concrete anchors require a minimum embedment of 5-1/2 inches into masonry or concrete unless indicated otherwise on Contract Drawings.
3. Protect bolt threads from damage during driving. Rest bolt heads and nuts squarely against surfaces. Where bolt heads or nuts rest on beveled surfaces having slope greater than 1 in 20 with plane normal to bolt axis, provide beveled washers to give full bearing to head and nut. Correct poor matching of holes by drilling to next larger size and use larger diameter bolt.

B. Welding:
1. Perform welding in accordance with AWS D1.2. Use only welding procedures and welding operators qualified in accordance with the requirements of this Section. Field welding of aluminum is not allowed unless specifically indicated on the Contract Drawings.

3.5 HOLES FOR OTHER WORK

A. Provide holes as necessary or as indicated for securing other Work to structural aluminum framing, and for passage of other Work through aluminum framing members.

B. No torch cut holes will be permitted.

3.6 SETTING BASES AND BEARING PLATES

A. Prior to placement of non-shrink grout beneath base and bearing plates, clean bottom surface of plates of all bond reducing materials, and clean concrete and masonry bearing surface of all bond reducing materials and roughen to improve bonding.

B. Loose and attached base plates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Tighten anchor bolts after supported members have been positioned and plumbed and non-shrink grout has attained its indicated strength.

D. Grout base plates with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.7 FIELD ASSEMBLY

A. Set structural frames accurately to the lines and elevations indicated.
1. Align and adjust various members to form a part of a complete frame or structure before permanently fastening.
2. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact.
3. Perform necessary adjustments to compensate for discrepancies in elevations and alignments.

B. Level and plumb individual members of structure within specified tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of structure.

3.8 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify Engineer.
   1. Propose a method to remedy the misfit for review by Engineer.
   2. Engineer will determine whether remedy is acceptable or if the member must be refabricated.

B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

C. Pay costs associated with repair of misfits at no increased cost to Owner.

3.9 GAS CUTTING

A. Do not use gas cutting torches in the field for correcting fabrication errors in structural framing, except when approved by Engineer.

B. Finish gas cut sections equal to a sheared appearance.

3.10 PROTECTION

A. Suitably protect aluminum surfaces against lime mortar stains, discoloration, surface abrasion, and other construction abuses.

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, fabricate, and install metal fabrications in accordance with Contract Documents.

1.2 RELATED SECTIONS

A. Section 05 14 00 – Structural Aluminum

B. Section 05 52 13 – Pipe and Tube Railings

C. Section 09 90 00 – Painting and Coating

D. Section 09 97 10 – Pipeline Coatings and Linings

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Specification for Structural Steel
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Gray Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A197	Standard Specification for Cupola Malleable Iron
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	Specification for Structural Bolts, Steel Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A563	Specification for Carbon and Alloy Steel Nuts
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTMA668	Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B211	Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B308	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

B. American National Standards Institute (ANSI) standards, most recent editions:

ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements

C. American Welding Society (AWS) Standards, most recent editions:

AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS QC1	Specification for AWS Certification of Welding Inspectors
AWS Welding Handbook	

D. American Water Works Association (AWWA) standards, most recent editions:

AWWA C105	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines

E. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects.

F. Federal Specifications:

MIL-A-907E	Anti-seize Thread Compound, High Temperature

G. Occupational Safety and Health Administration (OSHA), most recent editions:

OSHA 1910.27	Fixed Ladders

H. Society for Protective Coatings (SSPC):

SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel

1.4 DEFINITIONS

A. Metal Fabrications: Defined as items to be fabricated from metal shapes, plates, or bars and their products.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Submit shop drawings of all metal fabrications to the Engineer for review.
   1. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

2. Submit layout drawings for grating showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners. Submit load and deflection tables for each style and depth of grating used.

C. Submit ICC-ES report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor submitted. Submit manufacturer's recommended installation instructions and procedures for adhesive anchors. Upon review, by Engineer, these instructions shall be followed specifically.

D. No substitution for the indicated adhesive anchors will be considered unless accompanied by an ICC-ES report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

1.6 QUALITY ASSURANCE

A. All weld procedures and welder qualifications shall be available in the Contractor's field office for review.

B. Qualification of Welders: Use welders with current certifications (previous 12 months) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to the following:
1. AWS D1.1, Structural Welding Code – Steel.
2. AWS D1.2, Structural Welding Code – Aluminum.
3. AWS D1.6, Structural Welding Code – Stainless Steel.

C. Furnish a welding inspector who is qualified in accordance with AWS requirements and approved by Engineer. Inspector to inspect all welding.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Metal fabrications shall be loaded for transport in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

C. Protect metal fabrications from corrosion and deterioration.

D. Store material in a dry area and do not place in direct contact with the ground.
1. Do not place materials on the structure in a manner that might cause distortion or damage to the members or supporting structures.
2. Repair or replace damaged materials or structures as directed.

1.8 PROJECT CONDITIONS

A. Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Castings, trench covers, and accessories:
      a. D&L Foundry and Supply
      b. Deeter Foundry company.
      c. Neenah Foundry Company.
      d. Engineer approved equal.
   2. All-purpose metal framing
      a. Allied Tube and conduit.
      b. B-Line Systems.
      c. Unistrut Building Systems.
      d. Engineer approved equal.
   3. Steel Ladder Rungs:
      a. Perforated “Traction Tread”; McNichols, Co.
      b. Engineer approved equal.
   4. Anti-seize lubricant:
      a. AS-470 by Dixon Ticonderoga
      b. PURE WHITE by Anti-Seize Technology
      c. Engineer approved equal.
   5. Drill-in anchors:
      a. Epoxy anchors (Concrete):
         1) HIT-HY 200.
         2) Set 3G, Simpson Strong-Tie.
         3) Pure110+, DeWalt
         4) Red Head C6+, ITW Ramset/Redhead.
         5) Engineer approved equal.

2.2 MATERIALS

A. Steel:
   1. Wide flange steel shapes shall be ASTM A992. Other steel shapes, plates, and bars shall be in accordance with ASTM A6 and ASTM A36, unless otherwise shown.
   2. Structural steel pipe shall be ASTM A53, Type E or S, Grade B.
   3. Structural tubing shall be ASTM A500, Grade C or ASTM A1085. Furnish members full length without splices unless otherwise noted or approved by Engineer.
   4. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated in the Contract Documents.

B. Steel Forgings: ASTM A668.

C. Stainless steel: ASTM A666 and ASTM A276, Type 316 or 316L

D. Aluminum: Refer to Section 05 14 00 – Structural Aluminum.

E. Iron:
   1. Ductile iron: ASTM A536.
   2. Gray cast iron: ASTM A48.
   3. Malleable iron: ASTM A47, A197.

F. Bolts and Anchors:
   1. Provide stainless steel for bolts, nuts, and washers in the locations listed below.
      a. All buried locations except as noted below for pipe flange, fitting, and coupling connections.
      b. All submerged locations.
      c. Inside hydraulic structures, below the top of the structure.
      d. Inside buried vaults, and manholes.
      e. All chemical handling areas.
      f. Other locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.
   2. Stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, conforming to ASTM F593 for bolts and to ASTM F594 for nuts. Protect all threads on stainless steel bolts with an anti-seize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E and classified as acceptable for potable water use by NSF. Coat buried bolts in poorly drained soil the same as the buried pipe.
   3. Pipe Flange, Fitting and Coupling Connection Applications: Unless otherwise noted, all pipe flange, fitting and coupling connection bolts for welded steel pipe shall be carbon steel per ASTM A193, Grade B7 hex bolts, with nuts per ASTM A194, Grade 2H and all pipe flange, fitting and coupling connection bolts for ductile iron pipe shall be carbon steel per ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex nuts. All bolts, nuts and washers shall be zinc plated. Protect all threads on bolts and nuts with anti-seize lubricant.
      a. Exposed Connections: For exposed pipe connections in buried vaults, manholes, and structures with forced-air ventilation and which drain through a gravity sewer or to a sump with a pump, prepare and coat bolts and nuts after installation with the same system as the adjacent flanged piping, in accordance with Section 09 90 00 – Painting and Coating.
      b. Buried Connections: Coat all buried connections in accordance with Section 09 97 10 – Pipeline Coatings and Lining. Provide wax tape coating per AWWA C217 for steel pipe connections, including sleeve couplings and restrained sleeve couplings. For other pipe materials, grease and wrap connections per AWWA C105.
      c. Submerged Connections: Bolts for submerged flanges and pipe connections shall be Type 316 stainless steel, ASTM A193/A193M, Grade B8M hex head bolts, and ASTM A194/A194M Grade 8M hex head nuts. Fabricate in accordance with ASME B18.2.2.
      d. Provide two washers for each bolt and nut with a washer installed on each side of the flange. Washers shall be of the same material as the nuts.
      e. Provide bolts of the proper length to accommodate flange, washer, and gasket thickness to accommodate bolt minimum length per AWWA C207.

4. Bolt Requirements:
    a. The bolt and nut material shall be free-cutting steel.
    b. The nuts shall be capable of developing the full strength of the bolts.
    c. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
    d. Provide bolts with hexagon heads. Provide nuts conforming to Heavy Hexagon Series.
    e. Install all bolts and nuts with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification.
    f. Install lock washers with washers where indicated and fabricated of material matching the bolts.

G. Provide bolts of length such that after joints are made up, each bolt extends through the entire nut, but in no case more than 1/2-inch beyond the nut.

H. Drill-in anchors:
1. Epoxy anchors: Unless otherwise indicated, all drilled concrete and masonry anchors shall be epoxy anchors. No substitutions will be considered unless accompanied by ICC-ES reports verifying strength and material equivalency.
    a. Epoxy anchors are required for drilled anchors exposed to weather, in submerged, wet, splash, and corrosive conditions, and for anchoring handrails, pumps, and mechanical equipment. Provide threaded stainless steel rod, Type 316.
    b. Unless otherwise indicated, epoxy anchors will also be permitted in locations not indicated above.
2. Expansion Anchors: Not Permitted.
3. Screw Anchors: Not Permitted.

I. Corrosion Protection:
1. Hot dip galvanize all miscellaneous steel metalwork after fabrication.
    a. Galvanizing: ASTM A123 or A653 with minimum coating of 1.5 ounce per square foot.

2.3 MANUFACTURED UNITS

A. Handrails and Guardrails: Refer to Section 05 52 13 – Pipe and Tube Railings.

B. Bollards:
1. Standard weight steel pipe, diameter as shown on Drawings.
2. Minimum 48 inches projection above finish grade.
3. Minimum 42 inches embedment in concrete.
4. Fabricate sleeves for removable bollards from steel pipe with 1/4-inch thick steel plate welded to bottom of sleeve.

C. Ladders:
1. Ladders shall be of aluminum as shown on the Contract Documents.
2. Design to support minimum 300-pound concentrated vertical load with 150-pound concentrated horizontal load.
    a. Maximum allowable stresses per AISC manual.

b. Maximum lateral deflection: Side rail span/300.
c. Design in accordance with OSHA standards.

3. Fabricate ladders for the locations shown, with dimensions, spacings, details, and anchorages as indicated. Comply with requirements of ANSI A14.3.
4. Side rails, minimum sizes: Continuous, 1 1/2-inch nominal diameter pipe. Fabricate with eased edges, spaced 18 inches apart.
5. Rungs: 1-1/8 inch by 1-5/8 inch by 14 gage perforated "traction tread" rungs.
   a. Top rung level with top platform.
6. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
7. Support each ladder at top and bottom and at intermediate points spaced not more than 4 feet on center with welded or bolted steel brackets.
8. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.

D. Metal Grating:
1. Metal grating shall be of the design, sizes, and types indicated. Completely band at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support grating at bearings by support members. Where grating is supported on concrete, embedded support angles matching grating material shall be used unless indicated otherwise. Such angles shall be mitered and welded at corners.
2. Bearing Bars:
   a. Type: Rectangular bar.
   b. Thickness: 3/16 inch minimum.
   c. Depth: 1-1/2 inch unless otherwise indicated on Contract Documents.
   d. Spacing: 1 3/16 inch maximum.
   e. Configuration of top surface: Plain unless otherwise indicated on Contract Documents.
3. Cross Bars:
   a. Cross bars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.
   b. Spacing: 4 inches maximum.
4. All pieces of grating shall be fastened in at least two locations to each support.
5. Where grating depth is not given, grating shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of ¼-inch or the span divided by 180, whichever is less. For standard duty plank, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater or a concentrated moving load of 1000 pounds.
6. Material:
   a. Aluminum: Bearing and banding bars, alloy 6063-T5.
   b. Grating which may be partially or wholly submerged shall be fabricated entirely of stainless steel.
7. No single piece of grating shall weigh more than 80 pounds or be wider than 3 feet, unless indicated otherwise on Contract Documents.

E. Iron Castings:
1. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shot blasting. Castings shall be prefabricated, conforming to ASTM A48 or A536.

2. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finished surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.
3. Covers and grates with matching frames shall be designed to support the following loadings:
    a. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is given, a minimum of 300 pounds per square foot.
    b. Exterior covers and grates shall be designed for AASHTO HS-20 loading unless indicated otherwise.

F. All Purpose Metal Framing:
1. Material: Carbon Steel.
2. Channels and inserts:
    a. Minimum 12 gage.
    b. Channels to have one side with a continuous slot and inturned lips.
3. Fittings: Hot-rolled steel strip and plate.
4. Nuts: Steel, ASTM A563, with toothed grooves in top of nuts to engage the inturned lips of channels.
5. Finish: Epoxy coated. Galvanize items which cannot be epoxy coated.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

C. Form exposed work true to line and level with accurate angles and surfaces straight and sharp edges.

D. Drill and punch holes with smooth edges.

E. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
1. Temperature Range: 0 degrees F minimum to 110 degrees F maximum ambient temperature.

F. Shear and punch metals cleanly and accurately. Remove burrs.

G. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

H. Remove sharp or rough areas on exposed traffic surfaces.

I. Welding

1. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
2. In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.
3. Weld corners and seams continuously to comply with the following:
    a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    b. Obtain fusion without undercutting or overlap.
    c. Remove welding flux immediately.
    d. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners whenever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

K. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

L. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

M. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

N. Fabricate joints that will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

2.5 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Hot dip galvanize after fabrication.

2.6 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel studs for embedding into concrete.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports.

C. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection.

D. Cut, drill, and tap units to receive hardware, hangers, and similar items.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

B. Inspect and verify condition of substrate. Correct any surface defects or conditions which might interfere with or prevent a satisfactory installation.

C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.

B. In fabrication and erection of structural steel, conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

C. Shim and grout as necessary.

D. To the maximum extent possible, use bolted field connections. Where practicable, conceal the fastenings. When field welding is warranted, comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercutting or overlap.
   3. Remove welding flux immediately.

4. At exposed connections, finish/grind exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

E. Unless notes or specified otherwise:
1. Connect steel members to steel members with 3/4-inch diameter high strength bolts.
2. Connect aluminum to aluminum with 3/4-inch diameter stainless steel bolts.
3. Connect aluminum to structural steel using 3/4-inch diameter stainless steel bolts.
4. Connect aluminum and steel members to concrete using 3/4-inch stainless steel epoxy anchors. Provide a minimum of 5 1/2 inches of embedment into concrete.

F. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing. Provide fully welded splices where continuity is required.

G. Provide each fabricated item complete with attachment devices as indicated or required to install.

H. Anchor metal items so that items will not be distorted, nor fasteners overstressed from expansion and contraction.

I. Install bollards in concrete as detailed. Fill pipe with concrete and round off at top of pipe.

J. Attach grating to end and intermediate supports with grating saddle clips and bolts.
1. Maximum spacing: 2 feet on center with a minimum of two attachments per support.
2. Attach individual units of grating together with clips or attachments at 2 feet on center maximum with a minimum of two clips per side.

K. Coat ferrous metals in accordance with Section 09 90 00 – Painting and Coating.

L. Coat surfaces of aluminum that will come in contact with grout, concrete, masonry, wood or dissimilar metals with the following:
1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.3 DRILLED ANCHORS

A. Drilled-in 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, cleaned and dried. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength. Epoxy anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

3.4 SETTING LOOSE PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

B. Set loose level and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove

wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.

1. Use non-shrink grout in concealed locations where not exposed to moisture.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780

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SECTION 05 52 13
PIPE AND TUBE RAILINGS

PART 1 - GENERAL

A. SUMMARY

B. Section includes guardrails and handrails to be fabricated and installed complete, in accordance with the Contract Documents.
   1. Aluminum pipe railings.

1.2 RELATED SECTIONS
   1. Section 03 60 00 – Grouting
   2. Section 05 50 00 – Metal Fabrications

1.3 REFERENCES

A. Aluminum Association (AA) standards, most recent editions:

ADM 1	Aluminum Design Manual, Part 1-A Aluminum Structures, Allowable Stress Design
ASD 1	Aluminum Standards and Data
DAF 45	Designation System for Aluminum Finishes
SAA 46	Standards for Anodized Architectural Aluminum

B. ASTM International (ASTM) standards, most recent editions:

ASTM A312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108	Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B429	Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

C. American Welding Society (AWS) standards, most recent editions:

D1.2	Structural Welding Code – Aluminum

D. National Association of Architectural Metal Manufacturers (NAAMM) standards, most recent editions:

Metal Finishes Manual for Architectural and Metal Products

AMP 521 Pipe Railing Systems Manual

E. The Society for Protective Coatings standards, most recent editions:

SSPC-SP 6 Commercial Blast Cleaning

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Submit shop drawings of all railings to the Engineer for review, including the following information:
1. Manufacturer's installation details.
2. Layout drawings showing location of each railing, type of railing, and type of anchorage to be used.
3. Manufacturer's recommendations on fastening and cleaning after installation.

C. Mill Certificates: Signed by manufacturers of stainless steel products certifying that products furnished comply with requirements.

D. Product Test Reports: From a qualified testing agency indicating railings comply with ASTM E985, based on comprehensive testing of current products and current building code required by authority having jurisdiction, whichever is more stringent.

E. Certification: Submit a written certification, prepared by a Professional Engineer, licensed to practice in the state of Utah, verifying that the railing system design and related structural connections will meet the indicated loading requirements specified herein and included in the codes and standards referenced.

F. Engineer's seal and signature to be affixed to shop drawings, and certification.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single manufacturer.

B. Welding
1. Maintain all weld procedures and welder qualifications available in the Contractor’s field office for review.
2. Qualification of Welders: Use welders with current certifications (previous 12 months) for the material, type, and position of welding used. Certify in accordance with AWS Specifications according to the following:
   a. AWS D1.2, Structural Welding Code – Aluminum.
3. All welding shall be inspected by a Contractor-furnished inspector qualified in accordance with AWS requirements and approved by the Engineer.

C. Licensed Professional: Design railings, including comprehensive engineering analysis by a qualified Professional Engineer who is licensed to practice in the state of Utah, using performance requirements and design criteria indicated herein.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver products to site in original, unbroken packages, containers, or bundles and bearing the label of the manufacturer.

C. Store all materials off the ground and protect from weather until ready for use.

1.7 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, which are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated, install all railings complete and ready for use with all anchors, attachments, balusters, brackets, caps, fasteners, gates, posts, sleeves, trim, and other items required or necessary for the complete installation. Attachment details shown on the Contract Drawings are for the purpose of indicating the type of attachment and may be substituted with the Manufacturer's standard products for the same type of attachment.

B. Structural Design Requirements:
   1. Unless otherwise specifically noted, all railings, guardrails and handrails shall conform to the code requirements for industrial-commercial, non-public use under the State-approved OSHA. Railings, guardrails, and handrails, when part of a means of egress as defined by the governing codes, shall conform to the requirements of the most stringent of the codes or reference standards. The whole project shall conform to the code and State-approved OSHA for industrial-commercial, non-public use unless otherwise indicated. Limited public use shall mean that the facility is not designed for public use; however, occasionally the public is allowed controlled access when approved.
   2. Loading Conditions: Provide railings and handrail brackets capable of withstanding the following loading conditions without exceeding the allowable working stress of the material and without permanent deformation:
      a. General: Distribute loads to the various parts of the railing system consistent with methodology described in ANSI/NAAMM AMP 521 – Pipe Railing Systems Manual.

b. Top Rail of Guards: Concentrated load of 200 pounds applied at any point and in any direction, and a uniform load of 50 pounds per lineal foot applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently.

c. Handrails Not Serving As Top Rails: Concentrated load of 200 pounds applied at any point and in any direction, and a uniform load of 50 pounds per lineal foot applied in any direction. Concentrated and uniform loads need not be assumed to act concurrently.

d. Intermediate Rails: Uniform load of 50 pounds per lineal foot applied horizontally. Reactions due to this loading are not required to be applied concurrently with loadings specified above.

e. Posts: Concentrated load of 200 pounds applied at any point and in any direction.

3. In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   a. Aluminum: Referenced Aluminum Association publications.

C. Height Requirements: Set top of upper railing at 42 inches above the working surface or toe line of stairs. Install toe boards not more than 1/4 inch off the working surface and provide where indicated and required by codes or referenced standards. Provide a separate handrail at stair locations.

D. Guardrail Configuration: Three-rail system with equal open spaces between rails (and toe board when required) as required by OSHA.

E. Thermal Movements:
1. Exterior railing systems to provide for 1/4 inch expansion and contraction per 20 linear feet of railing.
2. Interior railing systems to provide for 1/8 inch expansion or contraction per 20 linear feet of railing.
3. Temperature change (range): 120 Degrees F, ambient; 180 Degrees F, material surfaces.

F. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.2 MATERIALS

A. Aluminum
1. Pipe: Alloy 6061-T6 or 6063 – T6, ASTM B429, 1-1/2 inch diameter, Schedule 40 unless another grade and weight is required by structural loads.
2. Sheet and plate: Alloy 6061 – T6 or 6063-T6, ASTM B209.
3. Extruded bars, rods, shapes, and tubes: Alloy 6061-T6 or 6063-T6, ASTM B221.
4. Cast fittings: Aluminum, ASTM B108 or ASTM B26.

B. Brackets: Handrail brackets shall be stainless steel or aluminum that matches the handrail or railing of which they are a part, including the finish.

C. Toe Boards: Toe board material and finish shall match railing system and be not less than 4 inches in height. Toe boards shall be formed in an angle or channel section for strength.

D. Connection splices: Internal mechanical connection splices for aluminum railings shall be of extruded aluminum.

E. Fasteners:
1. Aluminum Railings: Type 316 stainless-steel fasteners.
2. S
3. Fasteners for anchoring railings to other construction shall be of stainless steel, per requirements of Section 05 50 00 – Metal Fabrications.
4. Fasteners for Anchoring Railings to Other Construction: Select fasteners to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads. Unless otherwise indicated, provide stainless steel fasteners per requirements of Section 05 50 00 – Metal Fabrications.
5. Fasteners for interconnecting railing components shall be of the same basic metal as the fastened metal. Do not use metals that are corrosive or incompatible with materials being joined.

F. Miscellaneous Materials:
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded. For both aluminum and stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
3. Grout: Refer to Section 03 60 00 – Grouting.

2.3 FABRICATION

A. General
1. Fabricate handrails and railing systems with welded or non-welded (aluminum only), internal and mechanical connections to comply with manufacturer's printed requirements, Construction Documents, details, dimensions, finish and member sizes, including post spacing and anchorage, but not less than the structural requirements to support applied loadings.
   a. Clearly mark component units for site assembly and installation.
   b. Use only connections that maintain structural capacity of joined members.
2. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
3. Provide weep holes or other means to exit entrapped water from hollow section of railing members exposed to exterior, condensation, or moisture from other sources.
4. Fabricate smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.
5. Form exposed elements with smooth, long radius bends, accurate angles and straight sharp edges.
   a. Ease exposed edges to a radius of approximately 1/32 inch.
   b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the work.
6. For aluminum railings with exposed connections with flush, smooth, hairline joints.
   a. Hand file to remove burrs and sharp edges before assembly.

b. Use recessed screws or flush blind rivets.
c. Top rail splices and expansion joints shall be located within 8 inches of post or other support.

7. Provide for anchorage to side face of support unless shown otherwise in Contract Drawings. Where this is impractical, provide for top face attachment.
8. Handrail Termination:
   a. Fit exposed ends of handrails with solid terminations.
   b. Handrails to extend not less than 12 inches beyond the toe of the top and bottom risers in a run of stairs.
   c. Ends of handrails to be returned to the wall or to be terminated in posts or safety terminals. Posts and safety terminals may be used only when approved by the Engineer. Close ends of returns unless clearance between end of railing and wall is 1/4 inch or less.

B. Welded Railing Fabrication:
1. All welding to be continuous.
2. Remove flux immediately.
3. All exposed welds to be ground and buffed smooth and flush to match and blend with adjoining surfaces.
4. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.

C. Non-welded Railing Fabrication:
1. All railings to be prefabricated or component formed, marked and sized for on-site installation.
2. Top railing to be single continuous length attached to a minimum of three posts where possible.
3. Posts and intermediate railings shall be single continuous lengths of pipe.

D. Form changes in direction by bending or by inserting prefabricated elbow fittings.
1. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of members throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

2.4 FINISH

A. General
1. Comply with NAAMM "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage per manufacturer's recommendations.
3. Noticeable variations in appearance within the same piece or adjacent pieces are not acceptable.

B. Aluminum
1. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.
   a. Anodized finish shall be Class I provided in accordance with AA-M12 C22 A41, clear.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine system components, substrate, and conditions where railing systems are to be installed. If unsatisfactory conditions exist, notify Engineer in writing of unsatisfactory conditions, and do not begin this Work until such conditions have been corrected.

B. Commencing installation of this Work constitutes acceptance of conditions.

3.2 PREPARATION

A. Prepare surrounding construction to receive railing system installations complying with railing manufacturer's requirements.

B. Review and coordinate setting drawings, shop drawings, templates, and instructions for assembly and installation of railing system and related items to be embedded in concrete and masonry.

3.3 DISSIMILAR MATERIALS

A. When aluminum railing components come into contact with dissimilar metals, masonry, or concrete, surfaces shall be kept from direct contact by painting the contact surface with a heavy coat of bituminous paint (cast aluminum) or two coats of clear lacquer (extruded aluminum).

3.4 INSTALLATION

A. Install railing system and related components in strict accordance with approved shop drawings and manufacturer's printed instructions.

B. Preassemble railing system, including posts, into the largest practical sections possible.
   1. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members, do not exceed tolerances specified in this Section. Erect work free from distortion or defects detrimental to appearance or performance.
   2. Separate aluminum which might contact concrete, masonry and other dissimilar metals to prevent electrolytic action.

C. Align railings prior to securing in place to assure proper matching at abutting and expansion joints and correct alignment throughout their length.
   1. Provide for thermal expansion and contraction by use of expansion joints in top rails at 20-foot maximum intervals.
   2. Space posts not more than 6 feet on center.
   3. Space wall brackets not more than 5 feet on center.

D. Provide anchorage for posts as indicated on Contract Drawings and in the following manner:
   1. Top of concrete walls, slabs, walkways, stairs and removable railing sections:

a. Furnish posts with floor flange, welded or mechanically attached to post, with predrilled holes for bolting to surface.

2. Side of concrete walls, slabs, walkways, stairs, and removable railing sections:
   a. Furnish posts with side plate, welded or mechanically attached to post, with predrilled holes for bolting to surface.
3. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete or attached to side as indicated on Drawings.

E. Gates and removable sections:
1. Provide safety gates in railing systems where ladder tops occur and at other locations shown on the Contract Drawings. Safety chains will not be accepted. Provide gates with self-closing hinges and self-closing latch bolts.
2. Provide removable railing sections where indicated on the Contract Drawings.
3. Provide gate and removable railing section hardware with color to match the railing system of which it is a part.

3.5 TOLERANCES

A. Limit variation of cast-in-place inserts, sleeves, and field-drilled anchor and fastener holes to the following:
1. Spacing: ± 3/8 inch.
2. Alignment: ± 1/4 inch.
3. Plumbness: ± 1/8 inch.

B. Handrails and Guardrail System Plumb Criteria:
1. Limit variation of completed handrail and guardrail system alignment to 1/4 inch in 12 feet with posts set plumb to within 1/16 inch in 3 feet.
2. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Provide "hairline" thin butt joints.

3.6 CLEANING

A. As installation is completed, clean the railings in accordance with the manufacturer's printed instructions.

B. If cleaning operations remove anodized finish, remove the affected rail and replace it with new material.

3.7 PROTECTION

A. Suitably protect rail surfaces against lime mortar stains, discoloration, surface abrasion, and other construction abuses. Remove stained or otherwise defective work and replace with material that meets specification.

END OF SECTION

DIVISION 06
WOOD, PLASTICS, AND COMPOSITES

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SECTION 06 80 10
TENSIONED-FABRIC BAFFLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes design, fabrication, and erection of tension-fabric baffle systems composed of NSF 61 compliant geo-membrane for potable water storage tanks as shown on the Contract Drawings and specified herein. Furnish all labor, materials, and equipment required to design, fabricate, deliver, and install the tensioned-fabric baffle system.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrications

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM) standards, most recent editions:

ASTM A368	Standard Specification for Stainless Steel Wire Strand
ASTM A492	Standard Specification for Stainless Steel Rope Wire
ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM D413	Standard Test Methods for Rubber Property—Adhesion to Flexible Substrate
ASTM D471	Standard Test Method for Rubber Property—Effect of Liquids
ASTM D696	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer
ASTM D751	Standard Specification Making and Curing Concrete Test Specimens in the Field
ASTM D1204	Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D2136	Standard Test Method for Coated Fabrics—Low-Temperature Bend Test
ASTM D3389	Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader)

ASTM D4437	Standard Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
ASTM G153	Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

B. Federal Test Method Standards (FTMS), most recent edition:

FTMS 101C	Puncture Test

C. NSF International (NSF), most recent edition:

NSF 54	Flexible Membrane Liners
NSF 61	Drinking Water System Components, Health Effects

1.4 ACTION SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit manufacturer's product data and descriptive literature. Include evidence of qualifications for both manufacturer and fabricator as described in this Section.

C. Submit manufacturers' installation and maintenance instructions.

D. Submit shop drawings showing tensioned-fabric baffle sheet layout with proposed size, number, and position of factory-fabricated sheets and indicating the location of all joints. Show complete details and methods for anchoring the lining, making joints, seals at structures, etc.

E. Provide reports, produced by an independent laboratory, showing test results that indicate physical properties of the products provided meet or exceed the requirements of this Section.

F. Submit three samples (24-inch by 24-inch) of the tensioned-fabric baffle sheets with finished edges.

G. Submit results of seam strength tests and peel adhesion tests required under Paragraph 3.3.A herein.

H. Submit sample manufacturer's warranty for review and approval prior to shipment of materials.

1.5 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers: Qualified manufacturers must have at least 20 years of experience in the fabrication of geomembrane products and must have manufactured a minimum of 50 tensioned-fabric baffle projects for similar applications.
   2. Fabricators: Qualified fabricators must have furnished and had in satisfactory service for a period of not less than 5 years, at least 10 baffle systems with dimensions and quantities like those specified for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Packaging and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.

C. Storage and Handling Requirements: Comply with manufacturer's instructions.

1.7 SITE CONDITIONS

A. Do not install tensioned-fabric baffles until interior tank concrete operations have been completed and all concrete construction joints have been sealed.

B. Prior to installation of the tensioned-fabric baffles, remove all unnecessary material and equipment from inside the tank and sweep the floor clean.

1.8 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty, executed by the installer and baffle manufacturer, covering materials and labor, agreeing to repair or replace materials that fail due to defects in materials and/or workmanship at the time of final acceptance, and against deterioration due to effects of ozone, ultraviolet rays, or other normal weathering for 10 years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers
   1. Baffle Curtain Material
      a. 8130 XR®-3PW; Seaman Corporation
      b. Engineer approved equal.

B. Description

1. Tensioned-fabric baffles composed of 2-ply Elvaloy based coated polyester reinforced geomembrane.
2. All material must have NSF 61 approval.

C. Material Specification

1. Furnish a flexible, durable, watertight composite material, free of pinholes, blisters, holes, and contaminates that may delaminate in a potable water environment. Material to conform to the following:

Physical Properties	Test Method	Standard
Base Fabric Type	ASTM D751	Polyester
Base Fabric Weight		6.5 oz/yd^2 nominal
Thickness	ASTM D751	30.0 mil min
Composite Fabric Weight	ASTM D751	30.0 ±2 oz/yd^2
Tear Strength	ASTM D751 Trapezoid Tear	40/55 lb min
Breaking Yield Strength	ASTM D751 Grab Tensile Procedure A	550/550 lbs min
Low Temperature Resistance	ASTM D2136, 1/8-in mandrel, 4 hours	Pass at -30 deg F
Dimensional Stability	ASTM D1204, 212 deg F, 1 hour	0.5% max each direction
Hydrostatic Resistance	ASTM D751 Method A	800 psi min
Blocking Resistance	ASTM D751 180 deg F	#2 Rating max
Adhesion – Ply	ASTM D413 Type A	15 lb/in min or film tearing bond
Adhesion – Heat Welded Seam	ASTM D751 Dielectric Weld	40 lbs/2 in min
Dead Load Seam Strength	ASTM D751 4-hour test	Pass 240 lb/in @ 70 deg F Pass 120 lb/in @ 160 deg F
Bonded Seam Strength	ASTM D751 Procedure A Grab Test Method	550 lb min
Abrasion Resistance	ASTM D3389 H-18 Wheel 1 kg Load	2000 cycles minimum before fabric exposure, 50 mg/100 cycles maximum weight loss
Weathering Resistance	ASTM G153	8000 hours minimum with no appreciable change or stiffening or cracking of coating
Water Absorption	ASTM D471, Section 12, 7 days	0.025 kg/m^2 max @ 70 deg F and 0.14 kg/m^2 max @ 212 deg F
Wicking	ASTM D751	1/8-in max
Bursting Strength	ASTM D751 Ball Tip	750 lb min
Puncture Resistance	ASTM D4833	275 lb min
Coefficient of Thermal Expansion	ASTM D696	8E-06 in/in/deg F max
Puncture Resistance	FTMS 101C Method 2031	±350 lbs

Physical Properties	Test Method	Standard

2. Nylon reinforced materials are not acceptable.

D. Fabrication
   1. Provide minimum 3-inch wide, two-ply hem on all edges of the tensioned-fabric baffle curtains.

E. Color: White

2.2 ANCHORING HARDWARE

A. All bolts, washers, nuts, eye nuts, and expansion anchors shall conform to ASTM F593 for bolts and ASTM F594 for nuts, Type 316 stainless steel, minimum 3/8-inch diameter.

B. Batten connection shall conform to ASTM A666, Type 316 stainless steel flat bar, minimum 1/4-inch thickness by 2 inches wide.

C. Suspension and tension cable for the top and open ends of the curtains shall conform to ASTM A368 or ASTM A492, Type 316 stainless steel, 3/16-inch minimum diameter, cable with matching Type 316 stainless steel cable clamps and thimbles.

D. Continuous cable seamed into the edges of fabric-baffle panels shall conform to ASTM A368 or ASTM A492, Type 316 stainless steel, 3/8-inch minimum diameter, cable with matching hardware.

E. Supply all hardware in ready to install kits with batten cut and pre-drilled to minimize field cutting and drilling of attachment hardware.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate between the tensioned-fabric baffle manufacturer and Engineer concerning loading on the tank, attachment details, and the sequence of construction. General installation details are shown on the Contract Drawings and are provided as a guide for Contractor and tensioned-fabric baffle manufacturer.

3.2 PREPARATION AND FABRICATION

A. Visually inspect all roll goods from manufacturer prior to factory seaming. Make all factory seams by thermal fusion methods. Provide all factory seams with minimum scrim-to-scrim overlap of 1-1/2 inches when fabricated. Repair all fabricated seams found to have less than the specified minimum overlap by adding an overlap or cap strip that provides the minimum specified overlap. Make all seams so that thermal fusion bond extends fully along the width of the sheet and that no loose edges are present.

B. Field verify all dimensions and provide same to the tensioned-fabric baffle fabricator prior to fabrication of materials. Any installation shop drawings submitted for approval must include this information.

C. Fabricate all tensioned-fabric panels in accordance with the approved submittal drawings, including field verified dimensions. For those panels requiring widths greater than the coated fabric available from the manufacturer, factory seam all components. Field seaming will not be permitted.

3.3 INSPECTION

A. Visually inspect all sheets and seams 100% during fabrication. No defective seams or exposed scrim will be allowed. Seal all exposed scrim edges with an approved polypropylene edge sealant or cap with a strip of unreinforced polypropylene. All indicated repairs shall be made by the geomembrane fabricator before the panels are packaged for shipment

B. In addition to visual inspection, make a 48-inch weld sample with each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Take samples from a seam specifically made for quality testing and not taken from the fabricated panel itself. Cut test specimens at quarter points from each 48-inch seam sample (a total of three places) and tested for seam strength and peel adhesion. Test the shear seam strength in accordance with ASTM D751 as modified in Annex A of ANSI/NSF 54. Test the peel adhesion in accordance with ASTM D4437 as modified in Annex A of ANSI/NSF 54.

C. Maintain a log showing the date, time, panel number, and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the material and/or seams as appropriate. Submit the test results to Engineer prior to installation of the tensioned-fabric panels.

3.4 INSTALLATION

A. Schedule installation of the tensioned-fabric baffles to be performed after all other work is complete inside the tank.

B. Suspend the top of the tensioned-fabric baffle from the tank roof using a horizontal stainless steel cable, minimum 3/8-inch diameter. Attach vertical top cable support assemblies through the top support cable plates at 5-ft on center maximum, with one cable attaching to the tank roof. Attach all vertical top cable support assemblies to the tank roof with minimum 3/8-inch x 3-3/4-inch long stainless steel concrete anchors and 3/8-inch stainless steel eye nut per Contract Drawings.

C. Attach open ends of tensioned-fabric baffles to tank walls similar to top support.

D. Attach the side hems of the tensioned-fabric baffle to the tank walls by clamping the baffle material between batten and concrete wall and secured with concrete anchors spaced at maximum of 12-inches on center. This procedure also applies to intermediate support columns, if applicable.

E. Attach the bottom hems of the tensioned-fabric baffle to the column footings by clamping the baffle material between batten and side of footing with concrete anchors spaced at maximum of 12-inches on center. Do not attach tensioned-fabric baffles to floor slab between column footings.

F. Should vertical support member(s) be required by the manufacturer, embed a 3/8-in. stainless steel cable in the tensioned-fabric baffle material vertically and attach at the ceiling and floor through a 1/2-inch anchor with eye-nut using two stainless steel cable clamps.

3.5 FIELD QUALITY CONTROL

A. Upon completion of tensioned-fabric baffle installation, visually inspect the tensioned-fabric baffles for damage. As required by Engineer, make any repairs with newly manufactured material cut with rounded corners and extending minimum 4-inches in each direction from the damaged area. Completely weld the entire repair to the baffle wall.

END OF SECTION

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DIVISION 07
THERMAL AND MOISTURE PROTECTION

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SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes sealant work associated with joints between similar and dissimilar materials in the Work.

B. Work included consists of, but is not necessarily limited to the following:
   1. Sealing all joints which would otherwise permit penetration of moisture, unless sealing work is specifically required under other sections.
      a. Concrete control and expansion joints, exterior and interior.

1.2 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM C1193	Standard Guide for Use of Joint Sealants
ASTM C1247	Standard Test Method for Durability of Sealants Exposed to Continuous Immersion in Liquids

B. Federal Specification (FS), most recent editions:

TT-S-00227E	Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)

C. National Sanitation Foundation (NSF), most recent edition:

NSF 61	Drinking Water System Components, Health Effects

1.3 DEFINITIONS

A. Words "calk," "sealant," and "calking" mean sealant Work.

B. "Interior wet areas" mean toilets, showers, sinks, and similar areas.

C. "Applicator" means the individual actually on site performing the installation.

D. "Vertical" means any surface with a slope greater than 1.5 horizontal to 1.0 vertical.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data
   1. Letter of certification that products submitted meet requirements of standards referenced.
   2. Manufacturer's installation instructions.
   3. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling, and bond breaker.
   4. Applicator qualifications.
   5. Warranty.
   6. Certification from sealant manufacturer stating that product being used is recommended for and is best suited for joint in which it is being applied.

C. Field Samples
   1. Cured sample of each color for Engineer's color selection. Color chart not acceptable.

D. Preconstruction field test reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in below in QUALITY ASSURANCE.

E. Product test reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Sealant applicator shall have a minimum of five years of experience on projects with similar scope.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Deliver material in manufacturer's original unopened containers with labels intact. Labels shall indicate contents and expiration date of material.

C. Store all materials off the ground and protect from rain, freezing, or excessive heat until ready for use.

D. Condition the specified products before use as recommended by the manufacturer.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Schedule Work to be performed when temperature and humidity are as recommended by the sealant manufacturer during and after installation until products are fully cured.

1.8 WARRANTY

A. Material and Labor Warranty:

1. Sealant work shall be free of defects for a period of 5 years from date of final acceptance.
2. Failure of watertightness constitutes defect.
3. Remove any defective work and/or materials and replace with new materials.
4. Warranty must be sighed jointly by applicator and sealant manufacturer.

B. Special installer's warranty:
1. Installer's standard form in which installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified herein within specified warranty period.
   a. Warranty period: Five years from date of final acceptance.
2. Special warranties herein specified exclude deterioration or failure of elastomeric joint sealants from the following:
   a. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design.
   b. Disintegration of joint substrates from natural causes exceeding design specifications.
   c. Mechanical damage by individuals, tools, or other outside agents.
   d. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Polyurethane sealants.
   a. Pecora.
   b. PSI Polymeric Systems, Inc.
   c. Sika Chemical Corporation.
   d. BASF Master Builders.
   e. Engineer approved equal.

2.2 MATERIALS

A. Sealants – General:
1. Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
2. For joints in potable water reservoirs, provide only 2-component polyurethane sealant with NSF 61 certification.
3. Suitability for immersion in liquids: Where elastomeric sealants are indicated for submerged use, provide products that have undergone testing according to ASTM C1247 and qualify for the length of exposure indicated by reference to ASTM C920 for Classes 1 or 2. Liquid used for testing sealants is chlorinated potable water, unless otherwise noted.

B. Polyurethane Sealant:
   1. Two components.
   2. Meet ASTM C920; F.S. TT-S-00230C, Type I or Type II, Class A, or TT-S-00227E, Type I or Type II, Class A.
      a. Pecora Dynatrol II, Urexpan NR-200.
      b. PSI PSI-270.
      c. Sika Sikaflex-2C.
      d. Master Builders MasterSeal NP-II.

C. Bond breaker tape: Polyethylene tape of other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint surfaces of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
   1. Unless specifically shown on the Drawings, bond breaker shall not be used in joints within the reservoir.

D. Joint Cleaner, Primer, Bond Breaker:
   1. As recommended by sealant manufacturer.

E. Sealant Backer Rod: Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer to:
   1. Control joint depth
   2. Break bond of sealant oat bottom of joint
   3. Provide proper shape of sealant bead.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before using any sealant, investigate its compatibility with adjacent joint surfaces, fillers, and other materials in the joint system.

B. Use only compatible materials.

C. Clean and prime joint surfaces in accordance with manufacturer's instructions.
   1. Limit application to surfaces to receive sealant.
   2. Mask off adjacent surfaces.

D. Commencing sealant installation constitutes acceptance of joints and surfaces.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Where finish coating or covering is to be applied to surface, wait until such coating or covering has been applied before installing sealant; e.g., paint, wall covering, glazed coatings.

C. Make all joints water and air tight.

D. Make depth of sealing compounds not more than one-half width of joint, but in no case less than 1/4 inch nor more than 5/8 inch.

E. Provide correctly sized backer rod in all joints to proper depth

F. Apply bond breaker where required.

G. Tool sealants using sufficient pressure to fill all voids.

H. Upon completion, leave sealant with smooth even neat finish.

3.3 CLEANING

A. Clean adjacent soiled surfaces free of sealant.

3.4 PROTECTION

A. Protect finished installation.

B. Protect sealants until fully cured.

3.5 SCHEDULES

A. Furnish sealant as indicated for the following areas:
   1. Interior wet areas:
      a. Joints in concrete:
         1) Use 2-component polyurethane only.

END OF SECTION

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DIVISION 09
FINISHES

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SECTION 09 90 00
PAINTING AND COATING

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers surface preparation, furnishing, and application of protective coatings and architectural paint, complete.

B. It is the intent of this specification that all new or existing exposed metal surfaces shall be coated with a protective coating, unless specifically excluded.

C. Shop or existing surface preparation methods, cleanliness, and existing paint, rust, and mill scale removal are not known nor documented. Be solely responsible for determining work effort, abrasive blast requirements, and any other factors that may affect work productivity as required to provide the specified surface preparation cleanliness; regardless of prior system preparation or coating application.

D. This specification recognizes AWWA, NACE, and SSPC standards as minimum industry standards and they are referenced for purpose of conformance, except where modified herein. The requirements of this specification section have been written to a higher design standard with the intent of achieving long-term coating performance.

1.2 ABBREVIATIONS

ANSI	American National Standards Institute
AWWA	American Water Works Association
CSP	Concrete Surface Profile
FRP	Fiberglass Reinforced Plastic
HCl	Hydrochloric Acid
MDFT	Minimum Dry Film Thickness
MDFTPC	Minimum Dry Film Thickness Per Coat
mil	Thousandths of an Inch
MIL-P	Military Specification - Paint
OSHA	Occupational Safety and Health Act
PSDS	Paint System Data Sheet
SFPG	Square Feet Per Gallon

SFPGPC	Square Feet Per Gallon Per Coat
SP	Surface Preparation
SSPC	Steel Structures Painting Council
TCLP	Toxicity Characteristic Leaching Procedure
VOCs	Volatile Organic Compounds

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 20 - Submittal Procedures.

B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.

C. Product Data:
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. A sample PSDS form is appended at the end of this section.
2. The required information shall be submitted on a system-by-system basis.
3. Provide copies of the paint system submittals to the coating applicator.
4. Indiscriminate submittal of manufacturer's literature only is not acceptable.

D. Quality Control Submittals:
1. Signed letter from the coating manufacturer prefacing any coating product submittal. This letter shall indicate that the coating manufacturer’s representative is aware of the Project, recommends the specific products included in the submittal for use on the Project, and that these systems meet or exceed requirements specified herein.
2. Applicator's Experience: List of projects of similar scope and size completed by the Applicator along with references.
3. List of coating applicators, including supervisor, who have direct coating application responsibility with years of experience in application of indicated coating system.
4. The coating manufacturer shall provide a copy of the manufacturer’s coating application quality assurance manual. This shall include adhesion test data.
5. If the manufacturer of field-applied coating differs from that of shop applied primer, provide both manufacturer's written confirmation certifying that materials are compatible
6. Coating Application Company shall provide a Quality Control Plan.

E. Where ANSI/NSF Standard 61 and 600 approval is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits on size of tank or piping, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.

F. Provide TCLP test data for lead and other regulated heavy metals in non-recyclable, slag type abrasive blast media to be used on the project. Acceptable abrasive test data shall indicate

the abrasive manufacturer, location of manufacture, and media gradation and type. Surface preparation will not be permitted to begin until acceptable test data has been submitted.

1.4 QUALITY ASSURANCE

A. The paint manufacturer shall provide a representative to visit the 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, the manufacturer's products furnished under this Contract. Sales representatives are not acceptable as a technical representative unless written authorization from the coating manufacturer is provided which states the sales representative has full authority to act in behalf of the coating manufacturer.

B. Coating Applicator's Experience and Certification:
   1. Coating Application Company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years' experience applying the specified coating system.
   2. Coating application personnel, who have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.
   3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.

C. Continuity of Contractor: Site supervisor shall coordinate with the Engineer. Any replacement of the supervisor on site will require notification of Engineer 72 hours in advance, and will be subject to approval by the Owner.

D. Scheduling and Coordination of Work: It is the Contractor's responsibility for scheduling and coordinating the work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's work.

E. Engineer Observations:
   1. The Contractor shall give the Engineer notice a minimum of 14 days prior to start of work for scheduling shop or field observation.
   2. Provide Engineer minimum 3 days' notice prior to start of surface preparation work or coating application work.
   3. Provisions shall be made to allow Engineer full access to facilities and appropriate documentation regarding coating application.
   4. Perform work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence. Approval to perform work in the Engineer's absence is limited to the current day unless specifically noted to extend beyond the completion of the workday.
   5. Inspection by the Engineer, or the waiver of inspection of any portion of the work, shall not be construed to relieve the responsibility to perform the work in accordance with these specifications.
   6. Materials shall be subject to testing for conformance with this specification as the Owner's representative may elect, prior to or during incorporation into the work.

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 paint manufacturer.

C. Shipping:
   1. Where precoated items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
   2. Use nonmetallic or padded slings and straps in handling.
   3. Items will be rejected for excessive damage.

1.6 WARRANTY

A. Warranty: The Contractor and coating manufacturer shall jointly and severally warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of 2 years commencing on the date of final acceptance of the work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Coatings and linings will be stored and handled per manufacturer's written directions.

B. All metallic surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer, and these specifications, whichever is more stringent, unless specified otherwise.

C. Coatings shall be the product of a single manufacturer. Product substitutions during the project will not be permitted without Engineer approval.

2.2 PAINT AND COATINGS MANUFACTURERS

A. A manufacturer letter code as follows will be found following the generic descriptions of materials outlined in the specifications. Address is that of the general offices. Contact these offices for information regarding the location of representative nearest the project site.

B. Manufacturer Code A - Coatings Manufacturers (Able to supply most heavy-duty industrial coatings and architectural paints):
   1. Carboline Coatings Company, St. Louis, MO.
   2. ICI Devoe Coatings Company, Louisville, KY.
   3. International Coatings, Louisville, KY
   4. Pittsburgh Paints (PPG), Pittsburgh, PA
   5. Sherwin Williams, Cleveland, OH
   6. Tnemec Coatings, Kansas City, MO.

C. Manufacturer Code E - Fusion Bonded Coating Applicators:
   1. 3M Company, St Paul, MN.

2.3 PAINT MATERIALS

A. Products shall meet federal, state, and local requirements limiting the emission of VOCs. Specific information may be secured through the local Division of Air Quality.

B. Materials Including Primer and Finish Coats: Produced by same paint manufacturer of other components of the coating system, as previously stated.

C. Thinners, Cleaners, Driers, and Other Additives: As recommended by paint manufacturer of the particular coating. Where coatings are required to meet ANSI/NSF Standard 61 and 600, addition of thinners, driers, and other paint additives not approved under the ANSI/NSF certification letter will not be permitted.

D. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop.

E. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the established chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop.

F. Paint products are listed according to their approximate order of appearance in the paint systems. The letter designating the manufacturer code refers to Article PAINT AND COATING MANUFACTURERS.

Product	Definition
Epoxy, NSF	Amine or polyamine epoxy coating, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFTPC, approved for potable water contact in conformance to ANSI/NSF Standard 61 and 600, and suitable for the application temperatures and conditions. MANUFACTURER CODE: A
Epoxy	Polyamine or polyamide epoxy, two parts, suitable for immersion service, 75% volume solids minimum, capable of 4 to 8 MDFTPC, and suitable for the application temperatures and conditions MANUFACTURER CODE: A
Polysiloxane	Acrylic polysiloxane hybrid coating, single component, suitable for shop or field application at 32 degrees F, minimum, recoat window of not less than 12 months with preference for products with unlimited overcoat capability, solids content of 85% minimum, high gloss, and tintable colors. Tinted colors shall be capable of storage for 30 days or longer prior to application. Coating shall be capable of spray, roller, or brush application on all metal substrates and specified prime and intermediate coats. MANUFACTURER CODE: A
Polyamide, Anti-Corrosive, Epoxy	Polyamide or Polyamine epoxy primer, two parts, containing rust-inhibitive pigments.

Product	Definition
Primer	MANUFACTURER CODE: A
Organic Zinc Rich Primer	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 lbs. metallic zinc content per gallon. MANUFACTURER CODE: A
Inorganic Zinc Primer	Solvent or water based, 14 lbs. metallic zinc content per gallon minimum; unlimited recoat window, conform to manufacturer's recommended topcoats as specified herein MANUFACTURER CODE: A
Rust-Inhibitive Primer	Single-package steel primers with anti-corrosive pigment loading; may be alkyd, vinyl, epoxy ester, chlorinated rubber. MANUFACTURER CODE: A-B
Alkyd Enamel	Optimum quality, gloss finish, medium long oil. MANUFACTURER CODE: A-B
Wash Primer	Vinyl butyral acid or equivalent coating for enhancing finish coat adhesion to galvanized steel surfaces. MANUFACTURER CODE: A
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish, suitable for continuous dry service at 200 degrees F without discoloration or peeling. MANUFACTURER CODE: A
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy or polyurethane resin, suitable for intended service.
Modified Waterborne Acrylate	Single component, modified waterborne acrylate, flexible, breathable coating for concrete. MANUFACTURER CODE: A

2.4 COLORS

A. Provide as selected by the Owner.

B. 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 matches.

D. Equipment Colors:
   1. Equipment shall be meant to include the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
   2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as itemized below:
      a. Dangerous parts of equipment and machinery: OSHA Orange
      b. Fire protection equipment and Apparatus: OSHA Red
      c. Radiation hazards: OSHA Purple
      d. Physical hazards in normal operating area: 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. Pipe Identification Painting:
   1. Color code non-submerged metal piping except electrical conduit. Paint fittings and valves the same color as the pipe.
   2. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at all connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along the piping not greater than 9 feet on center, with identification labels applied to each exposed run of pipe as specified herein.
   3. Pipe supports: Galvanized steel does not require painting. Mild steel, painted ANSI 70 Light Gray, as manufactured by:
      a. Tnemec Co., Series 90-97 Tneme-Zinc or Series 394 PerimePrime
      b. Or equal.
   4. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe located outside of buildings and enclosed structures will not require painting, except as noted.

F. Labels for Piping: Provide pipe labels in coordination with the Engineer.

2.5 QA/QC TESTING AND INSPECTION

A. General
   1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
   2. Quality control testing as specified in AWWA standards are minimum industry standards and it is the intent of this specification to provide a higher level of quality control for the objective of achieving maximum coating performance.
   3. If any conflict between this specification and referenced standards occurs, the more stringent requirement shall apply and any interpretation of this requirement or results shall be with the objective of achieving maximum coating performance.
   4. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this specification.

B. Surface Profile Testing
   1. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP0287.
   2. Tester tape shall be suitable for the intended profile height.
   3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.
   4. Electronic surface profilometer shall be used, where deemed necessary, to verify tester tape measurements.
   5. Adhesion testing: Where directed by the Engineer for assessing coating application problems.

C. Holiday Testing
   1. Holiday tests on epoxy or polyurethane coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE SP 0188 and these specifications.
   2. Coating thickness used for high voltage holiday testing setting shall be the average dry coating thickness.

D. Dry Film Thickness Testing

1. Coatings shall be tested for dry film thickness using properly calibrated magnetic pull off, eddy current, or ultrasonic equipment.
2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

PART 3 - EXECUTION

3.1 GENERAL

A. The intention of this specification is for all existing and new, interior and exterior, wood, 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 prime coat only unless modified herein. Exterior concrete surfaces will not be painted unless specifically indicated herein.

B. Surface preparation and coating application shall be in conformance with these specifications and the coating manufacturer's written product data sheets and written recommendations of the manufacturer's technical representative. Where conflicts occur between the manufacturer's recommendations and these specifications, the more stringent of the two shall apply unless approved by the Engineer.

C. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.

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)

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 perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.

B. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere.

C. Do not apply paint when:
   1. Surface temperatures exceeds the maximum or minimum temperature recommended by the paint manufacturer,
   2. In dust, smoke-laden atmosphere, damp or humid weather, or under conditions which could cause icing on the metal surface.
   3. When it is expected that surface temperatures will drop below 5 degrees above dew point within 8 hours after application of coating.

D. Daily environmental condition monitoring and maintenance of the equipment shall be documented in writing and provided to the Engineer.

3.4 DEHUMIDIFICATION

A. Where environmental conditions cannot be met or controlled, provide and operate desiccant dehumidification equipment to maintain environmental conditions for 24 hours a day during abrasive blasting and coating application and cure. Liquid, granular, or loose lithium chloride drying systems will not be acceptable.

B. Provide dehumidification equipment sized to maintain dew point temperature 17 degrees or more below surface temperature of metal surfaces to be cleaned and coated. System shall provide ventilation within the environmentally controlled areas and shall meet the following requirements:
   1. Two air changes per hour, minimum
   2. Maintenance of personnel exposure limits (PEL) at 50 percent of OSHA PEL limits for all chemicals used in the performance of the work, and
   3. Maintenance of lower explosive limits (LEL) to less than 50 percent of the most volatile solvent used in the performance of the work.

C. Dehumidification equipment type, size, air flow, and power requirements shall be designed by a qualified company knowledgeable in dehumidification equipment, and its operation based on project requirements and anticipated seasonal weather conditions for the project schedule. Design to include evaluation of existing conditions, humidity, and temperature within the environmentally controlled area, proper air exchange requirements, ventilation requirements, ducting requirements for adequate air flow, and any other issues necessary to achieve the specified performance and environmental conditions throughout the duration of the project.

D. Submit written recommendations from dehumidification subcontractor for bulkhead locations, bulkhead venting, duct work for each bulkhead section, any secondary ventilation requirements for coating cure, dust collection equipment, CFM requirements, and drying requirements for blast hose compressed air necessary to maintain environmental control as specified herein.

E. Dehumidification equipment subcontractor shall either operate the equipment or provide training on the proper operation and setup of dehumidification equipment. Dehumidification subcontractor shall provide a technical representative on site for a minimum of two 8-hour days to insure proper operation of the equipment, achievement of desired environmental

control, and to insure proper setup, operation, monitoring, and maintenance of the equipment.

F. Dehumidification shall be operated in a manner that prevents all condensation or icing throughout surface preparation and coating application and cure.

G. Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor. Cleaned metal surfaces subject to flash rusting shall be cleaned to the same cleanliness as prior to the flash rust formation and shall be approved by the Engineer.

H. Monitor ambient temperature, humidity, dew point temperature, and pipe surface temperature both outdoors and within the environmentally controlled area at the start, midpoint, and end of each work shift, minimum, but not more than 5 hours between measurements.

3.5 VENTILATION AND ILLUMINATION

A. Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.

B. Ventilation shall be used to control potential dust and hazardous conditions within the work area. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to non-hazardous conditions.

3.6 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise stated herein or shown, the following areas or items will not require painting:
   1. Concrete and masonry surfaces, except where indicated otherwise.
   2. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
      a. Required for electrical insulation between dissimilar metals.
      b. Aluminum is embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
      c. Color coding of equipment and piping is required.
   3. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for architectural painting or color coding.
   4. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches, acoustical tile, cabinets, elevators, building louvers, wall panels, etc.; color coding of equipment is required.
   5. Non-submerged electrical conduits attached to unpainted concrete surfaces.
   6. Heating and ventilation ducting, unless otherwise specified.
   7. Cathodic protection anodes.

8. Items specified to be galvanized after fabrication unless specifically required elsewhere or subject to immersion.
9. Insulated piping and/or insulated piping with aluminum or stainless steel jacket will not require exterior coating, except as required for architectural painting or color coding.

3.7 PREPARATION AND TESTING OF SURFACES

A. Surface Preparation Inspection and Testing:
   1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied.
   2. Perform such work only in the presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

B. Metal Surface Preparation:
   1. General:
      a. Do not perform a surface preparation blast prior to submission of samples. Workmanship for metal surface preparation as specified shall meet current Steel Structures Painting Council (SSPC) Specifications as follows:
         1) Solvent Cleaning: SP 1
         2) Hand Tool Cleaning: SP 2
         3) Power Tool Cleaning: SP 3
         4) White Metal Blast Cleaning: SP 5
         5) Commercial Blast Cleaning: SP 6
         6) Brush-Off Blast Cleaning: SP 7
         7) Pickling: SP 8
         8) Near-White Blast Cleaning: SP 10
         9) Bare Metal Power Tool Cleaning: SP 11
      b. All surface preparation shall be assumed to be on a SSPC Grade A steel surface condition, unless specifically noted otherwise.
      c. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.
      d. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply. Wet blasting methods shall be approved by the Engineer.
      e. Hand tool clean areas that cannot be cleaned by power tool cleaning.
   2. Welds and Adjacent Areas:
      a. Prepared such that there is:
         1) No undercutting or reverse ridges on the weld bead.
         2) No weld spatter on or adjacent to the weld or any other area to be painted.
         3) No sharp peaks or ridges along the weld bead.
      b. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
   3. Preblast Cleaning Requirements:

a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate (coating manufacturer approved) detergent additives followed with clean water rinsing.
c. Clean small isolated areas as above or solvent cleaned with suitable solvents and clean cloths.
d. Round or chamfered all sharp edges and grind smooth burrs, jagged edges, and surface defects.

4. Blast Cleaning Requirements:
   a. General:
      1) Type of equipment and speed of travel: Designed to obtain specified degree of cleanliness.
      2) Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
      3) Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.
      4) Do not reuse abrasive, unless abrasive is a recyclable steel grit or shot abrasive.
   b. Shop Blasting
      1) Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the work during surface preparation and shop application of paints. Work shall be subject to the Engineer's approval before shipment to the jobsite.
      2) Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning. Blast clean and prime in accordance with these Specifications.
   c. Field Blasting
      1) Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures, shall meet requirements of Steel Structures Painting Council.
      2) Field blasting in areas with electrical or mechanical equipment, within buildings or on coated surfaces with lead paint that exceed environmental regulations shall be performed with dustless abrasive systems such as "Sponge-Jet", dry ice abrasive blasting.

5. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.
   b. Paint surfaces the same day they are sandblasted. Reblast surfaces that have started to rust before they are painted to original cleanliness prior to occurrence of flash rusting.

C. Masonry Surface Preparation:
   1. Complete and cure for 14 days or more before starting surface preparation work.
   2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
   3. Cleaned masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
      a. Brush-off blasting.
      b. Water blasting.
   4. Do not damage masonry mortar joints or adjacent surfaces.
   5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
   6. Masonry Surfaces to be coated: Uniform texture and free of surface imperfections which would impair the intended finished appearance.
   7. Uncoated or Clear Coated Masonry surfaces: Free of discolorations and be uniform in texture after cleaning.

D. Concrete Surface Preparation:
   1. Do not begin until 30 days after the concrete has been placed.
   2. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.
   3. Clean concrete using mechanical or chemical methods for the degree of cleaning specified for the coating system in accordance with SSPC-SP 13, Surface Preparation of Concrete.
   4. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to coating.
   5. Prepare concrete to CSP 5 (or appropriate CSP designated by manufacturer and approved by Engineer for the coating and intended service).
   6. Bug holes, air pockets, and other voids in the concrete will be filled or patched in chemical exposure areas, secondary containment, and where specifically required.
   7. Concrete Surface Preparation Inspection:
      a. Adhesion Testing:
         1) Tensile testing of the surface preparation shall be performed by the coating applicator as necessary using Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D7234 using 2-inch diameter dollies for concrete surface adhesion testing.
         2) Applied coating greater than 20 mils in thickness or with a tensile strength greater than 2,500 psi shall be scored for concrete adhesion testing.
         3) Adhesive failure greater than 50 percent of the dolly surface area shall indicate inadequate surface preparation.
         4) Cohesive failures which results in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.
         5) Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.
      b. Concrete Soundness:
         1) Concrete soundness shall be determined using the scratching or hammer impact methods as defined in SSPC-SP 13.
      c. Moisture Content:

1) Moisture shall be tested as specified in SSPC-SP 13 and shall not exceed the moisture content recommended by the coating manufacturer.

E. Plastic Surface Preparation:
1. Hand sand plastic surfaces to be coated with a medium grit sandpaper to provide profile for the coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so the surface is roughened without removing excess material.

F. Brush-off Blast Cleaning:
1. Equipment, procedure, and degree of cleaning shall meet SSPC-SP 7, Brush-off Blast Cleaning and shall achieve a profile on the coating equivalent to 80 grit sandpaper with no exposed metal. Profile shall be uniform over the surface with no glossy areas visible.
2. Where metal substrate is exposed, apply full coating system as specified for new metal surfaces.
3. Repair or replace surfaces damaged by blast cleaning, where damage is defined as visible metal substrate. If less than 5 percent of prepared surface has the metal substrate visible, the coating shall be repaired by application of a brush applied intermediate coat. If greater than 5 percent the coating shall be fully removed to meet the specified surface cleanliness and recoated with the specified coating system.
4. Abrasive: Either conventional abrasive blasting with sand, grit, or nut shells or specialized abrasive blasting. Abrasives shall be 60 mesh grit, maximum.
5. Select various surface preparation parameters such as size and hardness of the abrasive, nozzle size, air pressure, and nozzle distance from the surface such that the surface is cleaned without pitting, chipping, or other damage.
6. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
7. The Engineer shall approve trial blast cleaned area and shall use area as a representative sample of surface preparation.

G. Solvent Cleaning:
1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action.
2. Method meets SSPC-SP 1.

3.8 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.9 PAINT MIXING

A. Multiple-component coatings:
   1. Prepare using all the contents of the container for each component as packaged by the paint manufacturer.
   2. No partial batches will be permitted.
   3. Multiple-component coatings that have been mixed shall not be used beyond their pot life.
   4. Provide small quantity kits for touchup painting and for painting other small areas.
   5. Mix only components specified and furnished by the paint manufacturer.
   6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
   7. Fast set or plural component products shall be applied using an appropriate multipart pump that properly mixes both components at the recommended ratio using equipment recommended by the coating manufacturer. Hot mixing of fast set or plural component products will not be permitted.

B. Keep paint materials sealed when not in use and provide nitrogen blanket on fast set, plural, or moisture cured coatings on opened product containers when stored or not in use more than 8 hours.

C. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

3.10 APPLICATION OF PAINT

A. General:
   1. Schedule and attend a Pre-Application Conference with Engineer prior to proceeding with coating application. Attendees should include any subcontractors intended to participate in the application of coatings on the Project.
   2. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to the succeeding coat.
   3. Apply coatings in accordance with the paint manufacturer's recommendations. Allow sufficient time between coats to assure thorough drying of previously applied paint.
   4. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
   5. Paint units to be bolted together and to structures prior to assembly or installation.
   6. Shop Primed or Factory Finished Surfaces:
      a. Inspection: Schedule with Engineer in advance for shop primed or factory-finished items delivered to jobsite for compliance with these specifications.
      b. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
      c. For two-package or converted coatings, consult the coatings manufacturer for specific procedures as relates to top coating of these products. Where scarification of the existing coating is required, prepare the surface in accordance with Brush-off Blasting Cleaning in this section.
      d. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply a mist coat of specified primer, 1.0 mil dry film thickness.

e. After welding, prepare and prime holdback areas as required for the specified paint system. Apply primer in accordance with manufacturer's instructions.

7. Manufacturer Applied Paint Systems:
   a. Repair abraded areas on factory-finished items in accordance with the equipment manufacturer's directions.
   b. Carefully blend repaired areas into the original finish.
8. Apply finish coat in a manner that will present a uniform color and texture.

B. Application Safety:
1. Perform painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. NACE publication, "A Manual for Painter Safety".
   c. Federal, state, and local agencies having jurisdiction.
2. Be solely and completely responsible for condition of the project site, including safety of all persons (including employees) and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. Safety provisions will conform to U.S. Department of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal, state, county, and local laws, ordinances, and codes.
3. Comply with all safety-training requirements promulgated or required for this project.

C. Film Thickness:
1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC.
2. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer's recommended minimum thickness, whichever is greater. Where the manufacturer has not specified a minimum coating thickness on the product data sheets, the minimum recommended coating application thickness shall apply.
3. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.

D. Stripe Coats:
1. Surfaces that are subject to immersion, condensing environments, or where specified shall be stripe coated on all angles, edges, corners, threads, welds, and similar type surfaces.
2. Stripe coat shall be an extra coat of the intermediate or topcoat material and shall be applied between the prime and intermediate coats.
3. The stripe coat shall be a separate coat of paint from coats specified under the coating system.
4. Stripe coats shall be alternated in color like a full coat.

E. Number of coats:
1. Apply specified number of coats, minimum, irrespective of the coating thickness.
2. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

F. Porous Surfaces, Such as Concrete, Masonry:
   1. Prime Coat:
      a. May be thinned to provide maximum penetration and adhesion.
      b. Type and Amount of Thinning: Determined by the paint manufacturer and is dependent on surface density and type of coating.
      c. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of the coating.

G. Existing Coated Surfaces:
   1. General:
      a. Shop primed or coated surfaces shall be reviewed with the Engineer to determine the extent of coating damage, repair methods, surface preparation requirements, and suitability of the finish coats to adhere to the shop applied coats.
      b. All shop primed or finished coated surfaces shall be verified to be compatible with field applied finish coats.
      c. If a cured epoxy, polyurethane, or plural-component material is to be top coated, contact the coating manufacturer concerned for additional surface preparation requirements. Existing coated surfaces shall be prepared as follows:
         1) Existing coated surfaces shall be brush-off blasted as specified herein to remove all gloss and provide a uniform profile on existing coating for adhesion of subsequent coats.
         2) Power or hand sanding will not be allowed as a surface preparation procedure for existing coatings, unless reviewed and approved by the Engineer.
         3) Where coating manufacturer surface preparation recommendations conflict with this section, the more stringent requirements shall apply.
         4) Profile shall be as specified for by the manufacturer or equivalent of 80 grit sandpaper; whichever is more stringent. Profile shall be visible and uniform over existing coated surfaces.
      d. All existing coated surfaces, where demolition of equipment was specified or required, shall be surface prepared, touch-up coating repairs completed, and a cosmetic overcoat applied using the specified coating system on all existing coated surfaces associated with the demolition work, unless otherwise specified.
      e. Existing coatings on immersed equipment shall be removed to bare metal and recoated with the specified coating system where demolition work was specified.
      f. Apply sealer/primer where recommended by coating manufacturer for coating compatibility.
   2. To be Recoated or Final Coated:
      a. Detergent wash and freshwater rinse.
      b. Perform touch-up repairs of existing coating.
      c. Ductile iron pipe with asphaltic coating will require an application of a seal coat prior to the application of a cosmetic finish coat.
   3. Touch-up Repairs:
      a. Clean loose, abraded, or damaged coatings to substrate by Power Tool (SP 3).
      b. Feather surrounding intact coating.

c. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
d. Apply one full finish coat of the specified primer or finish coat(s) overall.

4. Application of a Cosmetic Coat:
   a. The exact nature of shop-applied coatings is not known in all cases.
   b. Check compatibility by application to a small area prior to starting the coating.
   c. If lifting or other problems occur, request disposition from the Engineer.
   d. Cured epoxy, polyurethane, plural component materials or any other coating system that has exceeded its maximum recoat window shall be prepared as specified in this section and as specified by the manufacturer.

H. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with the recommendations of the paint manufacturer.
2. Repair fusion bonded coatings as recommended by the original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by the coating manufacturer.
3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

I. Unsatisfactory Application:
1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.
3. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
4. Repair defects in coating system per written recommendations of coating manufacturer and as approved by the Engineer.
5. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

3.11 COATING INSPECTION

A. General:
1. Film thickness measurements and electrical inspection of the coated surfaces:
   a. Perform with properly calibrated instruments.
2. Recoat and repair as necessary for compliance with the Specifications.
3. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.
4. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper mil thickness in these areas.

B. Coating Thickness Testing:
   1. Engineer shall conduct coating thickness testing as necessary and without limitation. Testing conformance to the requirements of SSPC-PA 2 is specifically excluded from this specification.
   2. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge as specified.
   3. Check each coat for the correct mil thickness. Do not make measurement before a minimum of 8 hours after application of the coating.
   4. Tests for concrete coating thickness shall be with a Tooke Gauge, which is a destructive test. Repair coating after thickness testing.

C. Coating Continuity Testing:
   1. Holiday detect coatings with high voltage units in accordance with NACE SP0188. High voltage detector shall have adjustable voltages in 100 volt increments and shall be operated in accordance with the manufacturer's instructions and the specified standard.
   2. Use of an electrical holiday detector, low voltage, wet sponge type holiday detector will be permitted for coating systems less than 20 mils total dry film thickness and are not for immersion or condensing environments.
   3. Holiday detect coatings on pipe for buried application with high voltage spark tester in accordance with NACE RP0274.

3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroyed at the end of each day.

B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroyed 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 over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.13 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.

3.14 PROTECTIVE COATING SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified in these Specifications painted or coated the work in accordance with the following application schedule.

B. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the work in question.

System No.	Title
1	Submerged Metal – Potable Water
2	Concrete Encased Metal
4	Exposed Metal - Highly Corrosive
5	Exposed Metal - Mildly Corrosive
8	Buried Metal - General
10	Galvanized Metal Conditioning
11	Galvanized Metal Repair
27	Aluminum and Dissimilar Metal Insulation
29	Fusion Bonded Coating

C. System No. 1 Submerged Metal - Potable Water:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	NSF, Polyamide Epoxy Coating	3 coats, 3 MDFTPC

2. Application:
   a. All metal surfaces, new and existing, below a plane 1 foot above the maximum liquid surface, metal surfaces above the maximum liquid surface which are a part of the immersed equipment, concrete embedded surfaces of metallic items under submerged conditions, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel, excluding reinforcing steel, unless otherwise specified.
   b. Use on the following areas:
      1) Reservoir Pipe and Metals:
         a) All pipe and metal surfaces (except stainless steel)
      2) Piping:
         a) Lining for welded steel pipe 10-inches diameter and smaller.
3. Special Requirements:
   a. All existing immersed metal surfaces with an existing coating system, excluding new shop primed or coated equipment, shall be abrasively blasted to bare metal and recoated with this system.
   b. Epoxy coating applied to immersed surfaces that contact potable water shall be NSF certified for potable water contact.
   c. NSF certified fusion bonded epoxy linings will be permitted as alterative lining for small diameter pipes, valves, and couplings. FBE coating to be applied as specified for FBE coatings this section and in accordance with the manufacturer's recommendations.
   d. All welds, angles, edges, and bolted connections shall be stripe coated as specified this section.

D. System No. 2 Concrete Encased Metal:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Polyamide Epoxy	2 coats, 12 MDFT

2. Application:
   a. Metal surfaces encased in concrete, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel excluding reinforcing steel; and the following specific surfaces unless otherwise specified.
   b. Aluminum surface in contact with concrete or grout or embedded in concrete.
3. Special Requirements:
   a. May be used in lieu of System No. 27 at Contractor's option.
   b. Shop coated surfaces shall be prepared as specified.

E. System No. 4 Exposed Metal - Highly Corrosive:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Organic Zinc Rich Primer	1 coat, 2.5 MDFT
	Polyamide Epoxy	1 coat, 5 MDFT
	Polysiloxane	2 coats, 6 MDFT

2. Application:
   a. Exposed piping and metal surfaces, new and existing, located inside of structures, manholes, vaults, and the following specific areas unless otherwise specified.
   b. Use on the following areas:
      1) 3 MG Reservoir Valve Vault
      2) WaterPro Meter Vault
      3) All underground vaults and manholes.
   c. Contractor choice of topcoat material shall not be changed. Only one topcoat material will be permitted on the project.
3. Special Requirements:
   a. The surface preparation and primer shall be shop applied to all surfaces prior to installation. Final coats shall be field applied.
   b. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.
   c. Insulated piping shall be primed and coated prior to installation of insulation.
   d. All existing exposed metal surfaces with an existing coating system, including new shop primed or coated equipment, shall be prepared as specified under "Coating Application, Existing Coated Surfaces" and final topcoat applied per this system.
   e. Aliphatic polyurethane will not be allowed as a substitute for polysiloxane due to restrictive overcoat requirements.
   f. Dry film coating thickness of polysiloxane, including touch up repairs, shall not exceed the manufacturer's recommended maximum film thickness.
   g. Surface preparation and primer shall be shop applied to all surfaces prior to installation.
   h. DFT thicknesses greater than manufacturer’s recommendations shall be subject to rejection and removal.
   i. Intermediate and topcoats shall be field applied after installation.

j. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity throughout the vault or structure.

k. Color uniformity requirements shall apply to all components installed within the vault and visibly part of completed installation regardless of shop applied coating system.

l. Buried dielectrically coated pipe and fittings passing through a concrete structure wall or floor shall be dielectrically coated for a minimum of 4-inches beyond the interior wall or floor surface before transitioning to Coating System No. 4.

F. System No. 5 Exposed Metal - Mildly Corrosive:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Inorganic Zinc Rich Primer	1 coat, 2.5 MDFT
	Polysiloxane	2 coats, 6 MDFT

2. Application:

a. Exposed metal surfaces, new and existing, located outside of structures and exposed to weather and the following specific surfaces unless otherwise specified.

b. Use on the following items or surfaces:

1) Exposed surfaces of air vent piping, and all other piping exposed to weather, unless hot dip galvanized.

3. Special Requirements:

a. The surface preparation and primer shall be shop applied to all surfaces prior to installation. Final coats shall be field applied.

b. All shop primed or finish coated surfaces shall be prepared as an existing coated surface as specified herein and shall be top coated with intermediate and/or finish coats as required to provide color uniformity.

c. Color uniformity requirements shall apply to all components visibly part of the completed installation regardless of shop applied coating system.

d. Galvanized steel surfaces shall be coated per the coating manufacturer's requirements.

e. Polysiloxane coating to overlap buried pipe coating a minimum of 4 inches below top of concrete.

f. Aliphatic polyurethane will not be allowed as a substitute for polysiloxane due to restrictive overcoat requirements.

g. Dry film coating thickness of polysiloxane, including touch up repairs, shall not exceed the manufacturer's recommended maximum film thickness.

G. System No. 8 Buried Metal - General:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel Blast (SP 5)	As specified in Section 09 97 10, Pipeline Coatings and Linings	As specified in Section 09 97 10, Pipeline Coatings and Linings

2. Application:
   a. All buried steel pipe, joints, fittings, and other pipe appurtenances shall be coated as specified under Section 09 97 10, Pipeline Coatings and Linings.
   b. All buried, below grade portions of steel items, except buried stainless steel or ductile iron pipe, unless otherwise specified.
3. Special Requirements:
   a. Metallic air vent pipe, buried, may be coated with System No. 1 at Contractor's option.

H. System No. 10 Galvanized Metal Conditioning:
1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3)	Wash Primer	1 Coat, 0.4 MDFT
	Finish Coats to Match Existing Paint	As required to match surrounding area

2. Application:
   a. All galvanized surfaces requiring painting and the following specific surfaces unless otherwise specified.
3. Special Requirements:
   a. Sweep blast as specified in this section, may be used in lieu of hand or power tool cleaning of galvanized surfaces provided Contractor can demonstrate that damage to the zinc coating will not result. Engineer approval of sweep blasting locations, methods, and surface cleanliness and profile results is required.
   b. See applicable coating systems for finish coating system and coating requirements based on area or surface to be coated.

I. System No. 11 Galvanized Metal Repair:
1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2), or Power Tool (SP 3), or Brush-off Blast (SP 7)	Organic Zinc Rich Primer or Inorganic Zinc Rich Primer	1 Coat, 3 MDFT

2. Application:
   a. All galvanized surfaces which are abraded, chipped, or otherwise damaged and are not specified to be coated.

J. System No. 27 Aluminum and Dissimilar Metal Insulation:
1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer	1 coat, 0.4 MDFT
	Bituminous Paint	1 coat, 8 MDFT

2. Application:
   a. Use on all non-submerged concrete embedded aluminum surfaces, and the following specific surfaces unless otherwise specified:

1) All concrete embedded components of vault hatches.
2) All concrete embedded surfaces where electrical isolation from concrete reinforcement is required.

K. System No. 29 Fusion Bonded Coating:

1. Surface Preparation and Coating System

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10) or Acid Pickling (SP 8)	Fusion Bonded 100% solids Epoxy or Polyurethane	1 or 2 coats, 10 MDFT

2. Application:
   a. Use on the following surfaces:
      1) Valves, air valves and equipment.
      2) Concrete embedded anchor bolts, except threads.
      3) Removable handrail sleeves.
3. Special Requirements:
   a. Coating shall be NSF 61 approved for potable water applications.

3.15 ATTACHMENTS

A. List of Attachments:
   1. Paint/Coating System Data Sheet

END OF SECTION

PAINT SYSTEM DATA SHEET

Attached products' Technical Data Sheet (if applicable) to this sheet for each paint system submittal.

Paint System Number (from spec.):		
Paint System Title (from spec.):		
Coatings Manufacturer:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number Proprietary)**	**Min. Coats, Coverage**

Additional Information Required (check applicable items):

☐ ANSI/NSF Certification letter for each paint material listed above requiring ANSI/NSF Standard 61 and 600 approvals.

☐ Manufacturer's minimum and maximum recommended coating thickness per coat and for total coating system.

☐ Immersion coating cure requirements from minimum coating application temperature to 100 degrees in 15-degree temperature increments.

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SECTION 09 97 10
PIPELINE COATINGS AND LINING

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the work necessary to apply external coating and internal lining on steel pipe, field coating of joints, and field repair of coating damage, complete.

B. Steel pipe will be supplied from the fabricator with either a tape wrap or plural component epoxy coating system, and where specifically required the dielectric coating system shall be over coated with cement mortar.

C. Exposed steel pipe will be coated as specified in Section 09 90 00 - Painting and Coatings, unless specifically specified otherwise.

D. Hand applied tape wrap (with the exception of field-applied wax tape at buried fittings and flanges per paragraph 2.4.B) shall not be allowed under any conditions.

1.2 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Catalog cuts and other information for all products proposed. Provide copy of approved coating system submittals to the coating applicator.

C. Quality Control Submittals: Furnish the following:
   1. Applicator's experience with list of references substantiating compliance.
   2. Coating manufacturer's certification stating the applicator meets or exceeds their coating application requirements and recommendations.
   3. Coating manufacturer shall provide a copy of the manufacturer’s coating application quality assurance manual.
   4. If the manufacturer of field-applied coating differs from that of the shop applied primer, provide written confirmation from both manufacturers’ that the two coating materials are compatible.

1.3 QUALITY ASSURANCE

A. Coating Applicator's Experience and Certification:
   1. Coating application company and coating application supervisor (Certified Applicator) shall have a minimum of 5 years’ experience applying the specified coating system.
   2. Coating application personnel, whom have direct coating application responsibility, shall have a minimum of 2 years practical experience in application of the indicated coating system.
   3. Coating applicator shall be certified by the coating manufacturer as an approved applicator.

B. When requested by the Engineer, coating and/or lining manufacturer technical representative shall be present for a minimum of one day technical assistance and instruction at the start of coating and/or lining operations within the shop. During this visit, the technical representative shall observe surface preparation and coating application.

C. When requested by the engineer coating and/or lining manufacturer's technical representative shall be onsite for one working day, minimum, at the start of each construction season to inspect coating application and procedures in the field. During this visit, the technical representative shall observe surface preparation and coating application.

D. Coating and/or lining manufacturer shall include 8 hours per month of field or shop coating technical support when requested by the Engineer.

E. Technical representative shall provide a written report to the Engineer for each visit. Report shall include copies of test data collected, description of observations, and all recommended corrective actions. Report shall be submitted within 5 working days after the visit. .

F. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating or lining as may be required for product application quality assurance, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this project.

1.4 ABBREVIATIONS

MDFT	Minimum Dry Film Thickness
mil	Thousandths of an Inch

1.5 DEFINITIONS

A. Manufacturer's Representative: Employee of coating manufacturer who is factory trained and knowledgeable in all technical aspects of their products and systems.

1.6 REFERENCE STANDARDS

A. This specification recognizes AWWA, ASTM, NACE, and SSPC standards, latest edition, as minimum industry standards and they are referenced for purpose of conformance, except where modified in this section.

B. AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4-inch and Larger- Shop Applied.

AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines.
AWWA C216	Heat-shrinkable Cross-linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

AWWA C217	Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
NACE RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
SSPC-SP-1	Solvent Cleaning Surface Preparation
SSPC-SP-2	Hand Tool Cleaning Surface Preparation
SSPC-SP-3	Power Tool Cleaning Surface Preparation
SSPC-SP-5	White metal Abrasive Blast Surface Preparation
SSPC-SP-6	Commercial Abrasive Blast Surface Preparation
SSPC-SP-10	Near White Metal Abrasive Blast Surface Preparation
SSPC-SP-11	Power Tool Cleaning to Bare Metal

1.7 SPECIAL WARRANTY REQUIREMENTS

A. Warrant to the Owner and guarantee the work under this section against defective workmanship and materials for a period of two (2) years commencing on the date of final acceptance of the work.

1.8 OBSERVATION OF WORK

A. Give the Owner Representative a minimum of 14 days advance notice of the start of any work to allow scheduling for shop or field observation.

B. Provide Owner Representative a minimum 3 days' notice for actual start of surface preparation and coating application work.

C. Provisions shall be made to allow Owner’s representative full access to facilities and appropriate documentation regarding coating application.

PART 2 - MATERIALS

2.1 GENERAL

A. Coatings and linings will be stored and handled per manufacturer’s written directions.

B. Exterior and interior pipe and fitting surfaces shall be prepared and coated in accordance with referenced standards, written instructions of the coating or lining manufacturer’s, and these specifications.

C. Pipeline coating or lining shall be the product of a single manufacturer. Product substitutions during the project will not be permitted without Engineer approval.

2.2 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Plural Component Epoxy
      a. Tnemec Series 431, Kansas City, MO
      b. Engineer approved equal.
   2. Petroleum or Wax Tape Coatings
      a. Denso North American
      b. Trenton
      c. Engineer approved equal.
   3. High Build Epoxy Coating
      a. ICI Devoe
      b. Sherwin Williams
      c. Carboline
      d. Engineer approved equal.
   4. Fast Cure Epoxy Coating
      a. TC 7010, Tapecoat Inc.
      b. Protal 7125, North American Denso
      c. Engineer approved equal.
   5. Heat Shrink Sleeves
      a. Canusa
      b. Raychem-Covalence
      c. Engineer approved equal.
   6. Heat Shrink Sleeve (major repair)
      a. Canusa
      b. Raychem (Polyken)
      c. Engineer approved equal.
   7. Heat-Applied Patches (minor repair)
      a. CRP patch by Canusa
      b. PERP patch by Raychem (Polyken)
      c. Engineer approved equal.
   8. Plural Component Epoxy Coating or Lining Repair
      a. Protal 7125 by North American Denso, Inc.
   9. Holdback Corrosion Protection Primers
      a. Tnemec Omnithane – Suitable for all joints, except joints subject to weld after backfill.
      b. Tnemec 90E-92 Ethyl Silicate Inorganic Zinc Primer – suitable for all joints, including weld after backfill joints.
      c. ICI Devoe Cathacoat 304V Ethyl Silicate Inorganic Zinc Primer – suitable for all joints including weld after backfill joints.
      d. Polyken Tape Primers – Not allowed.

2.3 SHOP-APPLIED EXTERIOR COATINGS

A. General

1. Steel pipe shall be coated in accordance with plural component epoxy or AWWA C214, except as modified herein.
2. Mortar over coat of dielectric coating shall be provided over tape wrap coating system (AWWA C214) and where specified or indicated on the Drawings. Steel pipe specified to receive a cement mortar overcoat shall be shop-coated with the required coating system and cement mortar overcoat as specified herein.
3. Pipe that is atmospherically exposed shall be shop primed as specified herein and Section 09 90 00 – Painting and Coatings.
4. Buried dielectrically coated pipe and fittings passing through a concrete structure wall or floor shall be coated for a minimum of two-inches beyond the interior wall or floor surface.

B. Polyethylene Tape Wrap:
1. Pipe shall be coated with an 80 mil (nominal), tape-coating systems applied in accordance with AWWA C214, except as modified herein.
   a. Primer: Polyken 1019, 1027, 1029, or as recommended by the coating manufacturer.
   b. Weld Stripe Tape: Polyken 931 (no backing), 25 mils nominal, 4-inches wide minimum.
   c. Inner Wrap: Polyken 989 YGIII, 20 mils nominal, corrosion protection layer.
   d. Middle Wrap: Polyken 955 YGIII, 30-mils nominal, mechanical protection layer.
   e. Outer Wrap: Polyken 956 YGIII, 30 mils nominal, mechanical protection layer.
   f. Surface Preparation:
      1) Steel Pipe: SSPC-SP10, Near-White Metal blast, 2.5 mils blast profile, minimum.
2. Tape Coating:
   a. Tape layers shall have adhesive for the full width of the tape. Adhesive shall have the ability to stick to itself and to the proceeding tape layer or pipe.
   b. Each layer shall be a different color or shade with the outer layer white.
   c. Outer wrap shall have sufficient ultraviolet (UV) inhibitors to resist above grade exposure for a minimum of 12 months or the proposed storage and construction time, whichever is greater.
   d. Tape width shall be 12-inches maximum. Wider tape will be conditionally allowed if the coating applicator can demonstrate that proper tensioning can be maintained and mechanical wrinkling prevented throughout the coating application. If at anytime during the pipe fabrication tape quality becomes inconsistent with a wider tape, the Engineer can require the remainder of the pipe to be coated using the maximum specified tape width.

C. Plural Component Epoxy:
1. General:
   a. Plural component, epoxy coating system shall be applied in accordance with AWWA C210 and as modified as herein.
2. Shop Surface Preparation:
   a. Steel pipe: SSPC-SP10, Near-White Metal blast, 3.00 mil profile, minimum, or as required by the manufacturer, whichever is greater.
3. Shop Applied Coating Requirements:
   a. Thickness: One coat, 35 mils total dry film thickness, minimum, or as required to meet limits specified for holiday and coating defects, this section.

b. Or Equal Epoxy requirements: Self-priming, plural component, 100 percent solids, non-extended epoxy, suitable for burial or immersion, and meeting the requirements of AWWA C210 and the following,:

1) Resistance to Water Immersion (ASTM D870) or Wet Adhesion
   a) Acceptance criteria:
      i. Not greater than 10 percent loss of substrate adhesion when compared to substrate adhesion in an unexposed area of the same sample with adhesion tests completed within 12 to 24 hours after test termination. Average of three pulls per exposure area.
      ii. No blistering or underfilm corrosion when viewed at 10x magnification.
   b) Adhesion Testing:
      i. Method: ASTM D4541, Method E
      ii. Equipment: Type V, Delfesko Automatic AT Positest
      iii. Dollies: 20 mm and 14 mm, scored to metal substrate
      iv. Test Speed: 100 psi per second (both 14 and 20 mm)
   c) Test Duration: 30 and 60 days
2) Cathodic Disbondment (ASTM G95)
   a) Acceptance criteria: 8 mm, maximum
   b) Potential: -3.00 volts
   c) Test Duration: 28 days
   d) Evaluation: Measured from original holiday radius to edge of staining on metal surface.
3) Water Absorption (ASTM D570)
   a) Acceptance Criteria: 1.80 percent, maximum
   b) Test Duration: 30 day and 60 day
4) Long-Term Adhesion Test:
   a) Acceptance Criteria: Not more than 10 percent loss of adhesion over duration of test.
   b) Test Duration: 1 day, 7 days, 3 weeks, 2 months, and then monthly for total test duration of 12 months.
   c) Sample Preparation:
      i. SSPC-SP5, white metal abrasive blast, 3.00 mils profile, minimum.
      ii. Test area shall not exceed 18-inches by 18-inches.
      iii. Steel plate shall be a curved steel plate with a minimum radius of 15 inches to minimize standing water on the test panel.
      iv. Sample shall be exposed to ambient, outdoor conditions for the full duration of the test.
   d) Test Procedure:
      i. Long term adhesion shall be based on an 8 pulls per test period with the 3 lowest pulls discarded.
      ii. Test results per each test period shall be an average of the five highest pulls.

iii. All adhesion pulls and their failure mode shall be recorded and those included in the average calculation shall be identified.

D. Exterior Coating for Exposed Steel Pipe
1. All atmospherically exposed or vault piping shall be shop primed with the coating system as specified in Section 09 90 00 - Painting and Coating.
2. Intermediate and finish coats to be applied in the field after installation is complete.
3. Shop applied inorganic or organic zinc primer shall not be applied at thickness greater than recommended by manufacturer. Excess primer to be removed using method recommended by coating manufacturer.
4. Manufacturer of shop-applied primer shall be coordinated with field application to provide a completed system by a single manufacturer. Engineer approval of a coating system with two or more coating manufacturer's will require written approval from all coating manufacturer's as to compatibility and acceptance under warranty.

E. Cement Mortar Coating or Overcoat
1. When shown on the drawings, Cement mortar overcoat shall be applied over tape wrap coating system (AWWA C214) on steel pipe in accordance with AWWA C205, except as modified herein.
2. Holdback:
   a. Mortar overcoat shall be held back of dielectric coating a minimum of 3 inches for overlap of field applied joint coating onto dielectric coating system.
3. Shop Applied Coating System:
   a. Cement: Conform to AWWA C205 and ASTM C150, Type II or V or ASTM C595 Type IL (MS or HS).
   b. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
   c. Cement mortar mixture shall consist of 1 part cement to not more than 3 parts aggregate.
   d. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities. Use no more than 4-1/2 gallons of water per sack of cement.
   e. Cement mortar coating: Nominal 1-inch thick coating with permitted tolerance of ±1/4-inch.

2.4 SHOP-APPLIED INTERIOR LININGS

A. Cement Mortar Lining:
1. Clean and cement mortar line steel pipe and fittings in accordance with AWWA C205.
2. Cement: Conform to ASTM C150 Type II or ASTM C595 Type IL (10HS).
3. Shop applied cement mortar lining shall be uniform in thickness over the full length of the pipe joint.
4. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
5. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities.

B. Liquid Applied Epoxy Lining:
1. Cement Mortar Lined Steel Pipe:

a. Provide liquid epoxy primer and lining in all cement mortar lined metallic pipe at insulating joints for a minimum of two pipe diameters centered over the insulated joint.
b. Epoxy lining shall be polyamine or polyamide cured, NSF approved for potable water contact in accordance with ANSI/NSF Standards 600 and 61, and capable of achieving full cure before placement in service or exposure to water.
c. Application:
1) Apply in two coats at equivalent spread rate for 6 mils dry film thickness per coat with coating application efficiency of 80 percent.
2) Epoxy shall be applied over the cement mortar lining where specified for the pipeline lining material.
3) Cement mortar shall be allowed to cure for a minimum of 15 days prior to surface preparation and coating application or 7 days with steam curing. Mortar lining shall be dry when epoxy lining is applied.
4) Prepare the cement mortar lining by abrasive blasting to remove all laitance and provide a surface profile equivalent to 80 grit sandpaper.

2. Steel Pipe Lining:
a. Where epoxy lining is specified or shown on drawings, epoxy lining shall be applied directly to the steel surface.
b. Surface Preparation: SP-5, White Metal Abrasive Blast
c. Epoxy Lining: Polyamine or polyamide high build epoxy, NSF 600 and 61 approved, suitable for continuous immersion, and capable of achieving full cure before placement in service or exposing to water.
d. Application: Apply in three coats at 5 mils minimum dry film thickness per coat with separate stripe coat at welds.

2.5 FIELD APPLIED COATINGS

A. General
1. All buried miscellaneous metal components installed on the pipeline and that are supplied bare or with a shop coating system that is not equal to the specified pipeline coating shall be coated in the field with one of the following coating systems.
2. Miscellaneous metal components shall include, but not be limited too, all exposed metals surfaces, including bolts, couplings, flanges, valves, adapters, pipe spools, and other miscellaneous metal components.
3. Coating system applied shall conform to the manufacturer's requirements and shall be applied in accordance with the application requirements of the coating system.

B. Petroleum or Wax Tape Coating:
1. Coating System:
a. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
b. Primer: petroleum or petrolatum wax
c. Filler Material:
1) Filler materials shall be petroleum or petrolatum wax sealer/filler with closed cell plastic filler
2) Provide filler material to fill and smooth all irregular surfaces, such that no tenting or voids remain under the applied wax tape.

d. Inner Tape: Petroleum or petrolatum wax impregnated fabric, 6-inch width maximum, 40 mils thick
e. Outer Wrap: PVC or tape suitable for application to inner tape.

2. Application:
a. Coating shall be in accordance with AWWA C217, except as modified herein.
b. Wax tape coatings shall be field applied on all buried couplings, thrust restraint rods and brackets, valves, and on joints, fittings, or irregular shapes or complex configurations that are not suited for the use of heat shrink coating systems and is not cement mortar over coated.
c. Do not use wax tape coating systems on vault piping, atmospherically exposed piping and appurtenances, or where subject to UV exposures.
d. Use sand backfill to protect wax coating from damage.

C. Epoxy Coating:
1. Coating System:
a. Surface Preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
b. Primer: As required by the coating manufacturer.
c. High Build Epoxy Coating:
1) Two component, high build polyamide or polyamine cured epoxy coating, suitable for direct burial or immersion, dries to touch in 2 or more hours, suitable for immersion or burial after full cure of coating.
d. Fast Cure Epoxy Coating:
1) Two component, 100% solids by volume, fast cure epoxy coating suitable for direct burial or immersion, dry to touch in less than 1 hour at 72 degrees, capable of curing while immersed or buried.
e. Epoxy coatings on interior of pipe shall be NSF approved coatings suitable for potable water contact in accordance with ANSI/NSF Standards 600 and 61, unless otherwise approved by the Engineer.

2. Application:
a. Ensure that epoxy coating selected is suitable for the application temperatures anticipated and that project schedule will allow adequate cure time before backfill or immersion based on surface temperatures at the time of application.
b. Epoxy coating shall be used for coating concrete embedded surfaces to a distance of 4 inches outside the interior and exterior surfaces of concrete wall or floors. Epoxy coating at concrete penetrations shall be a minimum of 12 mils dry film thickness.

D. Heat Shrink Sleeves:
1. Coating System:
a. Surface preparation: SP11 Power Tool to Bare Metal or SSPC-SP10, near white abrasive blast.
b. Filler Material:
1) Filler material shall adhere to the pipe and heat shrink sleeve. Size and type shall be as recommended by the sleeve manufacturer for type of pipe and joint.
2) Filler mastic for joints subject to weld after backfill shall exceed 500 degrees F melting temperature.
c. Heat Shrink Sleeve:

1) Heat shrink, cross-linked polyolefin wrap or sleeve with a mastic sealant, 85-mils nominal thickness, suitable for pipeline operating temperature, as recommended by the manufacturer.
2) Provide standard recovery sleeve for welded or bell and spigot steel pipe joints. High recovery sleeves shall be provided for mechanical or bell and spigot pipe, flange joints, and coupling style joints.
3) Width of heat shrink sleeves shall be sufficient to overlap existing coating 2 inches minimum. Overlap on tape coated steel pipe shall be based on a sequential 2-inch wide step from outer wrap to middle wrap to inner wrap.
4) Sleeve shall meet requirements for "Well After Backfill" when allowed and approved by Engineer.

d. Application:
1) Heat shrink sleeves shall be applied to buried or concrete encased pipeline joints only. Application on vault piping or where exposed to the weather will not be allowed.
2) Provide filler material for all gasketed joints, flanges, and couplings and all step changes greater than 1/8-inch.
3) Filler material shall be applied in a manner and of sufficient thickness that no tenting or voids remain under the heat shrink sleeve.
4) Consider sleeve shrinkage and joint profile in determining sleeve width required. Overlapping of two or more heat shrink sleeves to achieve the necessary width on pipe joints will not be permitted without Engineer approval.
5) All transitions from tape wrap to epoxy or other brush, roller, or spray applied protective coating system shall be coated at the transition with a heat shrink sleeve with minimum 3-inch overlap onto both coating systems.

2.6 SPECIALS, FITTINGS, AND CONNECTIONS

A. Where machine applied C214 tape cannot be applied (i.e., special sections, connections, and fittings), coatings for steel pipe shall conform to coating system and application requirements as specified this section.

B. Specials, fittings, and connections shall be defined as any pipe section with turnouts for blowoffs, interconnects, any valve, or other appurtenances; tees; crosses; wyes; laterals; manholes; mitered angles or elbows; and pipes which require special fabrication that prevents mechanical production application of the specified coating system from end to end of pipe joint.

C. In addition to the items listed as specials, the following items shall also be considered as specials:
1. All pipe sections entering a structure.
2. Pipe joints with pass through holes.

D. Hand applied tape coatings will not be permitted on any pipe specials, valves, fittings, connections, and couplings.

E. Specials, fittings, and connections shall be externally coated with a plural component epoxy coating system, applied from end to end of pipe joint on all specials, fittings, and connections.

2.7 EXTERIOR PIPE JOINT FIELD COATING

A. Pipe joints shall be field coated after pipe assembly in accordance with AWWA C216, except as modified in this section.

B. Field joint coating shall be compatible with the shop-applied coating system.

C. All joints on pipe shall be coated with a heat shrink coating material.

D. Field joint coating materials shall be as specified for Field Applied Coatings, this section.

2.8 FIELD APPLIED INTERIOR JOINT COATING

A. Mortar Lining:
   1. After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout shall be tightly packed into the joint recess and flush with the interior surface. Excess shall be removed.
   2. In accordance with AWWA C205 with pipe smaller than 24-inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.

2.9 REPAIR OF COATINGS AND LININGS

A. General
   1. Coating or lining repair materials shall be compatible with the shop-applied coating or lining system and shall be approved by the coating or lining manufacturer.
   2. Repair materials shall be as required for the coating system and "major" or "minor" repair classification as defined in this section and determined by the Engineer.

B. Coating Repair Materials
   1. Heat Shrink Sleeves (major repair):
      a. Filler Mastic: Provide mastic filler to fill tape void as required.
      b. Full Wrap Coating: Cross-linked polyolefin wrap with a mastic sealant, 85-mil thickness minimum, suitable for pipeline operating temperature, sleeve material recovery as recommended by the manufacturer. Sleeve length shall provide a minimum of 3 inches overlap onto intact pipe coating.
   2. Heat-Applied Patches (minor repair)
      a. Heat applied adhesive, polyolefin backed, mastic coated tape, 12-inches maximum size.
      b. Patch shall provide a minimum of 2 inches overlap onto intact pipe coating.
   3. Plural Component Epoxy Coating or Lining
      a. Major repairs in the shop will be completed using the coating material specified for the coating or the lining. Coating shall be reapplied using plural component spray equipment by a manufacturer certified coating applicator.
      b. Major repairs in the field shall be completed using full wrap heat shrink sleeves as specified this section.

c. Coating material for minor repairs shall be single use epoxy kits similar to the existing coating
d. Pinhole holidays or adhesion test coating repairs shall be with minor repair coating material specified or fast cure epoxy.

C. Exposed Pipe Coating System
1. Touch-up repair all damage to the primer and/or intermediate coats with the specified coating system prior to final coating of the pipeline in accordance with Section 09 90 00 – Painting and Coatings.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL LIMITATIONS

A. General
1. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent, whenever surface temperature is less than 5 degrees above the dew point of the ambient air.
2. Do not apply coatings when:
a. Surface and ambient temperatures exceeds the maximum or minimum temperatures recommended by the coating manufacturer or these specifications,
b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
c. When it expected that surface temperatures would drop below 5 degrees above dew point within 4 hours after application of coating.
d. Whenever relative humidity exceeds 85 percent for polyurethane coating application.
3. Where weather conditions or project requirements dictate, provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as specified and in accordance with the manufacturers coating application recommendations.
4. Work activities can be restricted by the Engineer until adequate temperature and humidity controls are in place and functioning within the environmental limits specified.
5. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, surface preparation, holiday test and other parameters applicable to the type of coating.

B. Temperature Control
1. In cold weather or if moisture collects on the pipe, preheat pipe to a temperature between 45 and 90 degrees and 5 degrees above dew point, whichever is greater.
2. When temperatures are above or below the coating manufacturers recommended application temperatures, provide temperature controls as necessary to permit work to precede within the manufacturer's temperature limitations.
3. Provide tenting, insulating blankets, baffles, or bulkheads as required to zone and control heating or cooling effectiveness.

4. Heating shall be with indirect fired heaters that do not increase humidity levels within the work area. Heaters shall be sized for the area to be heated.

3.2 SURFACE PREPARATION

A. General

1. Inspect and provide substrate surfaces prepared in accordance with these Contract Documents and the printed directions and recommendations of coating manufacturer whose product is to be applied.
2. Visible oil, grease, dirt, and contamination shall be removed in accordance with SSPC-SP1, solvent cleaning.
3. Surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal shall be removed by filing or grinding prior to abrasive surface preparation.
4. Protect prepared pipe from humidity, moisture, and rain. All flash rust, imperfections, or contamination on cleaned pipe surface shall be removed by reblasting.
5. Priming and coating of pipe shall be completed the same day as surface preparation.

B. Weld Surface Preparation

1. Requirements:
   a. Spray applied coating systems do not require weld grinding.
   b. Welds on tape wrap coated pipe shall be either ground flush or a weld stripe tape applied over the weld, at the pipe fabricator's option, unless otherwise specified.
2. Weld Grinding:
   a. Under the weld grinding option, welds higher than 1/32 inch above pipe surface shall be ground to a tolerance of +1/32 inch to 0-inch above the pipe surface as measured on the lowest side of the weld.
3. Weld Stripe Tape:
   a. Weld stripe tape will be applied to primed metal.
   b. Tape will either have no polyethylene backing or will be double sided adhesive tape to permit adhesion of the inner corrosion protection layer to the weld stripe tape.
   c. Apply tape with a pressure roller to fully conform the tape to the weld surface.
   d. Adhesion of the weld stripe tape shall be as specified for the coating system.

C. Steel Surface Preparation

1. Grit and/or shot abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion specified.
2. Pipe cleaned by abrasive blasting with recyclable steel grit and/or shot or other abrasive shall be cleaned of debris and spent abrasive in an air wash separator.
3. Polyurethane coated steel shall have a sharp angular surface profile of the minimum depth specified.
4. After abrasive blasting surfaces and before coating application, the metal surface shall be cleaned of residual dust to a minimum of Grade 2 per ISO standard 8502-3, Test for the Assessment of Surface Cleanliness.
5. Rust back or flash rust shall be fully removed with the steel surface cleanliness equal to the metal surface cleanliness prior to rust back or flash rusting. Determination of the equivalent surface cleanliness shall be at the Engineer's sole discretion.

3.3 SHOP-APPLIED COATING SYSTEMS

A. Tape Wrap Coating
   1. Applicator shall provide a monitoring system approved by the tape manufacturer that constantly records pipe and tape conditions during coating application. Recorded monitoring parameters shall include, but not be limited too, pipe temperature; line speed, primer and tape roll body temperature, and tape tension.
   2. Pipe surface temperature shall be between 45 and 120 degrees and 5 degrees above dew point, whichever is greater.
   3. Tape roll temperature shall be in accordance with the manufacturer's recommendations.
   4. Apply a uniform coat of primer as recommended by the manufacturer without skips, runs, or sags. Allow to properly dry prior to applying the tape as required by the tape manufacturer and as necessary to achieve maximum tape adhesion. Rug type application will not be allowed.
   5. Tape layers shall be applied continuously with the use of hydro-tension tape stands. Tension shall be maintained between the manufacturer's minimum and maximum tension recommendations or as required to achieve approximately 2.0 percent reduction in tape width.
   6. Tape coating adhesion testing shall be performed on the pipe as specified this section.
   7. Holidays testing shall be conducted on the inner layer tape prior to proceeding with subsequent tape layers. All holidays detected shall be primed and patch using coating repair procedures specified herein.
   8. Perform coating and lining repairs as specified in this section.

B. Plural Component Epoxy Coating
   1. Applicator Qualifications:
      a. Equipment will be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.
      b. Equipment not meeting the written requirements of the coating manufacturer shall be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the Engineer.
      c. Personnel responsible for the application of the coating system shall have certification of attendance at the coating manufacturer's training class within the last three years. The certified applicator shall be present during all coating application work and shall have responsibility for controlling all aspects of the coating application.
   2. Coating application shall be performed in an environmentally controlled shop area that meets or exceeds the written environmental application requirements of the coating manufacturer. Application in outdoor conditions will not be acceptable without adequate environmental shelter, environmental controls, and/or dehumidification.
   3. Coating adhesion and holidays testing shall be tested as specified this section.
   4. Coating manufacturer shall provide to the Engineer a copy of the manufacturer's coating application quality assurance manual prior to beginning coating application. Strict conformance to the requirements of the manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.
   5. Unacceptable Coating Application, includes but is not limited to:

a. Coating applied under improper environmental conditions will be rejected.
b. Pipes that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected.
c. Coating which fails the adhesion or holiday testing as specified in this section shall be rejected.
d. Pipe coating that is subject to off ratio application, blistering, or is not applied in conformance with the coating manufacturer's written instructions or recommendations shall be rejected.

C. Cement Mortar and Overcoat Coatings
1. Dielectrically coated steel pipe, when specifically required or specified, shall have a cement mortar overcoat applied over the dielectric pipe coating in accordance with AWWA C205, except as modified herein.
2. Cement Mortar Overcoat:
a. Cement mortar overcoat dielectrically coated steel pipe as specified in AWWA C205, except mortar coating shall be applied over exterior pipe coating.
b. Mortar coating shall be held back 3 inches, minimum, behind dielectric coating system cut back at joints.
c. Coating Defects:
1) Cracking in the mortar "armor" coat less than 1/8-inch in width will be acceptable.
2) Disbondment of the cement coating over a dielectric coating system should be anticipated and will not be grounds for repair or rejection of the pipe.
3) Losses of cement mortar coating due to impact, movement, or shipping damage shall be repaired in accordance with C205.
d. Joint Coating:
1) Joints do not require field application of cement mortar overcoat when properly coated with heat shrink sleeve joint coating system.

3.4 EXTERIOR COATING HOLDBACK

A. Coating holdbacks shall be straight and cut through the full thickness of the coating.

B. Cutbacks shall be completed in a manner that permits field coating of joints in accordance with the manufacturer's recommendations and as specified herein.

C. Holdbacks shall be as required for pipe joints as listed below. Pipe manufacturer may adjust holdback limits as required for special joint assemblies, and with consideration for the joint coating provided and joint welding requirements.

Tape wrap coating	
Push-on joint, spigot	4-inches, minimum
Push-on, bell	Flush with bell end
Welded, spigot	3 inches, minimum
Welded, Bell	4-inches, minimum
Plural component epoxy coating	
Push-on joint, spigot	1-inch before centerline of gasket
Push-on, bell	Flush with bell end
Welded, spigot	3 inches, minimum

Welded, Bell	4-inches, minimum

D. Holdback Corrosion Protection:
1. Holding primer for corrosion protection of cutbacks or holdbacks shall be compatible with the specified joint coating system and weld after backfill requirements, where applicable.
2. Primer shall not result in running or melting of the coating or cause toxic fumes when heated during welding on weld after backfill joints.
3. Application and thickness of holding primer shall be in accordance with the coating manufacturer's recommendations, but shall not impair the clearances required for proper joint installation.
4. Primer application on spigot end of weld after backfill pipe joints shall be held back a minimum of 1 inch from end of spigot to 2-inch maximum or as necessary to prevent toxic fumes during field welding.
5. Any corrosion within the holdback areas shall be abrasively blasted to near white metal in accordance with SP10 or power tool cleaned to bare metal in accordance with SP11 prior to applying joint coating.

3.5 PIPE LINING APPLICATION

A. Shop-applied Cement Mortar Lining:
1. Centrifugally line straight sections of pipe. Lining of special pieces or fittings shall be by mechanical, pneumatic, or hand placement. Provide cement mortar lining of uniform thickness. Finish to a smooth dense surface.
2. Hand applied lining for steel plate specials larger than 16 inches in diameter shall have lining reinforced with 2-inch by 4-inch No. 13-gage welded steel wire mesh.
3. Brace and support pipe during lining application to minimize pipe distortion or vibration. Bracing and supports shall not damage the pipe, coating, or lining.
4. Tightly close ends of pipe and fittings with plastic sheet caps. Plastic end caps shall be of sufficient thickness and strength to resist shipping, handling, and storage stresses.
5. Other requirements of mortar lining materials and processes: As specified in AWWA C205.

B. Liquid Epoxy Lining:
1. Where epoxy lining is specified or shown on drawings, epoxy lining shall be applied directly to the steel surface after abrasively blasting to SSPC SP-5, White metal blast.
2. Clean and coat the interior of cement mortar lined pipe at insulating joints or where specified with two coats of epoxy coating.
3. Epoxy coating applied at insulating joints shall be applied to both sides of the insulating joint for a minimum of one pipe diameter. If only one side of the joint can be coated the coating shall be applied for a minimum of two pipe diameters.
4. Mortar lining shall be allowed to cure 15 days or steam cured not less than 7 days prior to surface preparation of the mortar and epoxy coating application. Hand applied mortar lining shall be allowed to cure a minimum of 15 days or as required to meet the coating manufacturer's requirements for application on cement or concrete, whichever is greater.
5. Prepared mortar lining by abrasive blasting to remove all laitance and create a suitable anchor profile
6. Mortar lining shall be dry during epoxy lining application.

7. Epoxy coating shall be applied in two coats minimum, at a total coating thickness of 16 mils dry film thickness. Coating applied over cement mortar lining shall be applied in a manner that will minimize gassing and pinholes in the completed lining.

3.6 FIELD COATING JOINTS

A. Surface Preparation:
   1. All joints shall be prepared as follows:
      a. Remove all oil and grease contamination from pipe and adjacent coating in accordance with SSPC-SP1, Solvent cleaning.
      b. Without Holdback Primer:
         1) Clean pipe surface and adjacent coating of all corrosion and other foreign contaminates in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal or abrasive blast joints in accordance with SSPC-SP10, near white metal blast.
         2) Clean the full circumference of the pipe and a minimum of 4 inches onto the existing coating.
         3) No profile is required with SSPC-SP11 preparation and heat shrink sleeve joint coating.
      c. With Holdback Primer:
         1) All joints with a holdback primer shall be prepared by removing all oil and grease in accordance with SSPC-SP1, Solvent Cleaning, followed by spot preparation of visible corrosion or rust in accordance with SSPC-SP11, Power Tool Cleaning to Bare Metal.
         2) Clean the full circumference of the pipe and a minimum of 4 inches onto the existing coating.
         3) Remove primer in accordance with SSPC-SP11 as needed just prior to welding.
   2. Remove all loose or damaged pipe coating at joint and either repair the coating as specified herein or increase the length of the joint coating, where reasonable and practical.
   3. Joint bonds shall be installed before application of joint coating as specified in Division 13. Joint bonds shall be low profile bonds and all gaps and crevices around the bonds shall be filled with filler mastic.
   4. Electrically test completed joint coating for holidays with high voltage spark tester at Engineer's direction or if damage to the joint coating occurs.

B. Weld After Backfill Joint Requirements:
   1. Post welding of joints (weld after backfill) is not allowed, unless approved by the Engineer and the welding procedure approved meets the most current requirements for weld after backfill coating protection, holdback coating temperature resistance, heat input monitoring, and welding procedures.
   2. Post-welded or 'Weld after Backfill' joints are defined as welded pipe joints that have been coated and backfilled prior to completing interior welds.
   3. Post welded joints shall be coated and protected as follows:
      a. Joint coating shall be Canusa AquaWrap heat shrink joint sleeves only. Tape wrapped joints will not be acceptable.
      b. Provide 6-inch wide Canusa AquaWrap protective layer centered over the interior weld location as recommended by the joint sleeve manufacturer. Heat resistant tape will not be acceptable.

c. Hold back primer shall be suitable for post weld conditions as specified in this section and shall not exhibit any binder breakdown in the heat affected zone that causes loss of joint coating adhesion to the holdback primer.
d. Filler mastic materials shall be high temperature materials with 500 degree F melting point.
e. Joints shall be fully buried prior to welding, with not less than 12-inch cover of soil or flowable fill material on all sides. Sand or flowable fill backfill is preferred for weld after backfill joints.

4. Welding of the joints shall be in conformance with the Section 33 11 11 - Steel Pipe, and as modified herein:
   a. All welding shall be with two or more weld passes as required to meet the specified AWS qualified welding procedures and maximum coating temperature limitations. 'Weld after Backfill' procedures on wall thicknesses of ¼ inch or less must be approved by the Engineer based on field testing demonstrating the welding procedures can comply with the requirements of this specification.
   b. Maximum weld temperature and duration shall not result in carbonization of the joint coating adhesive. Carbonization is defined as the loss of volatile organic compounds that result in loss of tackiness, adhesion to the steel, and corrosion protection properties.
   c. Finished joint coating shall not have any visual creases or folds in the joint coating backing material that extends through both the inner protective layer and outer joint sleeve.
5. If elected to post-weld any joints, demonstrate that the joint welding procedures will not significantly damage the coating by fully excavating the first two joints for evaluation of the joint coating condition. Engineer will randomly select up to three additional post-welded joints for excavation for evaluation of joint coating condition. Joint coating will be destructively evaluated by the Engineer. Remove and replace joint heat shrink sleeve upon completion of the evaluation.
6. In the event that any excavated post welded joint exhibits any heat related damage as defined herein, modify and test a new post welding procedure prior to completing any additional post-welded joints. Demonstrate that the revised joint welding procedure will not significantly damage the coating by repeating the weld after backfill evaluation requirements defined this Section, including excavation of the three additional randomly selected joints for destructive evaluation.

C. Heat Shrink Sleeve Joint Coating:
1. Store, handle, and apply field heat shrink sleeve coatings in accordance with AWWA C216 and these specifications.
2. Store sleeves in shipping box until use is required. Keep dry and sheltered from exposure to direct sunlight. Store off the ground or concrete floors and maintain at a temperature between 60 and 100 degrees as recommended by the sleeve manufacturer.
3. Metal surface shall be free of all dirt, dust, and surface corrosion prior to sleeve application. Surface preparation shall be in accordance with the joint coating manufacturer's recommendations.
4. Where corrosion in the holdback area is visible, surfaces shall be prepared in accordance with SSPC-SP10, near white metal blast, or SSPC-SP11, power tool cleaning to bare metal.

5. Preheat pipe uniformly as recommended by the sleeve manufacturer. Monitor pipe temperature using a surface temperature gauge, infrared thermometer, or color changing crayons. Protect preheated pipe from rain, snow, frost, or moisture with tenting or shields and do not permit the joint to cool.
6. Fill all cracks, crevices, gaps, and step-downs greater than 1/8 inch with filler mastic. Application of filler material shall be in accordance with the manufacturer's instructions for the full circumference of the pipe.
7. Apply heat shrink sleeve when it is at a minimum temperature of 60 degrees and while maintaining the pipe temperature above the preheat temperature specified. Apply sleeve in accordance with the manufacturer's instructions and center the sleeve over the joint to provide a minimum 2-inch overlap onto the existing pipe coating.
8. Completed joint sleeve shall be fully bonded to the pipe and existing coating surface without voids. Mastic beading shall be visible along the full circumference of the sleeve. There shall be no wrinkling or excessive burns on the sleeves. Sleeves that do not meet these requirements shall be removed and the joint recoated as directed by the Engineer. Minor repairs may be repaired using heat applied patch material specified for minor coating repairs.
9. Allow the sleeve to cool before backfilling. In hot climates, provide shading from direct sunlight. Water quenching will be allowed only when permitted by the sleeve manufacturer.
10. Heat shrink joint coatings which have become wrinkled or disbonded because of prolonged exposure to UV light or thermal cycling shall be removed and replaced.
11. Double coating of defective or damaged heat shrink coatings will not be permitted. Any double coated heat shrink sleeves shall be immediately rejected and remove the existing coating and recoat the joint.

D. Cement Mortar Coating:
1. Pipe joints on cement mortar over coated steel pipe do not require cement mortar coating, unless shown on the Drawings.

3.7 REPAIR OF COATING AND LININGS

A. General:
1. All areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects shall be repaired. Areas where no holidays are detected, but are visually damaged shall also be repaired.
2. Maximum defects allowable shall be as specified herein for the coating system.

B. Tape Wrap Coating Repairs:
1. General:
   a. No more than five repairs per joint of pipe will be permitted with tape wrap coating, excluding adhesion test damage. The coating on any pipe with more than five coating repairs or with more than two areas of coating damage greater than five square feet will be rejected.
   b. Pipes exceeding the maximum number or size of coating defects shall be stripped, reblasted, and recoated.
   c. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the Contractor's expense.

d. The number of layers and total thickness of the tape repair coating shall be the same as the shop-applied coating; unless heat applied coating materials is used.
e. Wipe the area to be repaired with solvent for a minimum distance of 4 inches outside the damaged area.

2. Defect Size:
a. Minor repairs – Any repair that are less than 8 inches in the greatest dimension, measured after cutout of damaged tape layers. Damage to the corrosion protection tape layer will be considered minor if repairs are made using heat applied patch materials.
b. Major repairs - repairs that exceed 8-inches in the greatest dimension or where damage to the inner tape layer has occurred and hand applied tape repairs will be used.

3. Minor Repairs:
a. Complete minor repairs using a heat applied coating patch material.
b. Cut patch material to overlap onto the undamaged coating a minimum of 2 inches on all sides with 1-inch radius on each corner of the patch.
c. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.

4. Major Repairs (Over 24-inches Diameter):
a. Cigarette wrap coating repairs shall be with heat shrink sleeves as specified for joints.
b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
c. Holiday test the inner wrap and if a holiday is detected cut outer layers back to fully exposed the holiday(s) and retest for holidays.
d. Cut middle and outer layers in stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.
e. Width of sleeve shall be the width of the damaged area plus 4-inch overlap. Multiple sleeves may be used for larger repairs, but must be overlapped a minimum of 2 inches.

5. Major Repairs (24-inch Diameter or Less)
a. Cigarette wrap repairs on pipe less than 24-inches with heat shrink sleeves as specified for major repairs.
b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap. Holiday test the inner wrap and if a holiday is detected apply one extra layer of repair tape.
c. Clean surfaces by solvent wiping and applying primer over the inner tape layer for a minimum of 6-inches onto the outer wrap in all directions.

C. Plural Component Epoxy Coating or Lining Repairs
1. General
a. Complete coating or lining repairs in accordance with the coating manufacturers written instructions and these specifications, whichever is stricter.

2. Defect Size:
a. Minor repairs - repairs that are less than 8-inches in the greatest dimension.
b. Major repairs - repairs that exceed 8-inches in the greatest dimension.

3. Maximum Quantity of Defects Allowed:
    a. Major repairs shall not exceed two per pipe joint and the combined area shall not be greater than 40 percent of the pipe.
    b. Pipes exceeding the maximum number or size of coating defects shall be stripped of coating, reblasted, and recoated.
    c. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at the Contractor's expense.
4. Minor Repairs:
    a. Minor repairs
        1) Surface Preparation: Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coat and feather the edges of the defect for a minimum of 2-inches around the defect.
        2) Shop Repair Materials:
            a) Single use plural component epoxy coating kits using single use packaging that controls mix ratio.
            b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
                i. Protal 7125, North American Denso Inc, or equal
                ii. Or equal.
            c) Coating Manufacturer's plural component epoxy coating repair products subject to Engineer approval.
        3) Field Repair Materials:
            a) Heat applied coating materials; CRP Patch, Canusa; PERP Patch, Tyco Adhesives, or approved equal.
            b) Two component, fast cure epoxy coating, in controlled mix ratio packaging.
                i. Protal 7125, North American Denso, Inc,
                ii. Or equal.
            c) Single use plural component epoxy coating kits using single use packaging that controls mix ratio.
            d) Coating Manufacturer's plural component epoxy coating repair products subject to Engineer approval.
        4) Clean and feather the defect by power tool sanding with 80 grit or coarser sandpaper to roughen the existing coating and feather defect edges minimum of 2 inches.
        5) Apply a single coat of the specified patch coating material at the specified coating thickness.
5. Major Repairs:
    a. Major repairs:
        1) Surface Preparation:
            a) The metal surface and surrounding coating shall be abrasively blasted in accordance with SSPC-SP10, near white metal, or to equal in cleanliness and profile as the original surface preparation.
            b) Existing coating shall be feathered and roughened to the equivalent of 40 grit sandpaper.
        2) Shop Repair Materials:

a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.

3) Field Repair Materials:

a) Same material as the pipeline coating or lining and shall be applied by using plural component spray equipment.

b) Heat shrink sleeves as specified for pipeline joints.

b. One coat of the specified original coating material shall be applied over the repaired surface at the specified thickness.

c. Repair adhesion shall be equal to the specified coating adhesion.

3.8 INSPECTION AND TESTING

A. General

1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
2. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this specification.

B. Surface Profile Testing

1. Surface profile of abrasive blasted surfaces to be tested with "Press-O-Film" tester tape or equivalent in accordance with NACE RP287.
2. Tester tape shall be suitable for the intended profile height.
3. Profile shall be measured to a minimum tolerance of 0.1 mils, maximum.

C. Adhesion Testing

1. General

a. Adhesion testing shall be conducted at the shop prior to shipment. Pipe shipped without adhesion testing will be field-tested. Pipe rejected in the field will be returned to the shop for repair at the sole expense of the Contractor.

b. Coating adhesion testing shall be conducted on each pipe lot coated. The quantity of coating adhesion tests shall be the greater of the following:

1) Two pipes will be tested for the first 3,000 square feet of coating application plus on additional pipe for each increment of 2,000 square feet of coating application in excess of the first 3,000 square feet

2) Not less than 25 percent of each pipe produced within a lot.

c. A pipe lot is defined as the quantity of pipe that is coated by a single crew within a 12-hour or less work shift.

d. The pipe coating applicator shall repair all coating damage from adhesion testing.

e. Adhesion tests will be performed not less than 24 hours after coating application. Tests conducted prior to 24-hours will be acceptable only if the test meets or exceeds the adhesion criteria specified and the test was requested by the pipe fabricator.

f. Pipe will be randomly selected for adhesion testing.

g. Owner or Owner's Representative has the right to conduct additional adhesion testing as deemed necessary to assure the pipe meets or exceeds the requirements of this specification at any time and location.

h. Prior to beginning any QA/QC testing, the pipe fabricator, coating manufacturer, and Engineer shall review dolly attachment procedures,

adhesion test procedures, and data recording requirements for the project and ensure that test personnel are qualified and capable of performing the testing in accordance with required test standards and these specifications.

2. Rejection of Pipeline Coating or Lining
   a. Each pipe that fails the adhesion criteria, as defined this section, shall be rejected.
   b. If any pipe within a lot that fails to meet the adhesion criteria specified for the coating type, the pipe coating will be rejected and all pipes within the lot will be classified as rejected. Each remaining pipe within the rejected pipe lot will then be individually tested and rejected on a pipe-by-pipe basis in conformance with the test procedures and criteria specific to the coating type.
   c. All rejected pipe shall have the coating fully removed from the pipe and the pipe abrasive blasted and recoated.
3. Tape Coating Adhesion Testing:
   a. Adhesion Acceptance Criteria:
      1) Inner tape coating shall have an adhesion to substrate of 20 pounds per inch width, minimum, for steel pipe when tape is pulled in a continuous manner at an angle of 180 degrees to the pipe surface.
   b. Test Procedures
      1) Adhesion testing shall be conducted prior to application of the cement mortar overcoat, where applicable. Pipe that has been mortar coated prior to adhesion testing shall have the mortar coating removed as directed by the Engineer and of sufficient dimensional area to permit the adhesion test to be conducted.
      2) Adhesion tests shall be conducted at temperatures above 60 degrees and less than 75 degrees.
      3) Pulling tension shall be continuous, without stopping, and monitored throughout the length of the pull, which shall be not less than 12-inches in length.
      4) Adhesion test shall be prepared by making two parallel cuts through the coating, 1-inch apart, of sufficient length for the test pull. Peel the coating back at one end and attach the tension scale to the coating with a suitable clamp. Mark the coating at one (1) inch increments from 0 to 12 inches.
      5) The pull tension shall be recorded for each inch of pull. The two highest and two lowest readings shall be discarded and the remaining values averaged. Pull speed shall be between 5 and 10 seconds per inch. If significant elongation of the tape backing occurs, pull speeds may exceed 10 seconds per inch provided the minimum adhesion rating can still be achieved.
   c. Adhesion Pull Records and Evaluation
      1) Failure shall be by cohesive failure of the adhesive only. Delamination failure, defined as separation of the adhesive from the backing material, will result in rejection of the tape lot.
      2) Intermittent skip failures will be counted as zero pounds of adhesion and included in the calculations for average coating adhesion.
      3) Adhesive failure, defined as separation of the adhesive from the metal substrate, will be rejected.
      4) Pipe that fails the test by delamination will be retested on two other pipes within the same lot of coated pipe. Failure of any two pipes

within the lot will result in rejection of all pipes coated with the rejected tape lot.

4. Plural Component Epoxy Adhesion Testing:
   a. General:
      1) Adhesion testing shall be performed in accordance with AWWA C210 as applicable and this specification section.
   b. Coating and Lining Adhesion Acceptance Criteria
      1) Coating applied to each pipe is acceptable if first dolly pull test exceeds 1,750 psi, minimum.
      2) If first dolly pull is less than 1,750 psi, two additional tests shall be performed with acceptance based on "Best of Three" evaluation method defined herein.
   c. Pipe Lot Performance Criteria:
      1) Each lot of coated pipe shall be evaluated for general coating application based a median value for all coating or lining adhesion tests performed on a lot of pipe, which shall be greater than 2,000 psi.
      2) Any pipe lot failing the Pipe Lot Performance Criteria shall be classified as rejected until 100 percent of the pipe within the pipe lot has been tested for adhesion. Each pipe that fails the coating adhesion criteria shall be rejected.
   d. Test Procedures
      1) Coating adhesion testing shall be with self-aligning pneumatic pull off equipment, such as the Delfesko Positest AT-A, and test procedures in accordance with ASTM D4541, except as modified in this section.
         a) All adhesion tests shall be performed at an applied load rate of 100 psi per second, plus or minus 10 psi. Automatic pull rate adhesion test equipment shall be used.
         b) Adhesion tests shall be based on the ASTM D4541 using standard 20 mm dollies.
         c) Adhesion testing shall be based on three tests. All three tests shall be conducted by the same person, test equipment, and test procedure, and must be completed within a 30 minute period.
         d) All adhesion tests shall be conducted within an area not to exceed 6 inches by 6-inches.
         e) All dollies shall be scored to metal substrate using manual methods and tools, normal to the pipe surface, and in a manner that does not stress or over heat the coating.
         f) All adhesion tests shall be performed to glue or coating failure or test termination, whichever comes first.
      2) Dollies for adhesion testing shall attached to the coating surface using an two part epoxy or cyanoacrylate glue Glue type used shall be determined by the pipe fabricator and coating manufacturer for the pipe diameter, temperatures, and environmental conditions.
      3) Adhesion testing shall be performed in accordance with C210 and as recommended by the coating manufacturer.
   e. Adhesion Test Evaluation and Records
      1) The "Best of three" evaluation method shall be defined as two of three test values less than the Acceptance Criteria, which shall result in rejection of the pipe coating.

2) All adhesion tests shall be considered as valid and suitable for acceptance or rejection of the coating, except where retesting is allowed.
3) Adhesion test failure shall be by adhesive or substrate and cohesive failure as defined below:
   a) Adhesive or substrate failure is defined as a percentage of separation of the coating from the steel substrate or between distinct coating layers.
   b) Cohesive failure is defined as a percentage of failure within the coating, resulting in coating remaining both on the steel substrate and test dolly.
4) Retesting of coating adhesion tests shall be in accordance with D4541.
5) All coating adhesion retesting shall be within the same 6-inch by 6-inch test area as the original adhesion testing.
6) Disputed adhesion tests shall be retested as defined for adhesion retesting. Dolly attachment and adhesion retesting shall be witnessed by the Owner's representative.
7) Adhesion tests will be conducted on pipe coating and lining independently and will be accepted or rejected independently.
8) Records of all adhesion tests shall be maintained in an electronic spreadsheet that includes the following information:
   a) Pipe identification,
   b) Pipe coating date,
   c) Adhesion test date,
   d) Surface tested (interior or exterior),
   e) Surface temperature at time of test,
   f) Coating thickness,
   g) tensile force applied,
   h) Applied load rate per second,
   i) Mode of failure, and
   j) Percentage of failure types, previously defined, relative to dolly surface area,
   k) Dolly size and attachment glue used.
   l) If different coatings are tested, the records shall include coating manufacturer and product number.

f. Adhesion Test Repairs
   1) Complete adhesion repairs as specified this section.
   2) Repair patches on the polyurethane coating shall be randomly selected for adhesion testing in a manner as described herein and at the discretion of the coating inspector conducting the adhesion tests. Adhesion of repairs shall be as specified for the type of repair.

D. Holiday Testing
1. Holiday test the inner layer of tape wrap coatings after application and prior to the subsequent tape layer in accordance with AWWA C214 and NACE Standard RP-0274.
2. Holiday test extruded polyolefin coating after application in accordance with AWWA C215 and NACE Standard RP-0274, whichever is more stringent.
3. Holiday tests on epoxy coatings or linings will be conducted on the completed coating or lining after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE Standard RP-0274 and these specifications.

4. Coating thickness used for holiday testing shall be the minimum specified coating thickness.

E. Dry Film Thickness Testing
   1. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off or eddy current equipment.
   2. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

3.9 HANDLING, TRANSPORTATION, AND STORAGE

A. Pipe shall be handled in such a manner as to protect the pipe and coating from damage.

B. Coated pipe shall not be shipped or installed until coating has developed required full adhesion and cure for handling.

C. During coating application, storage, loading, transportation, unloading, laying and installation, every precaution shall be taken to protect and prevent damage to pipe, lining, and coating. Forklift equipment shall have all bearing surfaces padded with suitable padding material. Lift pipe with web slings a minimum of 12-inch wide and of a type that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.

D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. All pipe contact locations shall be heavily padded with carpet and strips of the outer tape wrap material (adhesive side against the carpet) during shipment to the project site and from the storage yard to the point of installation.

E. Pipe shall not be stored on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Pipe shall not be laid on asphalt without suitable padding at all contact points.

F. Pipe shall be inspected at the project site for damage. Any damage to the pipe, lining, or coating shall be repaired as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense to the Contractor.

G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk on the coating except when absolutely necessary and approved by the Engineer. When permitted, shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating shall be used.

H. Long-term Exposure:
   1. Pipe shall either be provided with UV inhibitor for lengthy above grade exposure or covered to prevent UV degradation of outer wrap.

2. Amount of UV stabilizers required will depend on the project location, laying schedule, anticipated length of exposure, and type of coating.
3. Manufacturer shall be consulted for recommended UV inhibitors requirements.
4. Protective covering can be colored plastic sheeting, canvas, or other UV blocking material. Clear plastic sheets are not acceptable.
5. Areas of coating that display UV degradation shall be removed and repaired at sole cost of the Contractor.

I. End Caps: Pipe ends of mortar lined pipe and fittings shall be tightly closed with a plastic wrap to aid in curing and to minimize drying out of and contamination of the lining. Plastic end cap shall consist of a minimum of one 10-mil sheet of polyethylene or other suitable material. End caps shall be substantial enough to resist shipment, handling, and storage loads and firmly attached in place. The plastic end cap shall remain intact and in place until pipe installation. Damaged or missing plastic end caps shall be repaired or replaced.

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SPECIAL CONSTRUCTION

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SECTION 13 11 40
CORROSION MONITORING AND CATHODIC PROTECTION

PART 1 - –GENERAL

1.1 WORK INCLUDED:

A. This section covers the work necessary to furnish and install a corrosion monitoring and cathodic protection on all buried steel piping, which includes test stations, electrical isolation, and pipe joint bonds for electrical continuity, complete.

B. Have a third-party Corrosion Expert to perform Contractor required quality control testing as defined this section.

1.2 STANDARDS

A. The following standards are included by:
   1. NACE SP-0169
   2. NACE SP-0177

1.3 QUALITY CONTROL

A. All CONTRACTOR specified testing shall be performed by a third-party Corrosion Expert whom holds a current NACE accreditation as a Cathodic Protection Specialist (CP-4) or Cathodic Protection Technologist (CP-3), and/or a registered professional engineer with verifiable expertise in corrosion control and cathodic protection.

B. Performed quality control testing shall include the following tests, which shall be performed as defined this section.
   1. Joint Bond Resistance test
   2. Insulating Joint Testing (before burial and filling the pipeline)
   3. Other testing as specified in contract documents

1.4 DEFINITIONS

A. Ferrous Metal Pipe: Pipe made of steel or iron, or pipe containing steel or iron as a principal structural material, except reinforced concrete pipe.

B. Foreign-Owned: Buried pipe or cable not specifically owned or operated by the OWNER.

C. Electrically Continuous Pipeline: A pipeline which has a linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable joint bond resistance for each bonded pipe joint as specified in this section.

D. Electrical Isolation: The condition of being electrically isolated from other metallic structures (including, but not limited to, piping, reinforcement, casings) and the environment as defined in NACE Recommended Practice SP-0169.

E. Lead, Lead Wire, Joint Bonds, Pipe Connecting Wires, Cables: Insulated copper conductor; the same as wire.

1.5 SUBMITTALS:

A. Shop Drawings: Catalog cuts and other information for products proposed for use.

B. Quality Assurance Submittals:
   1. Manufacturers' Certificates of Compliance.
   2. Field Test Reports.
   3. Qualifications of NACE Accredited Testing Personnel.

PART 2 - MATERIALS

2.1 GENERAL:

A. Like items of materials provided hereunder shall be the product of one manufacturer to achieve standardization for appearance, maintenance, and replacement.

B. The use of a manufacture's name and model or catalog number is for establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.

C. Materials and workmanship as specified in this section shall be installed concurrently with pipe installation. Coordinate all work specified herein with related sections.

2.2 SUPPLIERS:

A. Alternate suppliers will be considered, subject to approval of the ENGINEER. Address given is that of the general office; contact these offices for information regarding the location of their representative nearest the project site.
   1. Corrpro, Inc., Chicago, IL www.corrpro.com
   2. Farwest Corrosion Control, Gardena, CA www.farwestcorrosion.com
   3. Hoff Company, Inc., Denver, CO www.pipelinesupplies.com
   4. MESA Products, Tulsa, OK www.mesaproducts.com
   5. Northtown Products, Huntington Beach, CA www.northtownproducts.com

2.3 JOINT BONDS

A. General:
   1. All joint bonds provided by pipe manufacturer or Contractor shall meet the following minimum requirements:
      a. All connections shall be welded or soldered.
      b. Mechanical or compression type connections will not be permitted.
      c. Bonds and welds shall exhibit sufficient strength and flexibility to allow thermal movement of the pipe after pipe backfill without cracking or breakage.
      d. Bond connections to pipe shall be with an Engineer approved welding method.
   2. All installed bonds shall be insulated or coated copper with all exposed copper field coated to prevent galvanic corrosion of pipe.

B. Ductile or Cast Iron Pipe, External Bonds:

1. Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with formed copper sleeve on each end of the wire.
2. Quantity of joint bonds per pipe joint by pipe diameter shall be as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
#2 AWG Wire	16" or less	42" or less	Over 42"

3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
4. Bonds shall be as manufactured by Erico Products, Continental Industries, or approved equal. Third party manufactured bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.

C. Coated Steel Pipe, External Bonds:

1. Rolled joint or Carnegie joint bonds shall be one of the following types at the CONTRACTOR's option:
   a. Wire Bond: Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE or THWN insulation, 18 inches long, with a formed copper sleeve on each end of the wire.
   b. Strap Bond:
      1) Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWG wire, with two punched holes for thermite welding to the pipe. Strap holes shall be sized for the thermite weld mold and shall provide for physical centering of the mold over the hole.
      2) Strap bond shall be 12-inches long with dielectric coating applied to the center 8-inches of the strap bond. Strap bonds provided without a dielectric coating shall be coated prior to installation with filler mastic as specified for heat shrink sleeves in Section 09 90 10, Pipeline Coating and Lining.
      3) Strap bonds shall be as manufactured by Erico Products, Continental Industries, Hoff Company, or approved equal. Third party manufactured strap bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.
   c. Use of manufactured steel bonding clips will not be permitted with heat shrink sleeve coated joints.

D. Flange joints:

1. Flanged joint bonds shall be one of the following types at the CONTRACTOR's option:
   a. Steel flanges only: Steel rod, 5/8-inch diameter, length as required, arc welded to flange. Steel rod bonds will not be allowed where welding to the flange is not approved by the Engineer.
   b. Single-conductor, No. 2 AWG stranded copper wire with 600-volt HMWPE insulation, 18 inches long, with a formed copper sleeve on each end of the wire.

2. Quantity of joint bonds per pipe joint shall be as defined below per pipe diameter:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Steel Rod	36” or less	72” or less	Over 72”
#2 AWG Wire	NA	30” or less	Under 60”

3. Connection of wire joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for bond type used.
4. Coat steel rod bonds with fast curing epoxy after welding to joint as specified in this Section, except when pipe is specified to be coated in accordance with Specification Section 09 90 01 Protective Coatings.

E. Sleeve Coupling, Flanged Coupling Adapter, and Other Non-standard Joints:
1. Ductile Iron Pipe:
   a. Bond: No. 2 AWG wires, 24 inches long, HMWPE insulation, with two 12-inch long THHN insulated No. 12 AWG wire pigtails,
   b. Manufacturer: Erico Products Inc. (Cadweld), Cleveland, OH, Hoff Company, Denver, Colorado, or equal.
2. Steel Pipe:
   a. Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWG wire, with five punched holes for thermite welding to the coupling follower rings, middle, ring, and pipe. Strap bond shall be fabricated for the length of the coupling with sufficient additional length for 1 inch of joint movement. Strap holes shall be sized for the thermite weld mold and shall provide for physical centering of the mold over the hole.
   b. Strap bond shall be as manufactured by Erico Products, Continental Industries, Hoff Company, or approved equal. Third party manufactured copper strap bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.
3. Bond Quantity per Joint: Provide the quantity of bonds per pipe diameter as defined below:

Bond Type	Two Bonds	Three Bonds	Four Bonds
Copper Strap	NA	54” or less	Over 54”
No. 2 Wire Bond	NA	54” or less	Over 54”

4. Connection of wire or copper strap joint bonds to pipe shall be with the thermite weld method using molds and cartridges as recommended by the welder manufacturer for the bond type used.

F. Insulated Sleeve Coupling Joints:
1. Ductile Iron Pipe:
   a. No. 8 AWG wire, 18-inch long, with one 12-inch long THHN insulated No. 12 AWG wire pigtail.
   b. Manufacturer: Erico Products Inc. (Cadweld), Cleveland, OH, Hoff Company, Denver, Colorado, or equal.

2. Steel Pipe:
   a. Solid copper strap, 1-1/4-inch wide by 1/16-inch thick, equivalent to 1/0 AWGwire, with four punched holes for thermite welding to the coupling and pipe. Strap bond shall be fabricated for the length of the coupling with sufficient additional length for 1 inch of joint movement. . Strap holes shall be sized for the thermite weld mold and shall provide for physical centering of the mold over the hole.
   b. Strap bond shall be as manufactured by Erico Products, Continental Industries, Hoff Company, or approved equal. Third party manufactured bonds shall be approved by the Engineer for conformance with the requirements of this specification and proper thermite welding.
3. Bond Quality per Joint: Provide the quantity of bonds per pipe diameter as defined below:

Bond Type	One Bonds	Two Bonds	Three Bonds
Copper Strap	Up to 36”	36” to 60”	Over 60”
No. 2 Wire Bond	Up to 36”	36” to 60”	Over 60”

2.4 CATHODIC PROTECTION TEST STATIONS

A. Flush Style, Vehicular Traffic (Type 2):
1. Test Box: Concrete body cast with a cast iron ring, minimum weight of 55 pounds and minimum dimensions of 9-inch inside diameter and 12 inches long.
2. Furnish extensions as required to penetrate concrete surfaces by 4 inches minimum.
3. Furnish with a 14-pound cast iron lid with the words "CP Test" cast into the lid.
4. Manufacturer and Products: Brooks; Models 3RT or Christy Oldcastle Model G05, or equal

B. Flush Style Terminal Boards:
1. Dimensions: 5-inch by 8-inch by ¼ inch thick
2. Material: Phenolic, micarta, or fiberglass.
3. Terminals: Stainless steel bolts, double nuts, double flat washers, lock and shunt. Quantity and placement as shown on the Drawings.
4. Labels: Engrave terminal board with label of each terminal as shown Drawings and with the OWNER’s name and contact number.

C. Post Style, Steel Conduit:
1. Test Box:
   a. Cast aluminum with thread hub suitable for mounting to a 2-inch x 3-inch reducer. Reducing bushings will not be permitted.
   b. Manufacturer and Product:
   c. (1) Type T, C, and I Stations: Gerome Manufacturing, Testox 700 series (rectangle) with 2-inch threaded hub.
   d. (2) Type F and A Stations: Gerome Manufacturing, Testox 2000 series (rectangle) with 2 or 3-inch threaded hub.
2. Street Reducer:
   a. Hot dipped galvanized 2-inch x 3-inch reducer and close nipple. Not required with 3-inch threaded hub.

3. Terminal Block:
    a. Plastic or glass-reinforced laminated, 1/4-inch thick with seven terminals for Type T, C, and I test stations.
    b. Plastic or glass-reinforced laminated, 1/4-inch thick with eleven terminals for Type F, and A test stations.
    c. Terminal heads shall have special heads to keep them from turning or shall be easily accessible from both sides of the terminal block without requiring its removal.
    d. Terminal studs, washers, and nuts shall be stainless steel.
4. Mounting Structure:
    a. Rigid hot dipped galvanized steel conduit 3-inches diameter, threaded at one end (minimum), 5-feet long or as required for installation requirements.
    b. PVC long radius sweep elbow, 1-inch diameter, for wire protection as shown on Drawings.

2.5 REFERENCE ELECTRODES:

A. Prepackaged Copper-Copper Sulfate Reference Electrodes:
1. Material: Permanent type, copper-copper sulfate reference electrode suitable for direct burial with a minimum design life of 25 years.
2. Lead Wire:
    a. As specified under wire, this section,
    b. Length of 25 feet or as required for splice free installation.
3. Backfill: As recommended by the reference electrode manufacturer.

2.6 CORROSION COUPON

A. Application: Provide at all remote monitoring capable test stations, Type F test stations, and where shown on the Drawings.

B. Coupon:
1. Steel corrosion coupon with IR drop free measurement capability.
2. Exposed steel area to be 0.01 square feet.
3. Provide with two #12 or #14 AWG stranded copper wires leads, green insulation.

C. Switch:
1. Magnetic reed switch, normally closed, with connecting leads and terminals.
2. EDI Model UI-MS, board or adjustable mount as required, with activating magnet.

D. Manufacturers:
1. Cott Manufacturing,
2. M. C. Miller,
3. Or equal.

2.7 WIRE:

A. Pipe and Test Lead Wires:
1. Pipe Test Wires: No. 10 AWG wire, single-conductor, stranded copper with 600-volt, TW, THWN, or HMWPE insulation. Color coded insulation as specified.

2. Insulation Color: Color shall indicate the function of each test wire and shall be as follows:

a.	Pipe:	White
b.	Reference electrodes:	Yellow
c.	Casings:	Orange
d.	Foreign Pipe:	Blue (Water) or Red (Gas or Oil)
e.	Insulating Joints:	White and Green as shown on drawings
f.	Corrosion Coupons:	Green
g.	Galvanic Anode:	Black

3. Reference Electrode Wires: No. 14 or 12 AWG wire single-conductor, stranded copper with 600-volt, TW, THWN, USE2, or HMWPE insulation. Color code insulation as specified. Wire length of 25 feet or as required for splice free installation.

2.8 CONDUIT, LOCKNUTS, AND STRAPS:

A. Outdoors, Exposed Conduit
1. Rigid conduit shall be rigid galvanized steel.
2. Fittings, junction boxes, pull boxes, and outlet bodies shall be hot-dipped galvanized iron.
3. Locknuts, conduit clamps, and other miscellaneous hardware shall be hot dipped galvanized steel. Galvanized items shall be hot-dipped galvanized in accordance with ASTM A153.
4. Conduit clamps shall be two piece, malleable iron, one hole, strap and clamp back spacer, O. Z. Gedney 14-100G and 143G or similar, for mounting to surfaces with either lag bolts or concrete wedge anchors, as shown on the Drawings.

B. Buried Conduit:
1. Conduit and fittings shall be PVC coated rigid steel.

2.9 THERMITE WELD MATERIALS:

A. General:
1. Thermite weld materials consist of wire sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and material.
2. Welding materials and equipment shall be the product of a single manufacturer. Interchanging materials of different manufacturers is not acceptable.

B. Molds: Graphite, as recommended by manufacture for pipe and wire size.

C. Adapter Sleeves:
1. For No. 12 AWG and No. 2 AWG wires.
2. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable. Attach field-formed joint bonds sleeves with the appropriate size and type of hammer die furnished by the thermite weld manufacturer.
3. Extend wire conductor 1/8 inch beyond the end of the adapter sleeve.

D. Cartridges:
1. Steel: 32 grams, maximum.

2. Cast and Ductile Iron: 45 grams, maximum, XF-19 Alloy

E. Welders and Cartridges: For attaching copper wire to pipe material:

Pipe Material	Weld Type	Cartridge Size, Max.
No. 6 AWG Wire & Smaller		
Steel	HA, VS, HC	15 gm
Ductile or Cast Iron	HB, VH, HE	25 gm
No. 2 Wire Joint Bonds		
Steel	FS	32 gm
Ductile or Cast Iron	FC	45 gm
Copper Strap Joint Bonds		
Steel	M-128	15 gm

F. Welding Materials Manufacturers:
1. Erico Products Inc. (Cadweld), Cleveland, OH.
2. Continental Industries, Inc. (Thermo-Weld), Tulsa, OK.

2.10 COATING REPAIR MATERIAL FOR PIPE AND FITTINGS

A. General:
1. Complete coating repairs in accordance with recommendations of the pipe or fitting manufacturer.

B. Coating Requirements:
1. Steel Pipes:
   a. Coal tar based coatings: Koppers Bitumastic 50 or Denso or Tapecoat wax tape coatings; or equal, 20 mils dry film thickness, minimum.
   b. Polyurethane or Epoxy Coatings: Fast cure epoxy, 20 mils dry film thickness, minimum
   c. Tape Wrap Coating: Thermite Weld Cap, Canusa CRP Patch, or Raychem PERP patch, or equal
2. Ductile iron Pipe:
   a. Fast cure epoxy
   b. Thermite weld cap

C. Coating Materials:
1. Thermite Weld Caps:
   a. Royston Laboratories Handi-Cap IP, prefabricated primerless thermite weld cap and coating system.
   b. Provide primer unless specifically stated in product data sheet that no primer is required.
2. Fast Cure Epoxy Coating:
   a. 100 percent solids, fast curing epoxy suitable for submerged or buried conditions.

b. Acceptable products or equal:
   1) Denso Protal 7125 (low temperature) or Protal 7300
   2) Tapecoat TC 7010
   3) 3M ScotchKote 323

2.11 INSULATING JOINTS

A. General: Insulating joints shall be dielectric unions, flanges, or couplings. The complete assembly shall have an ANSI rating equal to or higher than that of the joint and pipeline. All materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.

B. Insulating Flanges:
   1. Flange:
      a. As specified in applicable pipe sections or in conformance with AWWA C207, whichever is more stringent.
      b. Bolt holes may be oversized not more 1/4 inch over nominal bolt diameter where required for insulating flange assembly.
   2. Gaskets:
      a. Full-face, fiberglass (G10) with O-ring seal gasket. Buried insulating flanges shall be full face gaskets only.
      b. Complete assembly shall have an ANSI rating equal to the flanged joint.
      c. Gasket materials shall be resistant to intended chemical exposure, operating temperatures, and pressures in the pipeline.
   3. Insulating Sleeves: Full-length Mylar or fiberglass reinforced epoxy (NEMA G-10 grade).
   4. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
   5. Steel Washers: Plated, hot-rolled steel, 1/8-inch thick.
   6. Manufacturers:
      a. GPT Industries, Houston, Texas
      b. Advanced Products and Systems, Scott, LA
      c. Central Plastics Co., Shawnee, OK.

C. Insulating Couplings:
   1. Coupling: As specified in Section 40 05 00 – Piping, General.
   2. Dielectric Boot: Rubber boot suitable for immersion service, two boots required per insulating joint.
   3. Manufacturers:
      a. Style IC400, Romac Industries
      b. Style 39, Dresser Industries

D. Insulating Unions: O-ring sealed with molded and bonded insulating bushing to union body, as manufactured by Central Plastics Company, Shawnee, OK; or equal.

2.12 CONCRETE

A. ASTM C94-90, Option A

B. Cement: ASTM C150-89, type II or V with minimum cement content of 6.5 bags (611 pounds) per cubic yard.

C. Coarse Aggregate Size: ¾ inches

D. Minimum Compressive Strength: 4,000 psi at 28 days with maximum water-cement ratio of 0.45.

E. Air Entrainment:
   1. ASTM C260, nontoxic after 30 days and containing no chlorides.
   2. Not less than 5 nor more than 7.5 percent entrained air at the project site.

2.13 OTHER MISCELLANEOUS MATERIALS

A. Test Station Wire Terminations: One-piece, tin-plated crimp-on ring tongue connector as manufactured by Burndy Co. or Thomas and Betts.

B. Shunts: Shunts shall be 0.01-ohm Holloway Type RS.

C. Compression Connectors:
   1. Compression connectors for in-line and tap splices shall be "C" taps made of conductive wrought copper, sized to fit the wires being spliced.
   2. Compression connectors shall be applied with the crimp tool and die recommended by the manufacturer for the wire and tap connector size. Connectors shall be Burndy Type "YC", or equal.

D. Electrical Tape:
   1. Linerless rubber high-voltage splicing tape and vinyl electrical tape suitable for moist and wet environments.
   2. Use Scotch 130 C and Scotch 88 as manufactured by 3M Products.

PART 3 - WORKMANSHIP

3.1 GENERAL:

A. The installation of the facilities herein specified and described shall conform to the latest applicable NEC rules.

B. The workmanship shall be of the highest grade and shall be in strict accordance with material manufacturer's instructions. Equipment or materials damaged in shipment or during installation shall be replaced.

C. The CONTRACTOR shall examine all Drawings and coordinate his work to avoid conflicts, errors, delays, and unnecessary interference with the construction of the facilities and to avoid duplication of the work such as excavation, filling, etc. In the event of any conflicts in the Specifications, the ENGINEER shall be consulted.

3.2 PIPE JOINT BONDING, NEW PIPE

A. To form an electrically continuous pipeline and associated appurtenances, all metallic pipe joints shall be electrically bonded; including buried, vault, and manhole pipe, fittings, and restrained joints; except threaded, welded, or insulated joints.

B. All buried pipe shall be electrically continuous from test station to test station and from test station to fire hydrant or blowoff. Contractor shall locate and repair any joint that is found to be discontinuous during ENGINEER performed electrical continuity testing.

C. Install the quantity of joint bonds at each joint required to be bonded as specified this section or shown on the Drawings. Should the specifications and drawings conflict, the larger quantity shall apply.

D. Electrical connection of bonds to pipe and fittings shall be by thermite or arc welding process. Bolted, compression, or mechanical connections will not be permitted.

E. CONTRACTOR shall test each bonded joint for electrical resistance as specified under CONTRACTOR QUALITY CONTROL TESTING, this section.

3.3 TEST STATION INSTALLATION

A. General:
1. Test station location, type, and style shall be as shown on the Drawings.
2. CONTRACTOR may relocate test station up to ±25 feet for site conditions without ENGINEER approval. Relocation greater than ±25 feet must be approved by the ENGINEER.
3. CONTRACTOR shall maintain records showing actual pipeline stationing of test station wire connections to the pipe.
4. Records of actual pipeline stationing shall be provided to ENGINEER prior to electrical continuity testing by ENGINEER.
5. Test stations shall be generally located as follows:
   a. Install Type T test stations or other type test stations as required or at 1/4 mile intervals, but not greater than 1,500 feet.
   b. Install a Type F test station where pipe crosses a foreign-owned metallic pipeline under cathodic protection.
   c. Install a Type C test station at both end of cased crossings, unless shown otherwise on the Drawings.
   d. Install a Type I test station at all buried insulated joints.
6. Locate post-mounted test stations directly over the pipe and, where possible, at protected locations such as structures, fences, manholes, power poles, or edges of cultivated land.
7. Locate flush mounted test stations directly over the pipeline, except in areas of heavy traffic conditions. When heavy traffic conditions exist, offset the test stations to the side of the street.
8. All offset test stations shall protect the test wires with PVC coated rigid steel conduit from pipeline centerline to within 6-inches of test station as shown on the
9. Drawings. Do not connect rigid steel conduit to test station.

B. Style:
1. Test station style shall be as shown on the Drawings and as follows:
2. Post mount style test stations shall be steel conduit style as shown on the Drawings.
3. Flush mount style test stations shall be as shown on the Drawings and used where directed by the ENGINEER.

C. Installation:

1. Post mounted test station:
    a. Height shall be between 36 to 42 inches above finish grade.
    b. Buried steel posts shall be concrete encased as shown on the Drawings.
2. Flush Mounted Test Stations
    a. Place in concrete pad or sidewalk with cast iron cover as shown on Drawings.
    b. Place concrete box on top of 3-inch base of compacted sand.
    c. In unimproved areas provide blue "Carsonite" utility marker with yellow reflector on each side 1 foot from test box or as directed by the ENGINEER.

D. Test Wires:
1. Wires shall be attached to the pipe as specified under WIRE CONNECTIONS, this section.
2. Wire connections shall be an individual connection with not less than 6-inches separation from other connections. Common connections will not be allowed. Where a steel tab is welded to pipe for test wire connections, a separate tab shall be provided for each wire connection.
3. Wires to foreign-owned pipelines shall be connected to the pipe by the CONTRACTOR unless the foreign pipeline owner has indicated otherwise in writing. The CONTRACTOR shall coordinate this work with the owner of the foreign pipeline.
4. Where foreign owners refuse test wire installation to their pipe, the Bidder shall obtain a written refusal from the field representative and install a Type T test station.
5. Wires shall be buried a minimum of 24 inches below finished grade, except in undeveloped or cultivated areas where test wires shall be a minimum of 30-inches below finished grade.
6. Wires shall be direct buried except where test station offset is required. Offset wires shall be installed in PVC coated rigid steel conduit from the centerline of the pipeline to 6-inches from test station. Rigid conduit shall not be connected to the test station.
7. Provide 12-inch diameter loop in wires at the pipeline connection, at each end of rigid conduit when required, and below post mounted test stations to prevent wires from being stressed or broken.
8. Maintain sufficient slack in flush mount test wires to permit extension of terminal block 18-inches above test station. Connect all wires to a terminal board as specified.
9. Make wire connections to test station terminals with crimp-on ring tongue terminals, except where solid wire is specified.

3.4 REFERENCE ELECTRODE INSTALLATION

A. Remove plastic or paper wrapper and place reference electrode within the pipeline trench excavation inches from pipe in a vertical position and activate reference electrode per manufacturer's written instructions.

B. Install reference electrode centered between foreign pipelines and OWNER's pipeline at pipe crossing location as shown on Drawings.

C. Backfill hole with select native material in 6-inch layers and hand tamp each layer around anode. Use only native soil for backfill; do not use sand or flowable fill. Exercise care not to strike reference cell or lead wire with tamper.

D. Terminate reference electrode wire in test station on separate terminal.

3.5 CORROSION COUPON INSTALLATION

A. Place corrosion coupons within 6-inches of pipe and reference electrode.

B. Install reference electrode centered between foreign pipelines and OWNER's pipeline at pipe crossing locations.

C. Terminate corrosion coupon lead wires in test station on separate terminals.

D. Connect coupon to pipeline with magnetic switch as specified and shown on drawings.

3.6 THERMITE WELD WIRE CONNECTIONS:

A. Use thermite weld method for electrical connection of copper wire to steel, ductile iron, and cast iron surfaces. Observe proper safety precautions, welding procedures, thermite weld material selection, and surface preparation as recommended by the material manufacturer. Assure that pipe or fitting wall thickness is of sufficient thickness that the thermite weld process will not damage the pipe or fitting wall's integrity or damage the lining in any way.

B. Before the connection is made, the surface shall be cleaned to bare metal by making a 2-inch by 2-inch window in the coating, and then filing or grinding the surface with a vitrified wheel to produce a bright metal finish. Wire sleeves shall be installed on the ends of the wire before welding to the metal surface.

C. After the weld connection is cooled, remove slag, visually inspect, and physically test wire connection by hitting with a hammer. Remove and replace any defective connections.

D. Make wire connections to concrete cylinder pipe by thermite welding to the shop welded steel plates provided on the pipe for this purpose.

E. Coat each completed wire connection as specified, this section. If lining is damaged by welding, repaired in accordance with the lining applicator's recommendations.

3.7 TRENCHING AND BACKFILL

A. General
   1. Complete excavations and trenching regardless of the type, nature, or condition of materials encountered, and as required to accomplish specified construction to lines and grades shown.
   2. CONTRACTOR shall complete all utility notifications prior to performing trenching and excavations work.
   3. Take care to avoid damage to existing structures and utilities during excavating and trenching process. CONTRACTOR may modify location, where approved by the ENGINEER, to minimize possible damage to existing structures. Trench shall be of uniform depth and width, level, smooth, and free of sharp objects.

B. Trench Depths:
   1. Trench depths vary for conditions and requirements. Trench depths provided are minimum requirements. CONTRACTOR to meet minimum requirements or that required by local utilities, ordinances, or regulations, whichever is more stringent.

2. Minimum depths for cathodic protection or corrosion monitoring work shall be as defined herein or shown on the Drawings. If in conflict, the more stringent shall apply.

a.	Pipeline Test wires, undeveloped	24-inches (direct bury)
b.	Pipeline Test wires, roadways	30-inches (conduit)
c.	All other	30-inches

C. Safety

1. Slope, shore, or brace excavations and trenches in accordance with OSHA regulations as necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public.
2. CONTRACTOR shall have sole responsibility for ensuring safety of trenches and conformance to OSHA trench safety requirements.

D. Backfill and Compaction

1. Backfill trench with excavated backfill materials, unless otherwise specified.
2. Compaction requirements shall be as specified for the pipeline or 90 percent compaction, whichever is more stringent. Backfill within 5 feet of roadways, paved areas, or other traffic areas shall be compacted to 95 percent.
3. Do not use backfill material of frozen or consolidated debris. Leave the trench with the excess backfill material neatly mounded, but not more than 4 inches above the existing ground level, for the entire width of the trench in undeveloped areas.
4. Replace topsoil in developed, landscaped, or cultivated areas.

3.8 SURFACE RESTORATION:

A. Contractor shall restore all existing surface improvements within the pipeline easement removed in the performance of this work.

B. Contractor to complete surface restoration as specified and shown on the Drawings.

3.9 CONCRETE:

A. Concrete used for slabs shall conform to the requirements for concrete in Section CONCRETE.

B. CONTRACTOR shall finish all concrete work to a smooth trowel finish with radius edges.

C. Concrete flatwork shall be sloped to drain water away from conduits and posts.

D. All forms shall be removed from concrete work prior to final acceptance and removed from the project site.

3.10 WIRE INSULATION REPAIR

A. Underground splicing of wire will not be permitted, except where specifically shown on the drawings and approved by the ENGINEER.

B. Where splicing is approved by the ENGINEER, splices shall mechanically secure and soldered with rosin cored 50/50 solder. Compression connectors will not be permitted.

C. Splices or insulation damage to test station wires shall be spirally wrapped with two coats of high-voltage self-vulcanizing rubber splice tape and two layers of vinyl electrical tape.

3.11 INSULATED JOINTS

A. Install insulated joints to electrically isolate the pipeline from other pipes or structures where shown on the Drawings.

B. Install insulated joints as shown on the Drawings.

C. Align and install insulating joints according to the manufacturer's recommendations to avoid damaging insulating materials.

D. Install a Type I test station at each buried insulated joint.

E. Provide a DC blocking device on all insulating joints, except buried joints, as specified herein and shown on the Drawings.

F. The CONTRACTOR shall test each insulated joint for electrical insulation as specified this section. Defective insulating joints shall be repaired by the CONTRACTOR at his sole expense. All damaged or defective insulation parts shall be replaced.

3.12 QUALITY CONTROL TESTING

A. General:
   1. Contractor shall correct all construction defects identified during testing.
   2. Provide engineer with 7 days advance notice of completion for Engineer acceptance testing.
   3. Contractor required testing as defined herein shall be performed by a Corrosion Expert, with qualifications as specified this section, whom is an employee or subcontractor to the Contractor.

B. Joint Bond Resistance Test:
   1. General
      a. The CONTRACTOR shall test completed joint bonds for electrical continuity using a digital low resistance ohmmeter.
      b. Joint bond quality control test shall be performed on all bonded joints after the bonds are installed but before backfilling of the pipe.
      c. Furnish all equipment and materials as required for test.
   2. Digital Low Resistance Ohmmeter Test Method:
      a. Required Equipment and Materials:
         1) One AVO Model DLRO10, digital low resistance ohmmeter or equivalent instrument.
         2) Two duplex, helical spring point leads with current and potential points, AVO Model No. 242011-7, or equivalent wire lead set.
      b. Test Procedure:
         1) Measure the resistance of joint bonds with the low resistance ohmmeter in accordance with the manufacturer's written instructions.

2) Use the helical handspikes to contact the pipe on each side of the joint, without touching the thermite weld or the bond. The contact area shall be cleaned to bright metal by filing or grinding and without any surface rusting or oxidation.
3) Record the measured joint bond resistance on the test form described herein.
4) Repair any damaged pipe coating in accordance with WIRE CONNECTIONS, this section.

3. Joint Bond Acceptance:
   a. Joint bond resistance shall be less than or equal to the maximum allowable bond resistance values shown below.

Joint Type	Max. Allowable Resistance (micro-ohms)		
	Two Bonds/Joint	Three Bonds/Joint	Four Bonds/Joint
No. 2 AWG wire (Steel)	162	108	81
No. 2 AWG wire (DIP)	185	123	93
Copper Strap (12-inch)	64	43	32
Copper Strap (9-inch)	48	32	24
Coupling, 24" No. 2 AWG	212	142	106
Coupling, 24" Copper Strap	128	85	64
MLC Steel Pipe Clips	N/A	55	42

   b. For bond quantities greater than shown above. Obtain maximum allowable bond resistance from the Engineer.
   c. The CONTRACTOR shall remove and replace all joint bonds on a joint that exceeds the maximum allowable resistance. R eplacement joint bonds shall be retested for compliance with the specified bond resistance.
   d. Any defective joint bond discovered during SYSTEM TESTS AND INSPECTION shall be located, excavated, repaired, and backfilled by the CONTRACTOR.
4. Test Records: Records shall be made of each bonded pipeline during the test and submitted to the ENGINEER. These records shall include:
   a. Description and location of the pipeline tested.
   b. Starting location and direction of test.
   c. Date of test.
   d. Joint type.
   e. Measured joint bond resistance
5. Report: CONTRACTOR shall submit a QC report upon completion of joint bond resistance testing which includes the information listed above.

C. Insulated Joint Isolation Test:
1. CONTRACTOR shall provide a Corrosion Expert to test each insulating joint after assembly with a insulator tester or equivalent instrument in accordance with the manufacturer's written instructions.
2. The Corrosion Expert shall conduct additional insulating joint testing as required to insure that insulating flanges are not electrically shorted by other equipment or incidental contact with concrete reinforcement.

3. Conduct test before burial and coating of buried insulating flanges.
4. CONTRACTOR to replace damaged or defective insulation parts identified during testing.
5. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
6. CONTRACTOR shall submit a report prepared by the Corrosion Expert certifying insulating joint testing isolation, test method(s), test data, and any corrective action required.

D. Casing Isolation Testing:
1. CONTRACTOR to test each casing and carrier pipe after assembly for electrical isolation before and after filling of casing with the specified fill material.
2. An electrical isolation test method and evaluation criterion to be utilized by Corrosion Expert is to be submitted in writing for approval by ENGINEER prior to beginning field testing.
3. Electrical Isolation is defined as a condition of being electrically isolated from other metallic structures (including, but not limited to, other piping, concrete reinforcement, casings, and other structures not intended to be cathodically protected) and the environment as defined in NACE Recommended Practice RP0169-83.
4. CONTRACTOR to conduct any and all remedial actions necessary to clear all electrical contacts between the carrier pipe and casing before filling of the casing shall be permitted.
5. CONTRACTOR shall submit a written report prepared by the Corrosion Expert certifying casing isolation, testing method(s), test data, and any corrective action required.

3.13 SYSTEM TESTS AND INSPECTION

A. General
1. All testing specified herein shall be performed by the Engineer and shall include:
   a. Preliminary electrical continuity testing of the full pipeline.
   b. Other tests as specified in Section 13115, Cathodic Protection.
2. CONTRACTOR shall correct all construction defects identified during testing.
3. Provide ENGINEER with one week advance notice of completion of corrosion monitoring system work.

B. Electrical Continuity Testing:
1. Preliminary Continuity Test by Engineer
   a. After the pipeline construction is completed and all test stations have been installed, the ENGINEER shall test all pipelines with joint bonds for electrical continuity using the four-wire lineal pipe resistance test method.
   b. Test will be conducted with a minimum test current of 15 amperes using a portable rectifier or dc welder.
   c. An electrically continuous pipeline will be defined as a pipe or section of pipe that has a linear electrical resistance equal to or less than the sum of the

resistance of the pipe plus the maximum allowable joint bond resistance for each joint as specified in this section.

d. The CONTRACTOR shall locate electrically discontinuous joints at his sole expense as specified herein.

e. Each discontinuous section of pipe shall be retested by the Engineer after all continuity repairs are completed to demonstrate that the pipeline is electrically continuous. Engineer retesting costs shall be at the Contractor's expense.

f. Electrical continuity testing requires two electrically continuous wires connected to pipeline at each test station. Any pipe section with one or more broken test wire(s) cannot be tested for continuity and will be classified as electrically discontinuous.

2. Electrical Discontinuity Location:

a. CONTRACTOR shall be solely responsible for location and repair of all discontinuous or high resistance joints bonds using a test method determined by the CONTRACTOR. Regardless of test method used to locate discontinuous joints, final acceptance of discontinuous sections shall be determined by the lineal pipe resistance method.

b. After all discontinuous or high resistance joint bonds are repaired, the repaired section shall have a resistance less than or equal to the calculated allowable lineal pipe resistance as determined by the initial final continuity testing.

c. Existing joint bonds damaged during excavation of the pipe for repairs or temporary wire connections shall be repaired by the CONTRACTOR.

d. Existing test stations shall be protected from damage. When damage occurs CONTRACTOR shall complete repairs while the excavation is open. Undisclosed test station damage that requires repairs to be made after backfilling the excavation will be repaired at the CONTRACTOR sole expense.

e. Upon completion of continuity repairs, the ENGINEER shall retest the continuity of repaired sections at the CONTRACTOR's expense in accordance with the General Conditions.

END OF SECTION

DIVISION 26
ELECTRICAL

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SECTION 26 05 00
ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide electrical and appurtenant Work necessary for a complete and operable electrical system, in accordance with the Contract Documents.

B. Make all field connections and terminations to all motors, switchgear, panels, control equipment and devices, instruments, and to all vendor-furnished packaged equipment. The requirements of this Section shall apply to all electrical items indicated in the various Sections of Division 26 unless otherwise indicated.

C. Provide all materials and incidentals required to complete the electrical work. Typical materials which may be incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and all control wires required by vendor-furnished equipment to interconnect with other equipment all specifically indicated on the Contract Documents.

D. All concrete work required for encasement, installation, or construction of the Work specified in the various Sections of Division 26 shall be 4,000 psi concrete, and the following requirements shall apply:
   1. Consolidation of encasement concrete around duct banks shall be by hand puddling, and no mechanical vibration shall be permitted.
   2. A workability admixture shall be used in encasement concrete, which shall be a hydroxylated carboxylic acid type in liquid form. Admixtures containing calcium chloride shall not be used.
   3. Concrete used to encase conduits shall be made with gravel containing rocks ¾ inch in size or less. It shall be wet enough to flow easily into the spaces around the conduits, but not so fluid as to float the conduits.
   4. Concrete for encasement of conduit or duct banks shall contain an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete.

1.2 INTERFACE TO EQUIPMENT, INSTRUMENTS, AND OTHER COMPONENTS:

A. The contract drawings, specifications, and overall design are based on non-certified information furnished by various equipment manufacturers. This “equipment” includes, but not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.

B. The electrical specifications, ladder logic diagrams, and installation details are based on non-certified vendor information and indicate minimum scope of supply from Manufacturers.

C. Include all labor, material, and others costs in the bid to add additional instrument, wiring, control system inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the Work based on the Equipment Manufacturer’s final certified Drawings.

D. Revise or produce new loop diagrams to meet the Equipment Manufacturer's wiring requirements.

E. Incorporate such changes to Instrumentation and Electrical Work at no additional cost to the Owner in light of the Contractor's knowledge that non-certified vendor information has been used in the design, and due to the fact that the final selection of the vendor may have been by the Contractor.

F. Submit all such changes and additions to the Engineer for acceptance before starting field installation Work.

G. The Contractor is responsible for providing all material and labor needed to install the actual equipment furnished, as such the Contractor's bid includes all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the design, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
   1. Make all changes necessary to meet the Manufacturer's wiring requirements.
   2. Incorporate such changes to the electrical installation into the final "As-Built" Drawings.

H. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appears on Drawings or Specifications from another discipline in the scope of Work and any costs for these items.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes and Standards

NEC National Electrical Code, latest edition

B. Government Standards

FS W-C 596E/GEN(1)	Connector, Plug, Receptacle and Cable Outlet, Electrical Power
FS W S 896E/GEN(1)	Switches, Toggle (Toggle and Lode), Flush Mounted (ac)
FS WW C 581D, E	Conduit, Metal, Rigid, And Intermediate; And Coupling, Elbow, and Nipple, Electrical Conduit: Steel, Zinc Coated
OSHA	Safety and Health Standards, 29 CFR 1910 and 29 CFR 1926 as applicable

C. Commercial Standards

ANSI C80.1	Zinc Coated, Rigid Steel Conduit, Specification for
ANSI C80.4	Fittings for Rigid Metal Conduit and Electrical Metallic Tubing, Specifications for
ANSI/UL 467	Grounding and Bonding Equipment, Safety Standard for

ASTM B 3	Soft or Annealed Copper Wire
ASTM B 8	Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, and Soft
ASTM B 33	Specification for Tinned Soft or Annealed Cooper Wire for Electrical Purposes
ICEA S 61 402	Thermoplastic Insulated Wire and Cable
ICEA S 68 516, NEMA WC8	Ethylene Propylene Rubber Insulated Wire and Cable
NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
NEMA PB 1	Panelboards
UL 6	Rigid Metal Electrical Conduit
UL 514	Electrical Outlet Boxes and Fittings

D. All equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL) or an independent testing laboratory acceptable to the local Code-enforcement agency having jurisdiction.

E. The construction and installation of all electrical equipment and materials shall comply with all applicable provisions of the OSHA Safety and Health Standards (29CFR1910 and 29CFR1926, as applicable), State Building Standards, and applicable local codes and regulations.

1.4 PERMITS AND INSPECTION

A. Permits shall be obtained, and inspection fees shall be paid for as required by local governmental jurisdictions.

1.5 CONTRACTOR SUBMITTALS

A. Shop Drawings and Catalog Data: Submit shop drawings and catalog data submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Submit complete material lists for the Work of this Section. Such lists shall state manufacturer and brand name of each item or class of material. Submit shop drawings for all grounding work not specifically indicated.

C. Shop drawings are required for materials and equipment listed in other sections. Shop drawings shall provide sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications. The following shall be included:
   1. Front, side, rear elevations and top views with dimensional data.
   2. Location of conduit entrances and access plates.
   3. Component data.

4. Connection diagrams, terminal numbers, wire numbers, internal wiring diagrams, conductor size, and cable numbers.
5. Method of anchoring, seismic requirement; weight.
6. Types of materials and finish.
7. Nameplates.
8. Temperature limitations, as applicable.
9. Voltage requirement, as applicable.
10. Front and rear access requirements.

D. Catalog data shall be submitted to supplement all shop drawings. Catalog cuts, bulletins, brochures, or the like or photocopies of applicable pages thereof shall be submitted for mass produced, non-custom manufactured material. These catalog data sheets shall be stamped to indicate the project name, applicable Specification section and paragraph, model number, and options. This information shall be marked in spaces designated for such data in the stamp.

E. Materials and Equipment Schedules: Furnish within 30 days, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

F. O&M Manuals: Furnish manuals as part of the shop drawing submittals under "Operation and Maintenance Manuals" in Section 01 33 20 – Submittal Procedures.

G. Record Drawings: In addition to the record drawings as a part of the record drawing requirements specified in Section 01 33 20 – Submittal Procedures, show depths and routing of all duct bank concealed below grade electrical installations. Said set of record drawings shall be available to the Engineer during construction. After final inspection, transfer all record drawing information using a red pen to a set of drawings which shall then be delivered to the Engineer. In addition, the record drawings shall show all variations between the Work as actually constructed and as originally shown on the Drawings, based upon information supplied by the Contractor.

1.6 QUALITY ASSURANCE

A. Field Control of Location and Arrangement: The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Determine exact locations in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions. Locations shown on the Drawings, however, shall be adhered to as closely as possible.

B. All conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms, as shown. Where the Drawings do not indicate exact locations, such locations shall be obtained from the Engineer. Where equipment is installed without instruction and must be moved, it shall be moved without additional cost to the Owner.

C. Workmanship: All materials and equipment shall be installed in accordance with printed recommendations of the manufacturer which have been reviewed by the Engineer. The

installation shall be accomplished by workmen skilled in this type of work and installation shall be coordinated in the field with other trades so that interferences are avoided.

D. All Work, including installation, connection, calibration, testing, adjustment, and paint touchup, shall be accomplished by qualified, experienced personnel working under continuous, competent supervision. The completed installation shall display competent work, reflecting adherence to prevailing industrial standards and methods.

E. Protection of Equipment and Materials: Furnish adequate means for and fully protect all finished parts of the materials and equipment against damage from any cause during the progress of the Work and until acceptable by the Engineer.

F. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts shall be kept clean and dry.

G. Replace or have refinished by the manufacturer, all damaged materials or equipment, including face plates of panels and switchboard sections, at no expense to the Owner.

H. Tests: Perform all tests required by the Engineer or other authorities having jurisdictions. All such tests shall be performed in the presence of the Engineer. Furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation. The following testing shall be accomplished:
   1. Insulation resistance tests under "Wire and Cable," below.
   2. Operational testing of all equipment furnished and/or connected in other Sections of Division 26, including furnishing of support labor for testing.

I. Standard test reports for mass-produced equipment shall be submitted along with the shop drawing for such equipment. Test reports on testing specifically required for individual pieces of equipment shall be submitted for review prior to final acceptance of the project.

J. Any test failure shall be corrected in accordance with the industry practices and in a manner satisfactory to the Engineer.

K. Regulatory Requirements:
   1. Perform all Work to meet the requirements of all legally constituted authorities having jurisdiction.
   2. Perform all Electrical Work, whether needed for the power, control system, process, HVAC, telephone, security, etc. in accordance with all codes and standards required by Division 26.
   3. Perform all Work so as to comply with the accepted editions, amendments, practices, and rulings of the applicable codes and standards, except where the Drawings and Specifications are more stringent.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Acceptance of material and equipment Furnished By Others (F.B.O.):
   1. Where equipment or materials are to be F.B.O. to the Contractor for installation and connection, the Contractor must:

a. Upon receiving such equipment or materials, make a complete check of all items and provide a transfer of materials document.
b. Provide the transfer of materials document as a receipt detailing the products received and the condition of the products delivered to the Contractor.
c. After Receiving and accepting the material, assume full responsibility for the safe keeping, handling, and the installation of the materials and equipment, until completed installation and final acceptance by the Engineer.

2. Failure to issue said receipt assumes that all equipment and materials were then delivered to the Contractor in the proper quantities and in perfect condition.

B. Storage and Protection:

1. Provide for the safe storage and delivery of materials, whether furnished by the Contractor or by others.
2. Replace all equipment or material, damaged before final acceptance by the Engineer in a manner acceptable to the Engineer.
3. Meet all storage requirements of the Manufacturer and provide for the safe storage of all materials and equipment as recommended by the Manufacturer.
4. Protect electrical Work at all times from damage, defacement, or deterioration from any cause whatever:
   a. Provide proper storage facilities and conduct operations to this effect.
   b. Perform electrical Work in a manner as to protect the Work of other trades.

1.8 AREA DESIGNATIONS

A. General: For purposes of delineating electrical enclosure and electrical installation requirements of this project, certain areas have been classified in the Contract Documents as defined below. Electrical installations within these areas shall conform to the referenced code requirements for the area involved.

B. General Purpose Indoor Locations: Electrical work installed in areas which are not otherwise specifically classified shall be "General Purpose." Workmanship and enclosures shall comply with the general requirements of these Specifications. Electrical enclosures shall be NEMA Type 12.

C. Outdoor and Damp Locations: In outdoor locations, raceway shall be rigid galvanized steel (GRS) conduit; entrances shall be threaded; and fittings shall have gasketed covers. Provisions shall be made to drain the fitting or conduit system. Threaded fastening hardware shall be stainless steel. Raceway supports such as hanger rods, clamps, and brackets shall be stainless steel. Attachments or welded assemblies shall be galvanized after fabrication. Instruments and control cabinets shall be NEMA Type 4X unless otherwise noted on the drawings. Switchboards, motor control centers, and panel enclosures shall be weatherproof NEMA Type 3R unless otherwise noted on the drawings. Locations which are indoors and below grade elevation or which are classified as damp locations on the Drawings shall have electrical installations which conform to the requirements for outdoor locations. "Damp locations" shall include pipe galleries, tunnels, vaults, and basements. All rooms housing liquid handling equipment are also classified as damp locations regardless of grade elevation.

D. Splash Locations: Areas shown as splashproof shall have electrical installations as described for "outdoor locations."

1.9 CLEANUP

A. In addition to the requirements of "Cleanup" in Section 01 77 00 Project Closeout, all parts of the materials and equipment shall be thoroughly cleaned. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. All oil and grease spots shall be removed with a nonflammable cleaning solvent. Such surfaces shall be carefully wiped, and all cracks and corners scraped out. Paint touchup shall be applied to all scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum cleaned before final acceptance.

B. During the progress of the Work, clean the premises and leave the premises and all portions of the site free of debris.

1.10 DEMOLITION AND RELATED WORK

A. The Contractor shall perform all electrical demolition work as indicated.
   1. Electrical equipment and components, terminal and relay cabinets, MCCs, shall be returned to the Owner in an orderly fashion to a designated location on the site.
   2. Wire, conduit, junction boxes, fittings, supports, and miscellaneous hardware removed a part of the demolition work shall not be reused and shall be returned to the Owner for their salvage use.
   3. Wires and/or conduits which need to be extended shall be terminated in a new terminal box with terminal strips. Terminal box shall be properly sized by the Contractor unless specified on drawings. Wires and terminals shall be properly identified before disconnection and after reconnection.
   4. Wiring in conduits located in or under slabs shall be removed. The conduit shall be plugged level with the floor where practical. In other cases, the conduit shall be cut three inches below the finished floor and the area shall be resurfaced.
   5. Openings in walls and platforms created by the removal of conduit or electrical equipment shall be patched with materials similar to those in surrounding work areas or as required to provide proper sealed conditions as reviewed and accepted by the Engineer.
   6. Electrical demolition work shall be as shown on the Drawings or as required by the Specifications.
   7. Exercise due care in the removal of the equipment made surplus by this project so as not to impair its resale value or reuse. The Owner has the right to salvage any wire or other electrical equipment removed from the project.
   8. Contractor shall be responsible for properly disposing of all electrical demolition materials, except those items to be salvaged to the Owner as directed by the Engineer.

B. Installation of New Equipment in Existing Structures
   1. Certain new equipment and devices' installation are required in existing structures. Under this phase of the Work the Contractor shall be required to remove existing equipment or devices, install new equipment as indicated, remove existing conductors from existing raceway, and pull new conductors in existing raceway, reconnect existing conductors or furnish and install new conduit and wires.

2. Visit the site before bidding and carefully examine existing installation so that its proposal will reflect all the Work necessary to provide a complete installation so that the resulting installation will function as required. Include in the bid price all costs of labor and materials necessary to complete installations.

C. Modifications to Existing Electrical Facilities

1. Provide all modifications or alterations to existing electrical facilities required to successfully install and integrate the new electrical equipment. All modifications to existing equipment, panels, or cabinets shall be made in a professional manner with all coatings repaired to match existing. The total costs for all modifications to existing electrical facilities required for a complete and operating system shall be included in the original bid amount and no additional payment for this Work shall be authorized. Extreme caution shall be exercised in digging trenches in order not to damage existing underground utilities. Cost of repairs of damages caused during construction shall be the Contractor's responsibility.
2. The Contractor shall be responsible for verifying all available existing circuit breakers in lighting panels for their intended use as required by the Drawings. It shall also be responsible for verifying the available space in substation switchboards to integrate new power circuit breakers. Expenses in time for all of this Work shall be included in the original bid amount.

1.11 PROJECT OR SITE CONDITIONS

A. Site Conditions:

1. Provide an electrical, instrumentation and control system, including all equipment, raceways and any other components required for a complete installation that meets the Environmental conditions for the Site as specified in the General Requirements and below.
2. Seismic Classification:
   a. Provide all electrical equipment and construction techniques suitable for the seismic requirements for the Site, as specified in 01 81 10.
3. Wind:
   a. Provide all electrical equipment and construction techniques suitable for the Site wind loading criteria, as specified in section 01 81 11.
4. Altitude:
   a. The site is located at approximately 5,015 feet above mean sea level. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
5. Humidity:
   a. The facility is located in an area where the relative humidity is 90 percent non-condensing. Furnish all components and equipment fully rated for continuous operation at this relative humidity level.
6. Temperature:
   a. The facility is located in an area where the temperature will vary from a minimum of -20 degrees Fahrenheit to a maximum of 100 degrees Fahrenheit.
   b. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10

degrees Fahrenheit below maximum operating temperature as determined by the equipment Manufacturer's guidelines.

7. Outdoor installations:
   a. Provide all electrical, instrumentation and control equipment installed outdoors that are suitable for operation in the ambient conditions where the equipment is located.
   b. Provide heating, cooling, and de-humidifying devices incorporated into and included with electrical equipment, instrumentation and control panels located outdoors in order to maintain the enclosures within the rated environmental operating ranges as specified in this Paragraph for the equipment:
      1) Provide all wiring necessary to power these devices.
8. Site Security:
   a. Abide by all security and safety rules concerning the Work on the Site.

1.12 WARRANTY

A. Warrant the performance and the hardware of the complete electrical systems including all lamps, lighting, switchgear, circuit breakers, transformers, MCCs, VFD, etc. for a period of 1 year following the date of substantial completion of the Work:
   1. To fulfill this obligation, provide technical service personnel designated by the Electrical Contractor and/ or Manufacturer.
   2. Perform services to correct any defect within 3 calendar days after notification by the Owner of a defect.

B. Warrant the satisfactory performance of the software, equipment, and materials under the specified operating conditions.
   1. In the event that operations, tests, or inspections disclose latent defects or failure to meet the specified requirements, upon notification by the Owner, promptly correct or repair any such defects or non-conformance, or furnish such new equipment or parts as may be necessary for conformity to the specified requirements.

C. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements. Following replacement or modifications retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

D. Provide all parts, material, labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period:
   1. Furnish spare parts and tools on site at inventory levels sufficient to meet the response and repair times specified.
      a. All spare parts and tools stored on-site become the property of the Owner upon completion of the warranty period.

1.13 MAINTENANCE

A. Provide similar items of same Manufacturer throughout the Electrical and Instrumentation portion of the project.

B. Furnish all spare parts as required by other sections of the Specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment and materials shall be new, shall be listed by UL, and shall bear the UL label, where UL requirements apply. All equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar items in the project shall be products of the same manufacturer. All equipment and materials shall be of industrial grade and standard of construction; shall be of sturdy design and manufacture; and shall be capable of reliable, trouble-free service.

2.2 GROUNDING

A. General: All components of the grounding electrode system shall be manufactured in accordance with UL 467 and shall conform to the applicable requirements of National Electrical Code Article 250.

B. Grounding cable shall be copper. Bare copper wire shall be annealed, No. 8 AWG minimum, if not called out in the Drawings.

C. Ground rods shall conform to ANSI/UL 467 and shall be ¾-inch diameter copper-clad steel, sectional type, joined by threaded copper alloy couplings.
   1. Grounding connectors shall be high-strength copper alloy suitable for direct burial.
   2. Wire connections shall be exothermic weld by Cadweld of Erico Products.
      a. Manufacturers of grounding materials shall be Copperweld, Blackburn, Burndy, or equal.

2.3 UNDERGROUND DUCTS AND MANHOLES

A. General: Where an underground distribution system is required, it shall be comprised of multiple runs of single bore nonmetallic conduits, with underground manholes and pullboxes. When nonmetallic conduits are required, they shall be rigid Schedule 40 PVC.
   1. Manholes and pullboxes shall be of precast concrete. Concrete construction shall be designed for traffic loading.

B. Covers shall be traffic type, except as shown otherwise. Manholes and pullbox covers shall be labeled as shown on drawings.

C. Manholes and pullboxes shall be equipped with pulling-in irons opposite and below each ductway entrance.

D. Manholes shall have concrete covers with 30- inch diameters lids. All covers and lids shall be bolted to cast-in-place steel frames with corrosion resistant hardware. Frames shall be factory-primed; covers shall be cast-iron and shall have pick holes or lifting handles.
   1. Manholes and pullboxes shall have cable supports so that each cable is supported at 3-foot intervals within the manhole or pullbox. Cable supports and racks shall be

fastened with galvanized bolts and shall be fabricated of fiberglass or galvanized steel. Porcelain insulators for cable racks shall be provided.

2. Manholes and pullboxes shall be Brooks, Quikset, U.S. Precast, or equal.

E. The concrete shall have a compression strength of 3,000 psi in accordance with the requirements of Section 03 30 00 Cast In Place Concrete.

2.4 RACEWAYS

A. General: Raceway shall be manufactured in accordance with UL and ANSI standards and shall bear UL label as applicable.

B. Galvanized Rigid Steel (GRS) Conduit

1. Rigid steel conduits and fittings shall be full weight, mild steel, hot-dip galvanized and zinc bichromate coated inside and outside after galvanizing.
2. Rigid steel conduit shall be manufactured in accordance with UL Standard No. 6 and ANSI 80-1.
3. Rigid steel conduit shall be manufactured by Triangle PWC, Republic Steel, or equal.

C. Rigid nonmetallic conduit shall be Schedule 40 PVC.

1. Nonmetallic conduits and fittings shall be UL listed, sunlight-resistant, and rated for use with 90 degrees C conductors.
2. Nonmetallic conduits and fittings shall be manufactured by Carlon, Condux, or equal.

D. Flexible metallic conduit shall be fabricated from galvanized interlocked steel strip. Liquid-tight flexible metallic conduit shall have an extruded PVC covering over the flexible steel conduit. For conduit sizes 3/4 inch through 1-1/4 inches, flexible conduits shall have continuous built in copper ground conductor. Flexible conduit shall be American Brass, Anaconda, Electroflex, or equal.

E. PVC-coated raceway system shall conform to Federal Specification WW C 581E, ANSI C80.1, and to Underwriter's Laboratories specifications.

1. The zinc surfaces of the conduits and fittings shall remain intact and undisturbed on both the inside and the outside of the conduit through the preparation and application processing.
2. A PVC coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic.
3. The thickness of the PVC coating shall be a minimum of 40 mils.
4. A PVC jacketed coupling shall be furnished with each length of conduit. A PVC sleeve equal to the OD of the conduit shall extend 1-1/2 inches from each end of coupling.
5. PVC-coated conduits shall be as manufactured by Robroy, Occidental (OCCAL), or equal.

2.5 WIRE AND CABLE

A. General: All conductors, including ground conductors, shall be copper. Insulation shall bear UL label and the manufacturer's trademark, type, voltage and temperature rating, and conductor size. Wire and cable shall be products of American, BICC/General, Rome Cable, Okonite, or equal.

B. Control Cables: All control cables shall be rated for 600 volts and shall meet the following requirements:
   1. Control wires shall consist of No. 14 gauge stranded copper conductors and shall be THWN/THWN-2 rated for 90 degrees C at dry locations and 75 degrees C at wet locations.
   2. Control wires at panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations.

C. Instrumentation Cables: Shielded instrumentation cables shall be rated at 600 volts and shall comply with the following requirements:
   1. Individual shielded cable shall consist of twisted 2 or 3 No. 18 gauge, stranded, color coded, tinned-coated copper in accordance with ASTM B 33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes and B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, and Soft. Color coding shall be black-clear, or black-red-clear.
   2. Insulation thickness shall be 32 mils of polyethylene, insulated with 2.3 mils 100 percent aluminum foil/polyester shield and No. 18 stranded tinned copper drain wire, all under a 32 mil PVC jacket. The shield shall be continuous and shall be grounded only at the receiving end, or as indicated.
   3. Multi-individual shielded pair or triad instrumentation cable shall consist of individual shielded and twisted pair copper conductors with an ethylene-propylene insulation, and No. 18 AWG tinned stranded copper drain wire, an overall aluminum mylar shield and an overall chloro-sulfonated polyethylene compound jacket. The cables shall be suitable for cable tray installation and shall be flame retardant.

D. Building Wire and Cable: Building wires and cables shall be rated at 600 volts and shall meet the following requirements:
   1. Building wire shall be single conductor copper cable listed by UL as Type THWN/THWN-2 rated 75 degrees C in wet locations and rated 90 degrees C in dry locations.
   2. Building wire; **all conductors shall be stranded**.
   3. No wire smaller than No. 12 AWG shall be used unless specifically indicated.

E. Cable Terminations: Cable terminations shall be in accordance with the following:
   1. Compression connectors shall be Burndy "Hi Lug", Thomas & Betts "Shure Stake", or equal. Threaded connectors shall be split bolt type of high strength copper alloy.
   2. Spring connectors (wire nuts) shall be 3M "Scotch Lok," "Ideal Wing Nuts", or equal.
   3. Preinsulated fork tongue lugs shall be "Thomas & Betts" RC Series, Burndy, or equal.
   4. General purpose insulating tape shall be Scotch No. 33, Plymouth "Slip knot", or equal. High temperature tape shall be polyvinyl by Plymouth, 3M, or equal.
   5. Epoxy resin splicing kits shall be 3M Scotchcoat 82 Series, Burndy Hy Seal, or equal.
   6. Motor load termination kits shall be 3M.

2.6 PULL AND JUNCTION BOXES

A. Outlet, switch, pull and junction boxes for flush-mounting in general purpose locations shall be one-piece, galvanized, pressed steel. Ceiling boxes for flush-mounting in concrete shall be galvanized, pressed steel.

B. Outlet, switch, pull and junction boxes where surface mounted in exposed locations shall be cast ferrous boxes with mounting lugs, zinc or cadmium plating, and enamel finish. Surface mounted boxes in concealed locations may be pressed steel.

C. Control station, pull and junction boxes, including covers, for installation in corrosive locations shall meet the NEMA 4X requirements and shall be stainless steel or fiber glass-reinforced polyester and shall be furnished with mounting lugs.

D. All cast boxes and pressed steel boxes for flush mounting in concrete shall be fitted with cast, malleable box covers and gaskets. Covers for pressed steel boxes shall be one-piece pressed steel, cadmium plated, except that boxes for installation in plastered areas and finished rooms shall be stainless steel over plaster rings. Stainless steel plates shall be Sierra S line, Hubbell, or equal. Cast boxes shall be as manufactured by Crouse-Hinds, Appleton, or equal.

2.7 CONDUIT FITTINGS

A. General: Fittings shall comply with the same requirements as the raceway with which they will be used. Fittings for use with rigid steel conduit, shall be cast or malleable ferrous metal. Such fittings larger than one inch shall be "mogul size." Fittings shall be of the gland ring compression type. Covers of fittings, unless in "dry" locations, shall be closed with gaskets. Surface-mounted cast fittings, housing wiring devices in outdoor and damp locations, shall have mounting lugs.

B. Insulated bushings shall be molded plastic or malleable iron with insulating ring, similar to O Z Type A and B, equivalent types by Thomas & Betts, Steel City, Appleton, O Z/Gedney, or equal.

C. Insulated grounding bushings shall be malleable iron with insulating ring and with ground lug, - by T & B, - no substitutions.

D. Crouse Hinds UNF or UNY unions shall be used at all points of union between ends of rigid steel conduits which cannot be coupled. Running threads and threadless couplings shall not be used.

E. Liquid-tight fittings shall be manufactured by T & B, no substitutions.

F. Hubs for threaded attachment of steel conduit to sheet metal enclosures shall be similar to Appleton Type HUB, equivalent types such as manufactured by T & B, Myers Scrutite, or equal.

G. Transition fittings to mate steel to PVC conduit, and PVC access fitting, shall be as furnished or recommended by the manufacturer of the PVC conduit.

H. Conduit sealant shall be Chico, or equal.

I. Expansion fittings shall be installed wherever a raceway crosses a structural expansion joint. Such fittings shall be expansion and deflection type and shall accommodate lateral and transverse movement. Fittings shall be O Z/Gedney Type "DX," Crouse Hinds "XD," or equal. These fittings are required in metallic and nonmetallic raceway installations. When the installation is in a nonmetallic run, a 3 foot length of rigid conduit shall be used to connect the nonmetallic conduit to the fitting.

2.8 CABINETS AND ENCLOSURES

A. General: All electrical cabinets and enclosures housing control relays and terminal blocks shall be manufactured in accordance with NEMA Publications 250, UL Standards 50 and 508.
   1. Relay or control, and terminal cabinets or outdoor cabinets shall be NEMA 4 enclosures. Sizes shown on the Drawings are minimum. Interiors of cabinets shall be finished white including internal back mounting plate.
   2. Pull boxes and fan timer enclosure in vault shall be fiberglass, NEMA type 4X.

B. Wiring of terminal cabinets, control or relay cabinets shall be accomplished with stranded copper conductor rated for 600-volts and UL listed as Type MTW. Wires for annunciator and indication circuits shall be No. 16 AWG. All others shall be No. 14 AWG. Color coding shall be as specified elsewhere in this Section.

C. All terminal block requirements shall be as manufactured by Entrelec with cage clamp, Phoenix, or equal.

D. Engraving shall be as shown or as directed by the Engineer. Characters shall be uniform block style not smaller than 1/8-inch. Nameplates shall be secured using cadmium plated steel or other corrosion resistant screws. Adhesive alone is not acceptable.

E. Each relay or control and terminal cabinets shall be completed, assembled, wired, and tested at the factory. Test shall be in accordance with the latest UL and NEMA Standards. All cabinets shall bear UL label, as applicable.

2.9 ELECTRICAL IDENTIFICATION

A. Nameplates: Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock, Formica type ES-1, or equal. Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style of adequate size to be read easily at a distance of 6 feet with no characters smaller than 1/8-inch high.

B. Conductor and Equipment Identification: Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices such as manufactured by Brady, Thomas & Betts, or equal, or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place, or equal.

C. Identification Tape: Identification tape for protection of buried electrical installation shall be a 6-inch wide red polyethylene tape imprinted "CAUTION - ELECTRIC UTILITIES BELOW."

PART 3 - EXECUTION

3.1 GROUNDING

A. General: Grounding cable shall be sized in accordance with code requirements when sizes are not indicated on the Drawings.

B. Equipment Ground: Ground continuity throughout the facility shall be maintained by installing a grounding conductor in all raceways.
   1. Metallic raceway shall be installed with double lock nuts or hubs at enclosures. Nonmetallic raceway containing dc conductors operating at more than 50 volts to ground, or any ac conductors, shall contain a copper-grounding conductor insulated green. Such conductor shall be bonded to terminal and intermediate metallic enclosures.
   2. Metal equipment platforms which support any electrical equipment shall be bonded to the nearest ground bus or to the nearest switchgear ground bus. This grounding requirement is in addition to the raceway grounding required in the preceding paragraph herein.

C. Grounding Electrode System: Install the grounding electrode system with all required components in accordance with National Electrical Code Article 250.
   1. Connection to ground electrodes and ground conductors shall be exothermic welded where concealed and shall be bolted pressure type where exposed. Bolted connectors shall be assembled wrench-tight.
   2. Insulated grounding bushings shall be employed for all grounding connections to steel conduits in switchboards, in motor control centers, in pullboxes, and elsewhere where conduits do not terminate at a hub or a sheet metal enclosure. Where insulated bushings are required, they shall be installed in addition to double lock-nuts.
   3. Copper bonding jumpers shall be used to obtain a continuous metallic ground.

D. Shield Grounding
   1. Shielded power cable shall have its shield grounded at each termination in a manner recommended by the cable manufacturer.
   2. Shielded instrumentation cable shall be grounded at one end only; this shall be at the RTU or otherwise at the "receiving" end of the signal carried by the cable, unless shop drawings indicate that the shield shall be grounded at both ends.
   3. Termination of each shield drain wire shall be on its own terminal screw. All of these terminal screws in one rack shall be jumpered with No. 16 solid tinned bare copper wire; connection to ground shall be accomplished with a No. 12 green insulated conductor to the main ground bus.

3.2 UNDERGROUND DUCTS AND MANHOLES

A. The underground duct bank shall be installed in accordance with the criteria below:
   1. Duct shall be assembled using high impact nonmetallic spacers and saddles to provide conduits with vertical and horizontal separation. Plastic spacers shall be set every 5 feet.
   2. The duct shall be laid on a grade line of at least 4 inches per 100 feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the duct is a minimum of 24 inches below grade.
   3. Changes in direction of the duct envelope by more than 10 degrees horizontally or vertically shall be accomplished using bends with a minimum radius 24 times the duct diameter.
   4. Couplings shall be staggered at least 6 inches vertically. Bottom of trench shall be of select backfill or sand. The duct array shall be anchored every 4 feet to prevent movement during placement of backfill.

5. Each bore of the completed duct bank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct through which the mandrel will be drawn. After passing of the mandrel, draw a wire brush and swab through.
6. A raceway, in the duct envelope, which does not require conductors, shall have a 1/8 inch polypropylene pull cord installed throughout the entire length of the raceway.

B. Duct entrances shall be grouted smooth; duct for primary and secondary cables shall be terminated with flush end bells. Sections of pre-fabricated manholes and pullboxes shall be assembled with waterproof mastic and shall be set on a 6-inch bed of gravel as recommended by the manufacturer or as required by field conditions.

C. Duct bank markers shall be installed every 200 feet along run of duct bank, at changes in horizontal direction of duct bank, and at ends of duct bank. Concrete markers, 6 by 6 inches square and one-foot long, shall be set 2 inches above finish grade. The letter "D" and arrow set in the concrete shall be facing in the direction of the duct alignment.

D. Duct bank penetration through walls of manholes or pullboxes, and on building walls below grade shall be watertight.

E. Trenches containing duct banks shall be filled with select backfill with no large rocks which could damage the duct.

3.3 RACEWAYS

A. General: Raceways shall be installed as indicated, however, conduit routings shown are diagrammatic. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical and shall be accomplished with tools designed for the purpose intended. Bends in metallic conduit shall be accomplished by field bending or by the use of factory elbows. All installations shall be in accordance with the latest edition of the National Electrical Code.

B. Raceways shall be installed in accordance with the following schedule:
1. Low Voltage Raceway (control and power):
   a. Rigid Schedule 40 PVC shall be used for burial in earth.
   b. Galvanized rigid steel (GRS) shall be used on exposed installations in general purpose areas.
   c. Galvanized rigid steel or PVC shall be used for conduits embedded in concrete slab on grade and above grade.
   d. Galvanized rigid steel shall be used in exposed installations in outdoor areas.
2. Exposed Raceways
   a. Conduits shall be rigidly supported with clamps, hangers, and Unistrut channels.
   b. Intervals between supports shall be in accordance with the National Electrical Code.
3. All underground elbows shall be GRS (PVC coated).

C. Conduit Terminations

1. Empty conduit terminations not in manholes or pullboxes shall be plugged. Exposed raceway shall be installed perpendicular or parallel to buildings except where otherwise indicated. Conduit shall be terminated with flush couplings at exposed concrete surfaces. Conduit stubbed up for floor-standing equipment shall be placed in accordance with approved shop drawings. Metallic raceways installed below-grade or in outdoor locations and in concrete shall be made up with a conductive waterproof compound applied to threaded joints. Compound shall be Zinc Clads Primer Coatings No B69A45, HTL-4 by Crouse-Hinds, Kopr Shield by Thomas & Betts, or equal.
2. Both rigid and flexible conduit shall be sealed against water at each entrance to enclosures. Unless indicated otherwise, rigid and flexible conduit shall enter panels through the top, shall continue down from the top to the bottom, and shall turn upward at the bottom.

D. Conduit Installations
1. Conduit may be cast integral with horizontal and vertical concrete slabs, providing one-inch clearance is maintained between conduit surface and concrete surface. If said clearance cannot be maintained, the conduit shall be installed exposed below elevated slabs; provided, that in the case of slabs on grade, conduit shall be installed below the slab and shall be encased with a minimum cover of 3 inches of concrete. Maximum size of conduit that can be cast in slab above grade shall be 3 inches, in slab on grade shall be 1-1/2 inches.
2. Nonmetallic conduit may be cast integral with horizontal slabs with placement criteria stated above. Non-metallic conduit may be run beneath structures or slabs on grade, without concrete encasement. In these instances, conduit shall be placed at least 12 inches below the bottom of the structure or slab. Nonmetallic conduit may be buried 24 inches minimum below grade, in open areas or where otherwise not protected by concrete slab or structures. Nonmetallic conduit shall be permitted only as required by the Specifications and in concealed locations as described above.
3. Where a run of concealed PVC conduit becomes exposed, a transition to rigid steel conduit is required. Such transition shall be accomplished by means of a factory elbow or a minimum 3-foot length of rigid steel conduit, either terminating at the exposed concrete surface with a flush coupling. Piercing of concrete walls by nonmetallic runs shall be accomplished by means of a short steel nipple terminating with flush couplings.
4. Flexible liquid-tight conduit shall be used for the connection of equipment such as motors, transformers, instruments, valves, or pressure switches subject to vibration or movement during normal operation or servicing. Flexible liquid-tightdisco conduit may be used in lengths required for the connection of recessed lighting fixtures; otherwise the maximum length of flexible conduit shall be 18 inches.
5. Equipment subject to vibration or movement which is normally provided with wiring leads, such as solenoid valves, shall be installed with a cast junction box for the make-up of connections. Flexible conduits shall be as manufactured by American Brass, Cablec, Electroflex, or equal.
6. Conduit penetrations on walls, concrete structures, pull boxes, and equipment cabinets shall be performed in accordance with the following:
    a. Seal all raceways entering structures at the first box or outlet with conduit sealant to prevent the entrance into the structure of gases, liquids, or rodents.

b. Dry pack with nonshrink grout around raceways that penetrate concrete walls, floors, or ceilings aboveground, or use one of the methods indicated for underground penetrations.

c. Where an underground conduit enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide an acceptable, malleable iron, watertight, entrance sealing device. When there is no raceway concrete encasement, provide such device having a gland type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement indicated, provide such a device with a gland type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.

d. Where an underground raceway without concrete encasement enters a structure through a nonwaterproofed wall or floor, install a sleeve made of Schedule 40 galvanized pipe. Fill the space between the conduit and sleeve with a suitable plastic expandable compound on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device may be used in lieu of the sleeve.

7. All underground GRS conduit shall be PVC coated.
8. Minimum size of buried conduit: 1".
9. Minimum size of exposed conduit: ¾"

3.4 WIRES AND CABLES

A. General: Conductors shall not be pulled into raceway until:
1. Raceway system has been inspected and accepted by the Engineer.
2. Plastering and concrete have been completed in affected areas.
3. Raceway system has been freed of moisture and debris.

B. Wire and Cables
1. Conductors of No. 1 size and smaller shall be hand pulled. Larger conductors may be installed using power winches. Pulling tensions on the cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
2. Wire in panels, cabinets, and gutters shall be neatly grouped using nylon tie straps and shall be fanned out to terminals.

C. Splices and Terminations
1. The Contractor shall provide, install, and terminate the conductors required for power and controls to electrical equipment instrumentation terminal cabinets, control and instrumentation equipment except where indicated elsewhere. There shall be no splices in underground manhole or pullboxes of conductors smaller than #10 AWG.
2. Two- and three-conductor shielded cables installed in conduit runs which exceed 2,000 feet may be spliced in pullboxes. These cable runs shall have only one splice per conductor.
3. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment. For the

purposes of the various Sections of Division 26 of the Specifications, "control conductors" are defined as conductors operating at 120 volts or less in circuits that indicate equipment status or that control the electric energy delivered to a power consuming device.

4. All 120/208-volt and 480-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the Contractor.
5. Stranded conductors shall be terminated directly on equipment box lugs making sure that all conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.
6. Splices in 600-volt wire which are not pre-insulated shall be insulated with three layers of tape each half lapped except that splices in below grade pull boxes or in any box subject to flooding shall be made watertight using in-line copper compression splices with heat shrink insulation.
7. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape. Provide 3M motor lead termination kits.
8. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable manufacturer. Submit the proposed termination procedure as described for shop drawings.
9. Control devices, such as solenoid operated valves that are normally supplied with conductor pigtails shall be terminated as described for control conductors.

D. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements ICEA Publication No. S-68-516 and other relevant ICEA publications. The following tests shall be the minimum requirements:

1. Insulation resistance shall be obtained and shall not be less than the value recommended by ICEA.
2. All cables rated at 600 volts shall be tested for insulation resistance between phases and from each Phase to a ground using a megohmeter.
3. All field testing mentioned above shall be done after cables are installed in the raceways.
4. Cables failing in the said tests shall be replaced with a new cable or repaired. Such kind of repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

E. Continuity Test: All control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed prior to placing all cables in service.

3.5 PULL AND JUNCTION BOXES

A. Pull and junction boxes shall be sized in accordance with the requirements of the National Electrical Code or as shown on drawings.

B. Outlet boxes shall be used as junction boxes wherever possible. Where separate pullboxes are required, they shall have screw covers.

C. Pullboxes shall be installed when conduit run contains more than three 90-degree bends and runs exceed 200 feet or as shown on drawings.

3.6 CABINETS AND ENCLOSURES

A. Cabinets shall be set plumb at an elevation that will cause the maximum circuit breaker height to be less than 5 ft 6 inches. Top edge of trim of adjacent panels shall be at the same height. Panels which are indicated as flush mounted shall be set so cabinet is flushed and serves as a "ground" for plaster application.

B. All factory wire connections shall be made at shipping splits, and all field wiring and grounding connections shall be made after the assemblies are anchored.

3.7 CONCRETE HOUSEKEEPING

A. Concrete housekeeping pads shall be provided for all floor standing electrical equipment. Housekeeping pads for all equipment, including future units, shall be 2 inches above surrounding finished floor or grade and 2 inches larger in both dimensions than the supported equipment, unless otherwise indicated.

B. Concrete housekeeping curb shall be provided for all conduit stub-up in indoor and outdoor locations, not concealed by equipment enclosures. Such curb shall be 3 inches above finished floor or grade.

3.8 EQUIPMENT ANCHORING

A. Freestanding or wall-hung equipment shall be anchored in place by methods that will meet seismic requirement in the area where project is located. Wall-mounted panels that weigh more than 500 pounds or which are within 18 inches of the floor shall be provided with fabricated steel support pedestal(s). Pedestals shall be of welded steel angle sections. If the supported equipment is a panel or cabinet and enclosed with removable side plates, it shall match supported equipment in physical appearance and dimensions. Transformers hung from 4-inch stud walls and weighing more than 300 pounds, shall have auxiliary floor supports.

B. Leveling channels anchored to the concrete pad shall be provided for all switchgear and pad-mounted transformer installations. Area between the channels shall be grouted perfectly flat.

C. Anchoring methods and leveling criteria specified in the printed recommendations of the equipment manufacturers are a part of the Work of this Contract. Such recommendations shall be submitted as required for shop drawings in Section 01 33 20 – Submittal Procedures.

3.9 CABLE AND EQUIPMENT IDENTIFICATION

A. General: The completed electrical installation shall be provided with adequate identification to facilitate proper control of circuits and equipment and to reduce maintenance effort.

B. Cable: Assign each control and instrumentation wire and cable a unique identification number. Said numbers shall be assigned to all conductors having common terminals and shall be shown on all shop drawings. Identification numbers shall appear within 3 inches of

conductor terminals. "Control" shall be defined as any conductor used for alarm, annunciator, or signal purposes:

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. All individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers indicated on the Drawings.
2. All 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase 1-black, Phase 2-red, Phase 3-blue, and Neutral-white. The 480/277-volt system conductors shall be color coded as follows: Phase A-brown, Phase B-orange, Phase C-yellow, and Neutral-gray. Color-coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase 1-2-3, top to bottom, or left to right, facing the front of the equipment.
3. General purpose ac control cables shall be pink. General purpose dc control cables shall be blue.
4. All spare cables shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by imprinted, varnished, marker strips attached under the terminal strip.

C. Equipment: Equipment and devices shall be identified as follows:

1. Nameplates shall be provided for all panelboards, panels, starters, switches, and pushbutton stations. In addition to the name plates shown, control devices shall be equipped with standard collar-type legend plates.
2. Control devices within enclosures shall be identified similar to the paragraph above.
3. Three-phase receptacles shall be consistent with respect to phase connection of receptacle terminals. Errors in phasing shall be corrected at the bus, not at the receptacle.
4. Toggle switches which control loads out of sight of switch, and all multiswitch locations of more than 2 switches, shall have suitable inscribed finish plates.
5. Empty conduits shall be tagged at both ends to indicate the destination at the far end. Where it is not possible to tag the conduit, destination shall be identified by marking an adjacent surface.
6. Provide typewritten circuit directories for panelboards; circuit directory shall accurately reflect the outlets connected to each circuit.
7. Install identification tape directly above buried unprotected raceway; install tape 8 inches below grade and parallel with raceway to be protected. Identification tape is required for all buried raceway not under buildings or equipment pads except identification tape is not required for protection of street lighting raceway.

3.10 EXAMINATION

A. Study all Drawings and Specifications and to report to the Engineer before bidding:

1. Any errors.
2. Any omissions

3. Any Electrical Code problems
4. Any Local Building Code problems.
5. Or any points of conflict with other trades.

B. Review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

C. The Contractor is responsible for the complete electrical and instrumentation Work:
1. Install extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, power, and Process Control and Instrumentation System.

3.11 GENERAL INSTALLATION

A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
1. Verify all dimensions indicated on the Drawings:
a. Actual field conditions govern all final installed locations, distances, and levels.
2. Review all information shown on the Contract Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.

B. Cutting and patching:
1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
a. Actual field conditions govern all final installed locations, distances, and levels.
1) Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made.
a) Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables etc.
b) Use tone-locate system or X-ray to ensure that area is clear of obstructions.
2) Review the complete Drawing set to ensure that there are not conflicts or coordination problems before cutting, channeling, or core drilling any surface.
2. Perform all patching to the same quality and appearance as the original Work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:

a.	3M	CP25	Caulk
b.	3M	303	Putty
c.	T&B	S-100	Caulk
d.	T&B	FS-500	Putty
e.	T&B	FST-60l	Putty

3. Seal around conduit penetrations of below grade walls with a waterproof, non-shrink, nonmetallic grout. Use Fox Industries FX-225 or equal. Install in accordance with manufacturer's recommendations.

C. Earthwork and Concrete:
1. Install all trenching, shoring, concrete, backfilling, grading, and resurfacing associated with the electrical work.
2. Notify the Engineer before encasing or backfilling any electrical work and arrange for inspection.

D. Terminations:
1. Terminate all conductors required to interconnect power, controls, instruments, panels and other equipment otherwise specifically identified.

E. Miscellaneous Installation Requirements:
1. In case of interference between electrical equipment shown on the Drawings and the other equipment, notify the Engineer in writing of the proposed change:
   a. Obtain Engineer's acceptance of the proposed changes before they are made.
2. Location of manholes and pullboxes shown on Drawings are approximate. Coordinate exact location of manholes and pullboxes with mechanical and civil Work.
3. Provide additional manholes or pullboxes to those shown where they are required to make a Workable installation.
4. Circuits of different service voltage:
   a. Install in separate raceways, hand holes, pullboxes, and junction boxes.
   b. In manholes, install all cables operating at less than 50 VDC PVC coated flexible metallic conduit.
   c. The voltage and service levels are:
      1) Medium voltage: 12:47 KV
      2) Low voltage: 120V, 208V, 480V
      3) Control: less than 50VDC

F. Labeling:
1. Provide all nameplates and labels as required on equipment.

G. Equipment Tie-Downs:
1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the site.
2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., must be permanently mounted and tied down to structures.

3.12 FIELD QUALITY CONTROL

A. Inspection:
1. Conduct inspection of electrical, instrumentation and control system installation.
2. Allow Owner, Engineer, or Owner's Representative access to site for inspection of materials, equipment, or installation at any time.
3. Provide any technical data or other assistance necessary to support inspection activities.
4. Electrical inspections include, but not limited to, the following:

a. Inspect equipment and materials for physical damage.
b. Inspect installation of compliance with plans and specifications
c. Inspect installation for obstructions and adequate clearances around equipment.
d. Inspect equipment installation for proper leveling, alignment, anchorage and assembly.
e. Inspect equipment nameplate data to verify compliance with design requirements.
f. Inspect raceway installation quality Workmanship and adequate support.
g. Inspect cable terminations.
h. Schedule Structural Engineer to inspect all mounting of electrical devices and all penetrations and connections to structures.
5. Inspection activities conducted during construction do not satisfy inspection requirements outlined in each section of the Division 26 specifications.

B. Testing:
1. When the electrical Work is substantially completed, notify the Engineer that the project is ready for Field Acceptance Testing.
2. Perform the acceptance test in conformance with each section of the Division 26 specifications.
3. Record results of the required tests along with the date of test:
a. Use conduit schedule identification numbers to indicate portion of circuit tested.

C. Workmanship:
1. Use only competent and skilled personnel experiences in their trade, Working under continuous competent supervision, to perform all Work, including installation, connection, calibration, testing, and adjustment.
a. Perform all Work, including aesthetic as well as electrical and mechanical aspects, to standards consistent with the best practices of the trade.
2. All Work is subject to review by the Engineer or Owner at any time.
3. Provide all Work to the complete satisfaction of the Engineer or Owner.
4. Repair or replace any Work, which, in the sole opinion of the Engineer, does not conform to these Specifications, or trade practices.
5. Make all changes of any installed items to meet the intent of the Drawings and Specifications.
6. Install all materials and equipment in accordance with the Manufacturer's printed installation instructions.
a. Where Contractor asks to deviate from the Manufacturer's recommendations, such changes shall be reviewed by the Engineer and Manufacturer before installation.

3.13 CLEANING

A. General Requirements:
1. Maintain all surfaces to be painted in a clean and smooth condition.
2. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.
3. Remove all debris, rubbish, and scraps, etc. each night.

4. Leave all areas swept clean each night.
5. Wipe clean all exposed threads of conduit of the KOPR-SHIELD compound after installation.

B. Vacuum clean all electrical enclosures of any debris before any wire or cable is installed.

C. Clean and re-lamp all new and luminaries that were used in the area affected by the construction and return all used lamps to Owner.

D. As specified in other Sections of the Specifications.

E. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
1. Neatly coil and label spare wiring lengths.
2. Shorten re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

END OF SECTION

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SECTION 26 05 83
WIRING CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. ASTM International.

B. Code of Federal Regulations.

C. International Electrical Testing Association, NETA.

D. National Electrical Manufactures Association.

E. NFPA 70, National Electrical Code.

F. Underwriters Laboratories Inc.

1.3 SUMMARY

A. Section Includes:
   1. Wiring connecting devices.
   2. Terminations.
   3. Splices.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all divisions and sections apply. It is the responsibility of the CONTRACTOR and its Sub-contractors to review all sections to ensure a complete and coordinated project.

1.4 DEFINITIONS

A. Definitions of terms are specified in Section 26 05 00.

1.5 SYSTEM DESCRIPTION

A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.6 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20 and 26 05 00.

B. Product Data:
   1. Catalog cut sheets.

C. Shop drawings:
   1. Drawings showing the installation of junction modules, splices and terminators.

D. Instruction and Operating Manuals:
   1. Include drawings and data for medium voltage cable connectors, splices and junction modules in the operating manuals.

1.7 QUALITY ASSURANCE

A. As specified in Section 26 05 00.

B. All materials shall be UL listed.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Control Connections:
   1. Use insulated ring type wire terminators for connections to all screw terminals:
      a. With chamfered/funneled terminal barrel entry.
      b. Deep internal serrations.
      c. Long barrel design to reduce electrical resistance and increased insulator- barrel surface area to ensure that the insulator remains in contact with the barrel.
      d. Electroplated-tin copper conductor.
      e. Manufactured by the following or equal:
         1) Thomas and Betts, Stakon.
   2. For process equipment connections work from manufacturer's drawings.

B. Joints, Splices, Taps, and Connections:
   1. For 600-volt conductors use solderless connectors.
   2. Use only plated copper alloy connectors or lugs:
      a. Aluminum connectors or lugs are not acceptable for copper conductors.
   3. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
   4. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps.
      a. Manufactured by the following or equal:
         1) Buchanan 2006S or 2011S with 2007 or 2014 insulating caps.
   5. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
      a. Manufactured by one of the following or equal:
         1) Burndy.
         2) Thomas and Betts.
   6. Where waterproof splices are required:

a. Suitable for indoor, outdoor, weather exposed, direct buried or submersed applications.
b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kV.
d. Two-part mold body with tongue and groove seams and built in spacer webbing.
e. Manufactured by the following or equal:
1) 3M – Scotchcast 72-N

7. Optical Fiber terminations:
a. All multimode optical fiber cable installed shall be terminated with a split-ferrule alignment sleeve and a precision ceramic tip. All multimode optical fiber connectors shall meet the following technical specifications:
1) Connector Type: ST
2) Fiber Outside Diameter: 125 microns Nominal
3) Loss Repeat: < 0.2 dB per 100 reconnects
4) Axial Load Minimum: 35 Pounds
5) Temperature Stability: +0.1 dB Maximum from -40°C to 75°C
b. All single mode optical fiber cable installed shall be terminated utilizing a split-ferrule alignment sleeve and a precision ceramic tip. All single mode connectors shall meet the following technical specifications:
1) Connector Type: SC
2) Fiber Outside Diameter 125 Microns
3) Loss Repeat: < 0.2 dB per 1000 reconnects
4) Axial Load, min. 30 pounds
5) Temperature Stability: -40°C to 85°C
c. Contractor shall provide multimode optical fiber patch cords. The multimode optical fiber patch cords shall be Lucent Technologies ML2SC-SC-XX, and shall meet the following technical specifications:
1) Number of fibers: 2
2) Approximate loss, mean, variance 0.1, 0.1
3) Minimum bandwidth: 160 MHz-km @ 850 nm
d. Contractor shall provide single mode optical fiber patch cords. The single mode optical fiber patch cords shall be Lucent Technologies MS2SC-SC-XX, and shall meet the following technical specifications:
1) Number of fibers 2
2) Approximate Loss, mean, variance 0.1dB, 0.7dB

C. Insulating Tape:
1. General purpose insulating tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application in an ambient of -18°C
c. (0°F).
d. Operating range up to 105°C (220°F).
e. Flame retardant, hot- and cold- weather resistant, UV resistant.
f. For use as a primary insulation for wire cable splices up to 600 VAC.
g. Meeting and complying with:
1) ASTM D-3005 Type I
2) UL 510

3) CSA C22.2

h. Manufactured by the following or equal:

1) 3M – Scotch Number Super 33+.

2. General-purpose color-coding tape:

a. Minimum 7 mil vinyl tape.

b. Suitable for application on PVC and polyethylene jacketed cables.

c. For use indoors and outdoors in weather protected enclosures.

d. Available with the following colors;

1) Red.
2) Yellow.
3) Blue.
4) Brown.
5) Gray.
6) White.
7) Green.
8) Orange.
9) Violet.

e. For use as phase identification, marking, insulating, and harnessing.

f. Meeting and complying with:

1) UL 510.
2) CSA C22.2

g. Manufactured by the following or equal:

1) 3M – Scotch Number 35.

3. Fire and Electric Arc Proofing tape:

a. Minimum 30-mil, flexible, elastomer tape that expands in fire to form an insulating firewall between flame and cable.

b. Bind in place with glass cloth electrical tape.

c. Manufactured by the following or equal:

1) 3M – Scotch Number 77.

4. Glass cloth electrical tape:

a. 7.4-mil thermosetting silicone adhesive that performs at Class H temperatures 180°C (356°F).

b. Use for the following applications:

1) To secure no-PSA insulations such as glass in high-temperature areas.
2) Splice wire rated at 180°C (356°F).
3) For binding Fire and Electric Arc Proofing Tape.

c. Meeting and complying with:

1) MIL-I-1966C.
2) UL Recognized Component listing for 200°C (392°F) (Guide OANZ2, File E17385).
3) CSA Accepted Component 180°C (356°F) File LR93411.

d. Manufactured by the following or equal.

1) 3M – Scotch Number 69.

5. Self-fusing Silicone Rubber Tape:

a. 12-mil, high-temperature, track resistant, insulating tape.

b. Composed of fully cured inorganic silicone rubber.

c. Use as a protective overwrap for terminating medium voltage cables.

d. Manufactured by the following or equal:

1) 3M – Scotch Number 70.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Load connections:
   1. Connect loads to the circuits as indicated. Color-code all branch circuits as per Section 26 05 53 "Electrical Identification."

B. Zero to 600-volt systems:
   1. Make all connections with the proper tool and die as specified by the device manufacturer.
   2. Use only tooling and dies manufactured by the device manufacturer.
   3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
   4. Number all power and control wires before termination.

C. Motor connections (600 Volts and below):
   1. Terminate wires with compression type ring lugs at motors.
   2. Connection at both the motor leads and the machine wires are to have ring type compression lugs.
   3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
      a. In damp and wet locations use a complete kit containing mastic that shall seal out moisture and contamination.
      b. Shrink cap with low heat as recommended by manufacturer.
   4. Wire markers shall be readable after boot installation.
   5. Manufactured by one of the following or equal:
      a. Raychem MCK.

END OF SECTION

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SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. General: The Contractor shall provide electric motors, accessories, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section apply to electric motors 250 hp and less.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Bearing Manufacturers Association (ABMA):
   1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 43 – Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   2. IEEE 112 – Standard Test procedure for Polyphase Induction Motors and Generators.
   3. IEEE 114 – Standard Test procedure for Single-Phase Induction Motors.
   4. IEEE 303 – Recommended Practice for Auxiliary Devices for Motors in Class 1, Groups A, B, C, and D, Division 2 Locations.
   5. IEEE 841 – Standard for Petroleum and Chemical Industry – Severe Duty totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – up to and including 500hp.
   6. IEEE 1349 – Guide for the Application of Electric Motors in Class I, Division 2 Hazardous (Classified) Locations.

C. National Electrical Manufacturers' Association (NEMA):
   1. MG-1 – Motors and Generators.
   2. MG-1 – Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators.

D. Underwriters Laboratories Inc. (UL):
   1. UL 674 – Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.

1.3 CONTRACTOR SUBMITTALS

A. Complete motor data shall be submitted with the driven machinery shop drawings. Motor data shall include:
   1. Machine name and specification number of driven machine.
   2. Motor manufacturer.
   3. Motor type or model and dimension drawing. Include motor weight.
   4. Nominal horsepower.
   5. NEMA design.

6. Enclosure.
7. Frame size.
8. Winding insulation class and temperature rise class.
9. Voltage, phase and frequency ratings.
10. Service factor.
11. Full load current at rated horsepower for application voltage.
12. Full load speed.
13. Guaranteed minimum full load efficiency. Also provide nominal efficiencies at 1/2 and 3/4 load.
14. Type of thermal protection or overtemperature protection, if included.
15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable.
16. Bearing data. Include recommended lubricants for relubricatable type bearings.
17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery.
18. Power factor at 1/2, 3/4 and full load.
19. Recommended size for power factor correction capacitors to improve power factor to 0.95 (lagging) when operated at full load.

B. If water cooling is required for motor thrust bearings, the shop drawing submittals shall indicate this requirement.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of providing full motor load, under the following conditions unless otherwise indicated:
1. See section 26 05 00 of the specifications for the project conditions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling of motors shall be in accordance with manufacturer's recommendations. Preferred storage is indoors in clean, dry space with uniform temperature to prevent condensation. Protect motors from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 QUALITY ASSURANCE

A. All motors shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:
1. Emerson, US Motors.
2. General Electric.
3. Reliance.
4. Toshiba.
5. Or Equal.

2.2 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall in all cases be equal to nameplate horsepower rating or less, exclusive of service factor and as verified with the approved submittal data of the driven machinery.

1. Minimum Motor Horsepower: All motors shall be sized to carry continuously all loads which may be imposed through their full range of operation. The motor horsepower shall be not less than the estimated minimum specified for each driven machine. If the estimated minimum horsepower specified is not adequate to satisfy the foregoing restrictions or any other requirements of these Specifications, the motor with the required horsepower shall be supplied at no additional cost to the Owner. In addition, any changes caused by increase in motor horsepower shall be made by the Contractor at no additional cost to the Owner; such changes may involve circuit breakers, magnetic starters, motor feeder conductors, conduit sizes, etc.
2. Exempt Motors: Motors which are for 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, part of domestic or commercial use apparatus may be excepted from these Specifications to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.3 DESIGN REQUIREMENTS

A. General: All electric motors shall comply with ANSI/NEMA MG 1 - Motor and Generator.

B. NEMA Design: Electric motors shall be NEMA Design B, (except as indicated in Equipment Specifications for motors controlled for variable speed operation and other special motors,) constant speed squirrel-cage induction motors having normal starting torque with low starting current. In no case shall starting torque or breakdown torque be less than the value in ANSI/NEMA MG 1. Motors shall be suitable for the starting method indicated on the Electrical Drawings.

C. Motor Voltage Ratings: Motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

1. Voltage:
   a. All motors ½ hp and larger shall be 460V, 3 phase unless otherwise indicated on the Drawings.
   b. dual voltage motors rated 230/460V, 3 phase are acceptable provided all leads are brought to the conduit box.
2. Motors driving identical machines shall be identical.
3. All motors 1 hp and larger shall be “Premium Efficiency” motors as defined in NEMA MG-1.
4. Horsepower as indicated on the Drawings:
   a. Horsepower ratings shown on the drawings are based on Vendor’s estimates. Provide motors sized for the load of the actual equipment furnished.
5. Service Factor:
   a. Provide motors rated at 1.15 Service Factor.

b. Provide motors capable of operating continuously at 1.15 Service Factor at project altitude.
    1) Without exceeding Class B temperature rise limits where motors are provided with Class F insulation.
    2) Without exceeding Class F temperature rise limits where motors are provided with Class H insulation.

6. Torque:
    a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
    b. When started using reduced voltage starters:
        1) Provide motors that develop sufficient torque for acceleration to full speed.
    c. NEMA Design B except where driven load characteristics require other than normal starting torque.
        1) In No case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
7. Enclosures:
    a. As indicated in the individual equipment Specifications or as specified in this section.
    b. Totally Enclosed Fan Cooled::
        1) Cast iron conduit box.
        2) Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for frames 324T and larger.
    c. Explosion-Proof:
        1) Tapped drain holes with corrosion resistant plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger.
    d. Lifting Devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
8. Manufactured with cast iron frames in accordance with NEMA MG-1.
9. Nameplates:
    a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
        1) NEMA Standard motor data.
        2) Bearing description and lubrication instructions.
10. Hardware:
    a. Type 316 stainless steel.
11. Conduit Boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
        1) Frames and conduit boxes.
        2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90 degree increments.
    e. Exceeding the dimensions defined in NEMA MG-1.
    f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor Bearings:
    a. Antifriction.

b. Regreasable and initially filled with grease.
c. Pumps Motor in excess of 100 HP shall have oil lubricated bearings.
d. Bearings and lubrication suitable for ambient temperature and temperature rise.
e. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
f. Fit bearings with easily accessible grease/oil supply, flush, drain, and relief fittings using extension tubes where necessary.
g. Where specified in the equipment specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.

13. Insulation Systems:
    a. Motors Installed in Ambient Temperatures of 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius and at the altitude where the motor will be installed.
    b. Motors Installed in Ambient Temperatures between 40 degrees Celsius and 65 degrees Celsius:
        1) Provide Class H insulation.
        2) Design temperature rise consistent with Class F insulation.
        3) Rated to operate at an ambient temperature of 65 degrees Celsius and at the altitude where the motor will be installed.
14. Motor Leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
    a. Maximum operating noise level of 85dB measured per IEEE 85.

D. Submersible Motors:
1. Enclosures:
    a. Totally Enclosed Non-Ventilated (TENV) watertight casing.
    b. Smooth outer surface. Cooling fins may clog with solids and are not acceptable.
    c. Inner and outer shaft seals separated by an oil chamber.
2. Cooling:
    a. Suitable continuous operation in totally, partially, or nonsubmerged condition without overheating.
    b. Convection cooling only.
    c. Water jackets and oil cooling are not acceptable.
3. Electrical Cables:
    a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
    b. Epoxy encapsulated cable entry into terminal box.
4. Insulation:
    a. Sealed moisture resistant windings.
5. Motor Protection:
    a. Provide temperature detection in motor windings.
    b. Provide moisture detection in motor housing.

c. Provide associated electronics and relaying in a separate enclosure to be mounted remotely.

E. Vertical Motors:
1. Enclosures:
a. Weather protected Type II (WPII) where installed outdoors.
b. Weather protected Type I (WPII) where installed indoors.
2. Thrust Bearings:
a. Selected for combined rotor and driven equipment loads.
b. Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.

F. Variable Frequency Drive Motors
1. Compatible with the variable frequency drives specified.
2. Inverter duty rated and labeled.
3. Meet the requirements of NEMA MG-1 Part 31.
4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
6. Service factor of 1.0 when driven by VFD.

G. Motors Installed in Corrosive Environments:
1. Nameplate indicating conformance to IEEE 841.
2. Stator double dipped in varnish and baked.
3. Stator and rotor coated with corrosion resistant epoxy.
4. Frame, brackets, fan guard and conduit box coated with minimum of two coats of epoxy paint.
5. Withstand salt spray tests per ASTM B-117.
6. Suitable for hose down areas.

H. Single Phase Motors:
1. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or as indicated on the Drawings.
2. Totally enclosed, fan cooled motors manufactured in accordance with NEMA MG-1.
3. Ball Bearings: Sealed.
4. ½ Horsepower or Less Fan Motors:
a. Split-phase or shaded pole type when standard for the equipment.
b. Open type when suitably protected from moisture, dripping water, and lint accumulation.
5. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the Engineer.
6. Integral overload protection.

2.4 ACCESSORIES

A. Space Heaters:
1. Provide all 3 phase motors with belted or cartridge space heaters mounted within the motor enclosure.

2. Space heater rating shall be 120 volts, single-phase, unless otherwise shown.
3. Power leads for heaters wired into conduit box.
4. Installed within motor enclosure adjacent to core iron.

B. Winding Temperature Detectors:
1. Provide temperature switches with normally closed contacts or resistance temperature detectors, 2 per each phase, as indicated on the Drawings.

C. Bearing Temperature Detectors:
1. Where required by the driven equipment specification or as indicated on the Drawings.
2. RTD type and wiring matches the winding RTDs.

D. Vibration Detectors:
1. Where required by the driven equipment specification.
2. In accordance with the driven equipment specification.

2.5 SOURCE QUALITY CONTROL

A. Factory Testing
1. Perform factory tests in accordance with:
   a. IEEE 112 for three phase motors.
   b. IEEE 114 single phase motors.
2. Furnish copies of test reports.
3. Include testing of:
   a. No load current.
   b. Locked rotor current.
   c. Winding resistance.
   d. High potential.
4. Tests required on motors 250 hp and larger:
   a. Manufacturer's routine test (use polarization index voltage = 5000V for insulation resistance tests).
   b. Efficiency and power factor versus load test performed at rated speed and 50 percent, 75 percent, 90 percent, and 100 percent of rated load. The curves from the motor tests shall be submitted for information.
   c. The maximum allowable residual unbalance in each correction plane (journal) shall be calculated using the following equation:
      1) U = 4 W/N
      2) Where:
      3) U = residual correction plane unbalance, in ounces-inches
      4) W = static correction plane journal loading, in pounds
      5) N = maximum specified operating speed, in revolutions per minute

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors in accordance with manufacturer's instructions.

B. Electrical work involving connections, controls, switches, disconnects, etc., shall be performed as provided in the applicable sections of Division 26.

3.2 FIELD QUALITY CONTROL

A. Before start-up perform insulation resistance test on each motor furnished or installed on this project.
   1. Windings energized to 1000 volts D.C. for one minute.
   2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
   3. Inform the Engineer of any unusual or unacceptable test results.

3.3 VISUAL AND MECHANICAL INSPECTION FOR MOTORS AND THEIR ROTATING MACHINERY:

A. Compare equipment nameplate information with the Drawings and Specifications.

B. Inspect physical and mechanical condition.

C. Inspect for proper anchorage, alignment, and grounding.

D. Inspect air baffles, filter media, cooling fans, slip rings, brushes and brush rigging.

E. Inspected bolted electrical connections for high resistance by one of the following:
   1. Use of low resistance ohmmeter.
   2. Calibrated torque wrench.
   3. Thermographic survey.

F. Verify correct application of appropriate lubrication and lubrication systems.

G. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

H. Special tests as suggested by manufacturer, such as gap spacing and pedestal alignment shall be made where applicable.

3.4 ELECTRICAL TESTS:

A. Perform resistance measurements through bolted connections with a low resistance ohmmeter.

B. Perform insulation resistance test in accordance with ANSI/IEEE43. Test voltage shall be as specified by the manufacturer:
   1. On motors 200 HP and smaller, test duration shall be one minute. Calculate dielectric absorption ratio using resistance measurements at 20 seconds and 60 seconds.
   2. On motors larger than 200 HP, test duration shall be 10 minutes. Calculate polarization index using resistance measurements at one minute and 10 minutes.
      a. Perform stator resistance test phase-to-phase.
      b. Perform insulation power-factor or dissipation-factor tests.
      c. Perform surge comparison tests.
      d. Verify operation of motor space heater.

e. Perform a rotation test to ensure correct shaft direction.
f. Measure no load and full load running current and compare to nameplate.
g. Observe proper operation and sequence of any reduced voltage starters.
h. Perform vibration base line test. Amplitude to be plotted vs. frequency.
i. Check all protective devices in accordance with other sections of these specifications.
j. After start-up of each motor, the current on each phase shall be measured:
    1) At no load.
    2) At defined load:
    3) Record the voltage of each phase to round during this test.
    4) Inrush current.

C. Measurements shall be recorded and submitted to the Engineer.

3.5 TEST VALUES:

A. Insulation resistance should be not less than 10 megohms.

B. Dielectric absorption ratio or polarization index readings less than the manufacturer's recommended values (not less than three for polarization index or 1.4 for dielectric absorption ratio) shall be investigated.

C. Motor measured full load current shall not exceed nameplate value.

D. Vibration amplitudes shall not exceed values furnished by manufacturer.

END OF SECTION

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MOTOR DATA SHEET

MOTOR NUMBER: _____ MOTOR/EQUIPMENT NAME _____

SPECIFICATION NUMBER OF DRIVEN MACHINE _____

MOTOR NAMEPLATE DATA

MANUFACTURER _____ MODEL/SERIES _____ MODEL NO. _____

FRAME		ENCLOSURE		NEMA DESIGN	
HP		SERVICE FACTOR		RPM	
INSULATION CLASS		VOLTS		FULL LOAD AMPS	
AMBIENT TEMP		PHASE		NO LOAD AMPS	
DESIGN TEMP RISE		HERTZ		LOCK ROTOR AMPS	
				INRUSH CODE LETTER	

	100 PERCENT LOAD	75 PERCENT LOAD	50 PERCENT LOAD
GUARANTEED MIN EFFICIENCIES			
GUARANTEED MIN POWER FACTOR			

MAX SIZE OF POWER FACTOR CORRECTION CAPACITOR _____ KVAR

ACCESSORIES

MOTOR WINDING HEATER _____ VOLTS _____ WATTS

WINDING THERMAL PROTECTION _____

WINDING TEMP SWITCHES (YES/NO) _____

RTD TYPE _____ QUALITY PER PHASE _____ # OF WIRES _____

NOMINAL RESISTANCE _____ NOMINAL TEMP _____ COEFFICIENT _____

RECOMMENDED ALARM _____ DEGREES C _____ RECOMMENDED TRIP _____ DEGREES C

SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO) _____ PART WINDING (YES/NO) _____ WYE-DELTA (YES/NO) _____

2 SPEED, 1 WINDING (YES/NO) _____ 2 SPEED, 2 WINDING (YES/NO) _____

AREA CLASSIFICATIONS

CLASS _____ DIVISION _____ GROUP _____ TEMP CODE _____

* Conforms to NEMA MG-1 Part 31.

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DIVISION 31
EARTHWORK

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SECTION 31 10 00
SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes all those measures required during the initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process: clearing, grubbing and stripping; and regrading of areas to receive embankment fill.

B. Protect and preserve all things designated to remain. Where operation causes damage or injury to trees and plants designated to remain, employ an arborist or other qualified professional shall be employed, at no additional cost to the Owner, to repair the damage or provide adequate replacement to the Owner's satisfaction where damage is beyond repair.

1.2 SITE INSPECTION

A. Prior to moving onto the Project site, inspect the site conditions and review maps of the existing plant site and off-site pipeline routes and facilities delineating the Owner's property and right-of-way lines.

B. Submit photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site preparation.

C. Identify and accurately locate utilities and other subsurface structural, electrical, and mechanical conditions. Incorporate existing conditions into the record drawings for the project.

1.3 DEFINITIONS

A. The following definitions apply to the Work of this Section:
   1. Clearing is defined as cutting trees, removing fences and posts, and removing curbs and other improvements to prepare the site for grubbing and stripping.
   2. Grubbing is defined as the below grade part of clearing to remove roots, small piping, irrigation systems, etc., to prepare the site for stripping.
   3. Stripping is defined as removing a surface layer of soil and organic material, sod, topsoil, and other unsuitable material as defined in Section 31 23 00 – Earthwork, to a depth that earthwork can proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Prevent existing site improvements that are marked to remain from being damaged during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
   2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
   3. Repairs of cut faces of roots more than 1-1/2 inches in diameter shall be coordinated with a qualified arborist, licensed in jurisdiction where project is located.
   4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Engineer.
   1. Employ a qualified arborist, licensed in jurisdiction where project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
   2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities upon request.
2. Arrange to shut off indicated utilities with utility companies.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Owner/Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner/Engineer's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.4 PRIMARY SITE ACCESS

A. Develop any necessary access to the site, including barrier facilities to be installed at the beginning of construction in order to prohibit entry of unauthorized persons.

B. Utility Interference: Where existing utilities interfere with the Work of this Section, notify the Owner/Engineer and work around the interferences until a directive is issued.

3.5 CLEARING, GRUBBING, AND STRIPPING

A. Clear all construction areas of grass and weeds to at least a depth of six inches and ensure they are cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Incorporate loose boulders within 10 feet of the top of cut lines in landscaping or remove them from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.

B. Within the limits of clearing, grub the areas below the natural ground surface to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Totally remove debris or waste if they are found on the site. Remove all objectionable material from the clearing and grubbing process from the site and waste in approved safe locations in compliance with state and federal regulations.

C. Remove and place the area to be affected by construction that has not been pre-excavated to the subgrade elevation in the designated stockpile areas, and/or incorporate it into landscaped areas or other nonstructural embankments.

D. For all areas that have not been previously disturbed, including staging areas and temporary construction easements, immediately follow clearing operations with topsoil-salvaging operations. Strip the area of topsoil to a depth of 8 inches. Do not consider unsuitable materials, specified in Section 31 23 00 - Earthwork, as topsoil. Strip to the depth indicated regardless of the material encountered. Stockpile all stripped topsoil within stripped areas in stockpiles not to exceed 15 feet in height. Grind or chip vegetation to a mulching consistency and mix with the stripped soil. Place stockpiles away from high-construction traffic areas, fenced and signed, to prevent accidental use as fill prior to topsoil replacement.

E. Upon completion of Work within the construction areas stripped of topsoil, respread the stored topsoil over the disturbed areas. Spread topsoil in about a 6-inch layer. Ensure that respread topsoil matches the existing terrain as much as possible. Chain drag interfaces between restored disturbed areas and undisturbed areas to eliminate obvious edges. Chain drag or hand rake all tracks and equipment marks away. Thoroughly water replaced topsoil for dust control upon completion of the respreading operations. Once topsoil replacement has been completed, do not allow vehicles or other motorized equipment to travel on the finished surface.

F. Unless otherwise indicated, do not remove native trees larger than three inches in diameter at the base without the Engineer's approval. If not necessary for the choice of means and methods, arrange and conduct the removal and replacement of any trees, shrubs, fences, or other improvements outside of rights-of-way with the property owner at no increased cost to the Owner.

G. Except in areas to be excavated, backfill holes resulting from Work of this section with suitable material in accordance with Section 31 23 00 – Earthwork.

3.6 SITE IMPROVEMENTS

A. Remove and properly dispose of existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincides with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner’s property.

END OF SECTION

SECTION 31 23 00
EARTHWORK

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. Perform all earthwork indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

29 CFR 1926	OSHA Safety and Health Regulations for Construction
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3)
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2901	Test Method for Cement Content of Freshly Mixed Soil Cement
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods
ASTM D 4253	Test Methods for Maximum Index Density of Soils using a Vibratory Table
ASTM D 4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4832	Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

ASTM D 5971	Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM)
ASTM D 6023	Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
ASTM D 6024	Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
ASTM D 6103	Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 SUBMITTALS

A. Attention is directed to the provisions of Subpart P, 29 CFR 1926 of the OSHA Safety and Health Standards for Construction, which relate to protection of employees in excavations. Submit for information to the Engineer, the project excavation plan and the name of the competent person, prior to commencing any excavation.

B. Submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01 33 20 – Submittal Procedures. Sample sizes shall be as determined by the testing laboratory.

C. Submit dewatering and water removal plan prior to performing any dewatering or water removal.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General: Fill, backfill, and embankment materials shall be suitable material.

B. Suitable Materials: Suitable material as defined in this specification and as selected or processed clean, well graded earth material, sands and gravels free of excessive fines, less than 20 percent rock and boulders larger than 4 inches, grass, roots, brush, vegetation, or other deleterious materials. Rocks or boulders within the pipe zone shall be screened and removed to match the maximum material particle allowed by the specification.

C. Fill and backfill materials within 6 inches of any structure or pipe shall be smaller than 1 inch in any dimension.

D. Suitable materials may be obtained from onsite excavations, may be processed onsite materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the Project, provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. Stockpile and segregate onsite materials prior to use.

E. The following types of suitable materials are defined:

1. Type A (Granular Backfill): Crushed rock or gravel, and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
No. 40	15 - 60
No. 200	0 - 15

2. Type B (Crushed Rock): Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/8-inch	100
No. 4	30 - 50
No. 200	0 - 5

3. Type C (Sand Backfill): Sand non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	80 - 100
No. 10	30-50
No. 40	10-30
No. 200	7 - 15

Squeegee is not acceptable as sand backfill.

4. Type D (Select Backfill): Suitable material that can be readily compacted and meets the requirements of AASHTO M 145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2 inches.

Sieve Size	Percentage Passing
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	5 - 15

5. Type E (Pea Gravel Backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a No. 4 sieve.

6. Type F (Drainrock): Crushed rock or gravel conforming to one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing		
Sieve Size	3-inch Max.	2-inch Max.	3/4-inch Max.
3-inch	100	-	-
2-inch	90 - 100	100	-
1-1/2 inch	70 - 100	90 – 100	-
¾-inch	0 - 50	0 – 15	100

1/2-inch	-	-	95 - 100
3/8-inch	0 - 10	0 - 5	70 - 100
No. 4	0 - 25	-	-
No. 8	0 - 5	-	-
No. 200	0 - 3	-	0 - 3

7. Type G (Type II Aggregate Base): Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, or crushed gravel, free of organic matter and contamination from chemical or petroleum products meeting State specification requirements and conforming to the following Table and gradations:

Aggregate Properties			
	Aggregate Class		
	A	**B**	
Dry Rodded Unit Weight	Not less than 75 lb/ft^3		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI ≤ 6	AASHTO T 89 AASHTO T 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table Below		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

Sieve Size	Percentage Passing
1 ½ -inch	100
1-inch	90 - 100
3/4-inch	70 - 85
1/2-inch	65 - 80
3/8-inch	55 - 75
No. 4	40 - 65
No. 16	25 - 40
No. 200	7- 11

8. Type H (Graded Drainrock): Graded drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting and drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
¾-inch	90 - 100
3/8-inch	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. 30	5 - 15
No. 50	0 - 7
No. 200	0 - 3

9. Type I: (Levee Material): Clayey sand to sandy clay obtained from off-site borrow sources or from onsite excavations, processed to the extent required to produce a material with a maximum size of 4 inches, well-graded from coarse to fine, and free from roots, sticks, organic matter, concrete, asphalt and other deleterious material. Levee material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
4-inch	100
No. 4	50 - 70
No. 200	30 - 50

10. Type J (Cement-Treated Backfill): Material which consists of Type F material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.

11. Type K (Topsoil): Stockpiled topsoil material obtained at the site by removing soil to a depth as defined in Section 31 10 00 - Site Preparation. Remove the topsoil after stripping the area of vegetation and debris.

12. Type M (Aggregate Subbase): Crushed rock aggregate subbase material that is non-plastic and can be readily compacted by watering and rolling to form a stable base. The sand equivalent value shall not be less than 18 and shall meet one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing	
Sieve Size	3-inch Max.	2-inch Max.
3-inch	100 -	
2-inch	90 - 100	100
1-1/2 inch	-	95 - 100
1-inch	70 - 90	-
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	2 - 12	2 - 12

13. Type N (trench plug): Low permeable fill material, a nondispersable clay material having a minimum plasticity index of 10.

14. Type O (Controlled Low Strength Material (CLSM)): CLSM shall consist of a mixture of portland cement, aggregate, fly ash, water, and approved admixtures conforming to the following requirements:
    a. Blended Hydraulic Cement: Comply with ASTM C595, Type IL (10) [Select level of sulfate resistance], grey color.
    b. Aggregate: Clean imported sand and gravel or selected material from the excavation, imported material, or a combination thereof as approved by the Engineer. Maximum aggregate size shall be 1 to 3 inches. The soluble sulfate content of aggregate in the mixture shall not exceed 0.3 percent by dry weight.
    c. Water: Potable quality.
    d. Fly Ash: Class C, ASTM C 618 or approved alternate.

e. The minus 200 sieve fraction shall be nonplastic, as defined by ASTM D 4318. By this standard, soil is considered nonplastic if either the liquid or plastic limit cannot be determined, or if the plastic limit is equal to or greater than the liquid limit.

f. Proportion the CLSM to be a flowable, nonsegregating, self-consolidating low shrink slurry. Determine the materials and proportions used to meet the requirements of these Specifications.

g. Note to Specifier: Compressive strength has been modified to match closer to UDOT Flowable Fill strengths. Higher strength CLSM may be specified for welded steel pipe design (100 to 200 psi).

h. The unconfined compressive strength per ASTM D4832:
   1) 7-day minimum strength of 50 psi.
   2) 28-day maximum strength of 150 psi.
   3) Slump to be 5 inches to 10 inches.
   4) Perform trial mixes before construction to demonstrate placing and strength characteristics. Notify Engineer one week before trial mix preparation. Provide both "stiff" and "fluid" mix designs. Where indicated on the Drawings, provide a CLSM wet density that is over 125 lbs/cubic foot to help prevent pipe floatation in areas with high ground water.

i. The temperature of the CLSM discharged into the trench shall be below 90 degrees F.

j. Protect CLSM backfill under concrete structures during curing as specified Section 03 30 00 - Cast-in-Place Concrete.

k. CLSM shall be tested in accordance with ASTM D 4832, ASTM D 5971, ASTM D 6023, and ASTM D6103.

15. Type P: (Suitable Trench Backfill): Suitable 4-inch minus, well graded material that can be readily compacted, with less than 35 percent passing the No. 200 sieve and a plasticity index of 10 or less.

2.2 UNSUITABLE MATERIAL

A. Unsuitable materials include but are not limited to the materials listed below.
   1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.
   2. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use.
   3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, slag, and any material which may be classified as hazardous or toxic according to applicable regulations.
   4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing onsite soils.
   5. Topsoil, except as allowed below.

B. Dispose of all unsuitable excavated material off site unless otherwise approved by the Owner/Engineer.

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. Use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, notify the Engineer immediately. In case of conflict between types of pipe embedment backfills, use the agency-specified backfill material if that material provides a greater degree of support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:
   1. Construct embankment fills with Type P material, as defined herein, or any mixture of Type P and Type D, Type G, or Type M materials.
   2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.
      a. Provide mortar coated pipe, concrete pipe, and uncoated ductile iron pipe with Type A or C material in the pipe zone.
      b. Backfill coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other nonmortar coated pipe with Type C material in the pipe zone.
      c. Backfill plastic pipe and vitrified clay pipe with Type C material in the pipe zone.
      d. Provide trench plugs of Type J, Type N, or Type O material at maximum intervals of 200 feet unless indicated otherwise where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve.
      e. Use Type O material in the pipe zone where shown on plans, specified, or required by the Engineer for special crossings or other locations, or where otherwise approved.
      f. Type E material will not be allowed for backfill within the pipe zone.
   3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type D backfill material.
   4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill.
   5. Trench backfill and final backfill for pipelines under structures shall be Type A, Type B, or Type G, as specified, except where concrete encasement is required by the Contract Documents.
   6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.
   7. Backfill around structures shall be Type P material, or Types D, Type G or Type M materials, or any mixture thereof, except as shown.
   8. Backfill materials beneath structures shall be as follows:
      a. Use Type H material for drainrock materials under hydraulic structures or other water retaining structures with underdrain systems.
      b. Use Type F, Type G, or Type H materials under concrete hydraulic structures or other water retaining structures without underdrain systems.

c. Use Type F material under structures where groundwater must be removed to allow placement of concrete. Place filter type geotextile fabric over the exposed foundation subgrade before placing the Type F material.

d. Use Type F, Type G, or Type H material under all other structures.

9. Use a layer of Type F material with a 6-inch top filter layer of Type E material or filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet when backfilling to replace pipeline trench overexcavation materials.

2.4 PIPELINE MARKING TAPE

A. Metallic Tape: Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be a minimum of 6 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, as indicated. Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D"), Allen (Detectatape), or equal.

B. Plastic Tape: Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalis acids, and chemicals and solvents which are likely in the soil. Tape shall be a minimum of 6 inches wide and lettering shall be 1-inch tall permanent black on a colored background. Tape shall be manufactured by Reef Industries (Terra Tape), Hytech Non-Detectable (Northtown) Allen (Markline), or equal.

C. Warning Tape: Warning tape manufactured for marking and identifying underground utilities continuously inscribed with a description of utility, colored as follows:

1. Red; Electric.
2. Yellow; Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water Systems.
5. Green: Sewer Systems.

2.5 MATERIALS TESTING

A. All soils testing of samples submitted will be done by a testing laboratory of the Owner's choice and at the Owner's expense. At its discretion, the Engineer may request that samples are supplied for testing of any material used in the work.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

E. The testing for chloride, sulfate, resistivity, and pH will be done by a testing laboratory of the Owner's choice and at the Owner's expense.

F. Test results for each material source shall be completed within the past six months prior to use.

PART 3 - EXECUTION

3.1 EXCAVATION – GENERAL

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including rock and all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, strip the entire construction site of all vegetation and debris, and remove such material from the site prior to performing any excavation or placing any fill. Furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Slope or otherwise support excavations in a safe manner in accordance with safety requirements of the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Maximum Length of Open Trench: The maximum length of open trench in urban and rural areas shall not exceed 500-feet at each pipe installation heading beyond the end of the installed pipeline, or the requirements of the agency with jurisdiction, whichever is lesser.

C. Construction Delays: In the case of any construction delay in excess of five calendar days, whether Contractor or Owner caused, backfill the excavation, install temporary paving including temporary traffic markings, and restore traffic to pre-construction condition to minimize disruption to traffic and the community at no additional cost to the Owner.

D. Removal and Exclusion of Water: Remove and exclude water, including storm water, groundwater, irrigation water, and wastewater, from all excavations. Use dewatering wells, well points, sump pumps, or other means to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation work begins at each location. Remove and exclude all water until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. Excavation Beneath Structures and Embankments: Except where otherwise indicated for a particular structure or ordered by the Engineer, carry excavation to the grade of the bottom of the footing or slab. Where indicated or ordered, overexcavate areas beneath structures or fills. Excavate the subgrade areas beneath embankments to remove not less than the top 6 inches of native material. Where such subgrade is sloped, bench the native material. When such overexcavation is indicated, perform both overexcavation and subsequent backfill to the required grade. When such overexcavation is not indicated but is ordered by the Engineer, such overexcavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or overexcavation has been completed, scarify the exposed surface to a depth of 6 inches, bring the surface soils to optimum moisture content, and roll the surface with heavy compaction equipment to obtain 95 percent of maximum density of the native soils.

B. Excavation Beneath Concrete Reservoirs: Extend excavation under reservoirs to the bottom of the drainrock layer. After such excavation has been completed, roll the exposed surface with heavy compaction equipment to 95 percent of maximum density and then grade the subgrade to provide a reasonably smooth surface for placement of the drainrock. Scarify areas under the reservoir upon which fill is to be placed to a depth of 6 inches, bring these soils to optimum moisture content, and compact the soil to obtain 95 percent of maximum density (ASTM D 1557) with moisture content within plus-or-minus 2 percent of the optimum moisture content.

C. Excavation Beneath Paved Areas: Extend excavation under areas to be paved to the bottom of the aggregate base or subbase, if such base is called for; otherwise, extend it to the bottom of the paving thickness. After the required excavation has been completed, scarify the top 12 inches of exposed surface, bring the surface soils to optimum moisture content, and then roll the soils with heavy compaction equipment to obtain 95 percent of maximum density (ASTM D 1557). The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Regrade areas that could accumulate standing water to provide a self-draining subgrade.

D. Notification of Engineer: Notify the Engineer at least 3 days in advance of completion of any structure excavation and allow the Engineer a review period of at least 1 day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise indicated or ordered, excavate open-cut trenches with widths as indicated for pipelines and utilities.

B. Trench Bottom: Except when pipe bedding is required, excavate the bottom of the trench uniformly to the bottom grade of the pipe zone. Excavate for pipe bells and welding as required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. Fully backfill all trenches at the end of each day or, in lieu thereof, protect open trenches in accordance with Section 01 71 50 – Protection of Existing Facilities. Provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Fully enclose open excavations and trenches with temporary fencing panels, and keep these fencing panels in place during all non-working hours.

D. Trench Overexcavation: Where trenches are indicated to be overexcavated, excavate to the depth indicated, and install backfill to the grade of the bottom of the pipe bedding.

E. Overexcavation: When ordered by the Engineer, whether indicated on the Drawings or not, overexcavate trenches beyond the depth and/or width shown. Overexcavate to the dimensions ordered. Then backfill the trench to the grade of the bottom of the pipe bedding. Any overexcavation less than 6 inches below the limits on the Drawings will incur no increase

in cost to the Owner. When the overexcavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made. Said additional payment will be made under separate unit price bid items for overexcavation if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.

F. Where pipelines are to be installed in embankments, fills, or structure backfills, construct the fill to a level at least one foot above the top of the pipe before the trench is excavated.

G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, excavate the trench as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVEREXCAVATION NOT ORDERED OR INDICATED

A. Backfill any overexcavation carried below the grade ordered or indicated to the required grade with the indicated material and compaction. Perform such work at no additional cost to the Owner.

3.5 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, carefully remove, dampen, and stockpile the sod to preserve it for replacement. Excavated material may be placed on the lawn, provided that a drop cloth or other suitable method is employed to protect the lawn from damage. Do not cover the lawn for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, replace and lightly roll the sod in a manner to restore the lawn as near as possible to its original condition. Provide new sod if stockpiled sod has not been replaced within 72 hours.

3.6 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, protect trees from injury during construction operations. Do not cut tree roots over 2 inches in diameter without express permission from the Engineer. Support trees during excavation by any means previously reviewed by the Engineer.

3.7 BACKFILL – GENERAL

A. Do not drop backfill directly upon any structure or pipe so as not to move or deflect the pipeline. Do not place backfill around or upon any structure until the concrete has attained sufficient strength, in accordance with Division 03 specifications, to withstand the loads imposed. Do not place backfill around water retaining structures until structures have been tested. Ensure the structures are full of water while placing backfill against the structure, unless otherwise directed by the Engineer. Do not construct structures on CLSM backfill until the CLSM has obtained a 7-day minimum cure as defined in this specification.

B. Except for drainrock materials being placed in overexcavated areas or trenches, place backfill after all water has been removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, move the shield by lifting the shield free of the trench bottom or backfill before moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, remove all loose sloughing, or caving soil and rock materials from the bottoms and sidewalls of trenches and structure excavations. Prior to placing pipe or any backfill material, remove all materials from the excavation walls and base that are disturbed from their intact condition and that are 4 inches or larger in least dimension or aggregates of soil material thicker than 4 inches. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placing backfill materials. All material within the pipe zone larger than ¾ inches shall be removed prior to placing pipe zone backfill materials.

3.8 PLACING AND SPREADING BACKFILL MATERIALS

A. Place and spread backfill materials evenly in layers. When compacting with mechanical equipment, evenly spread the layers so that the depth of each uncompacted layer (i.e., loose lifts) does not exceed 8 inches of thickness.

B. During spreading, thoroughly mix each layer as necessary to promote uniformity of material in each layer. Manually spread pipe zone backfill materials around the pipe so that the pipe zone backfill will provide uniform bearing and side support when compacted.

C. Where the backfill material moisture content is below the optimum moisture content, add water before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the indicated degree of compaction, dry or mix the material with drier material until the moisture content is satisfactory.

3.9 CLSM PLACEMENT

A. General:
   1. Deliver CLSM in ready mix trucks.
   2. Batch Tickets:
      a. Deliver batch ticket for each load to Engineer.
      b. Batch tickets shall indicate the following:
         1) Design mix.
         2) Batch time.
         3) Water content.
      c. Place CLSM as near to the final position as practical.
      d. Prevent cave-ins and mixing with subgrade or sides of excavation.
      e. Vibrate CLSM to fill all voids.
      f. Sample CLSM daily and submit break test results to Engineer.

B. Place CLSM by tailgate discharge, conveyor belts, pumps, or other appropriate means. Direct CLSM in place by vibrator, shovel, or rod to fill crevices and pockets. Avoid over-consolidation that causes segregation of aggregates.

C. Temperature Limits:
   1. CLSM temperature at placement: 50 degrees F to 90 degrees F.
   2. Air temperature at placement: Above 40 degrees F and rising.
   3. Do not place CLSM against frozen subgrade or other materials having a temperature less than 32 degrees F. CLSM placement shall follow ACI requirements for hot and cold weather placement.

D. Place CLSM continuously against fresh material unless otherwise approved by the Engineer. When new material is approved to be placed against existing CLSM, conform to the following:
   1. Clear the area of all loose and foreign material.
   2. Soak the surface of the existing material a minimum of 1 hour before placement of fresh material but do not create standing water.

E. CLSM Placement for Piping:
   1. Place pipe on soil pads.
   2. Place bedding under the pipe from one side and vibrate as necessary, so that the CLSM flows to the opposite side.
   3. Add CLSM to both sides of the pipe and vibrate until it fills the space between the pipe and the excavated trench bottom. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1.5 feet above the pipe bottom, but not uplifting the pipe. Adjust water in mixture to maintain fluid consistency but maintain strength requirements.
   4. Deposit CLSM in such a manner as to avoid uplift. Deposit in final position to avoid disturbing the pipe trench or causing foreign material to mix with the cement slurry.
   5. Do not place pipe zone backfill until the CLSM has reached initial set.
   6. Pipes placed on steep slopes may require a stiffer mix to prevent CLSM from flowing down the trench.
   7. Vibrate as necessary to ensure that the CLSM fills all voids.
   8. Remove and repair any damage to the pipeline system caused by movement of the pipe in full conformance with these Contract Documents at no additional cost to the Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

F. Maintain flowable fill damp for a minimum of 7 days or until final backfill is placed, whichever is greater.

3.10 COMPACTION OF EARTH FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Mechanically compact to the indicated percentage of density each layer of Types A, B, C, G, H, I, K, M, N, and P backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve. Use equipment that is consistently capable of achieving the required degree of compaction, and compact each layer over its entire area while the material is at the required moisture content.

B. Compact each layer of Type E and J backfill materials by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, use vibratory compaction at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.

C. Deposit fill on reservoir and structure roofs at least 30 days after the concrete roof slab has been placed. Do not use equipment weighing more than 10,000 pounds when loaded (or as indicated by Engineer) on a roof. When compacting fill on a roof, use a roller weighing not more than 8,000 pounds.

D. Use vibratory compactors to compact pipe zone backfill materials that are granular.

E. Do not use equipment weighing more than 10,000 pounds when adjacent to structure walls closer than a horizontal distance equal to the depth of the fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

F. Compact mechanically compacted backfill around and over pipelines using light, hand operated, vibratory compactors and rollers. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

G. Compaction Requirements: The following compaction test requirements shall be in accordance with ASTM D 1557, method C. Obtain compaction with the moisture content within plus or minus 2 percent of the optimum moisture content. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe embedment backfill for flexible pipe	90
Pipe bedding and overexcavated zones under bedding for flexible pipe, including trench plugs	90
Pipe embedment backfill for steel yard piping	90
Pipe embedment backfill for rigid pipe	90
Pipe zone backfill portion above embedment for rigid pipe	90
Pipe bedding and overexcavated zones under bedding for rigid pipe	90
Final backfill, beneath paved areas or structures	95
Final backfill, not beneath paved areas or structures	90
Final backfill, not beneath paved areas or structures	85
Trench zone backfill, beneath paved areas and structures, including trench plugs	95

Trench zone backfill, not beneath paved areas or structures, including trench plugs	90
Embankments and fills	90
Embankments and fills beneath paved areas or structures	95
Backfill beneath structures and hydraulic structures	95
Backfill and fill around structures on reservoir or structure roof	90
Topsoil (Type K material)	80
Aggregate base or subbase (Type G or M materials)	95

3.11 COLD WEATHER REQUIREMENTS FOR FILL AND BACKFILL

A. Unless accepted otherwise in Cold Weather Construction Plan, earthwork below 32 degrees F shall comply with the following:
   1. No frozen material is allowed in any fill.
   2. Do not place CLSM, concrete, or any fill of backfill material if excavation or subgrade contains frozen moisture (snow, ice, sleet), frozen earthen materials, or earthen materials which have been deposited in the excavation due to freezing, thawing, precipitation, or other inappropriate means.

B. Material excavated during inclement weather or below 32 degrees F shall not be used as fill or backfill until the material drains and dries sufficiently for proper compaction.

C. Cold Weather CLSM Placement and Curing:
   1. Do not place CLSM if ambient temperatures, pipe, or trench perimeter soils are below 40 degrees F unless conforming to cold weather placing and curing plan.
   2. Submit CLSM cold weather placing and curing plan detailing materials, insulation, equipment and means to place and cure CLSM at temperatures below 40 degrees F. CLSM placed or cured outside CLSM cold weather placement and curing limitations is subject to rejection, removal, and replacement.
   3. If CLSM is curing and ambient temperatures drop below 40 degrees F, measure (with a thermometer in CLSM or in soil just beside CLSM) during coldest time of 24-hour day (for example, 7:00 a.m.), the minimum curing temperature. Submit daily minimum curing temperatures each day if ambient temperatures are below 40 degrees F.
   4. Adjust cold weather curing plan and methods, as needed, and provide all insulation, materials, heating, and means to keep CLSM above 50 degrees F for at least 7 days after placement.

3.12 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone
   1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe. The bedding is defined as that portion of

pipe zone backfill material between the bottom of the trench and the bottom of the pipe. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 6 inches above the top surface of the pipe.

2. After compacting the bedding, perform a final trim using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavate for pipe bells and welding as required.
3. Backfill the pipe zone with the indicated backfill material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
4. If a moveable trench shield is used during backfill operations, lift the shield to a location above each layer of backfill material prior to compacting the layer. Do not displace the pipe or backfill while the shield is being moved.

B. Trench Zone: After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

C. Marking Tape Installation
1. Continuously install metallic marking tape along the pipe at a depth of 3 feet below finish grade, or as shown on the typical trench detail.
2. Continuously install plastic marking tape along the pipe at the elevation indicated on the Drawings.

D. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.13 FILL AND EMBANKMENT CONSTRUCTION

A. Clear all vegetation, roots and foreign material from the area where a fill or embankment is to be constructed. Following this, scarify the surface to a depth of 6 inches, moisture condition the surface, and roll or otherwise mechanically compact the surface to the required percentage of maximum density. Place and spread embankment and fill materials evenly in horizontal layers. Moisten and aerate each layer as necessary. Unless otherwise approved by the Engineer, the depth of each uncompacted layer (i.e., loose lifts) shall not exceed 8 inches of thickness. Compact the embankment, fill, and the scarified layer of underlying ground to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. When constructing an embankment or fill against hillsides or fill slopes steeper than 5H:1V, horizontally bench the slopes of hillsides or fills to key the embankment or fill to the underlying ground. Remove and recompact a minimum of 12 inches normal to the slope of the hillside or fill as the embankment or fill is brought up in layers. Recompact this cut material along with the new material at no additional cost to the Owner. Prepare hillside or fill slopes 5H:1V or flatter in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, construct the first 4 feet of fill over the pipe using light placement and compaction equipment that does not damage the pipe.

D. Stabilize the finished graded surface of the drainrock immediately beneath hydraulic structures to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. Where needed to protect slopes and prevent movement of the drainrock, spray asphalt on the finished drainrock surface in accordance with Section 32 12 16 - A. C. Pavement and Base.

3.14 FIELD TESTING

A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Field density in-place tests will be performed in accordance with ASTM D 1556 or by such other means acceptable to the Engineer.

C. In cases where the test of the fill or backfill show noncompliance with the required density, perform remedies as may be required to ensure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner, paid at no additional cost to the Owner.

D. Provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner's field soils testing operations. Provide trenches and excavations at the locations and to the depths required by the Owner. Provide all work for test trenches and excavations at no additional cost to the Owner.

E. Frequency of Testing
   1. During placement of materials, minimum testing frequency shall be as follows, with a minimum of one test performed per lift each production day:
      a. Earthfill: 100 cubic yards.
      b. Structural Fill: 75 cubic yards.
      c. Untreated Base Course: 75 cubic yards.
      d. Sand: 75 cubic yards.
      e. Other: 100 cubic yards.
   2. CLSM Testing.
      a. Sample and submit strength break data for CLSM at frequency and intervals listed below:
         1) Minimum of four cylinders for each day CLSM is placed. If different mix designs are used, sample and submit minimum of four cylinders for each mix design.
         2) When more than 100 cubic yards of CLSM is placed each day, provide an additional two cylinders for each 100 cubic yards of CLSM.
         3) Store cylinders at project site adjacent to CLSM placed and in same curing conditions and do not move cylinders for 72 hours.

4) For the initial four cylinders collected each day, break two cylinders at 7 days and one at 28 days. Remaining cylinder shall be tested after 90 days to test long-term strength gain.
5) For additional cylinders collected when more than 100 cubic yards of CLSM is placed in one day, test one of the cylinders at 7 days and the other at 28 days.
6) Submit results within a day after each break.

3. Repeat quality control tests that fail to meet specification at no additional cost to the Owner.

END OF SECTION

SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide excavations with ground supports conforming with 29CFR1926, Subpart P-Excavations, OSHA requirements, and the General Conditions.

B. The Contractor shall prepare and follow in his work the following plans for worker and property protection:

1. Plan for trench and structure excavations

2. Plan for supporting trenches and structure excavations

3. Plan for movement monitoring.

C. These plans shall be prepared, signed and properly sealed by a Professional Engineer registered in the State of Utah with suitable license and experience to prepare said plans. Submit such plans to Engineer. No excavation or blasting shall take place until these plans have been prepared, signed, sealed and reviewed by all pertinent members of Contractor's staff.

D. These plans shall address temporary excavations for tank structure, vault structures, pipeline trenches, temporary stockpile slopes, and other temporary excavations and stockpiles.

E. Excavation and support plans shall address the following topics:

1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.

2. Design assumptions and calculations.

3. Methods and sequencing of installing excavation support.

4. Proposed locations of stockpiled excavated material.

5. Minimum lateral distance from the crest of slopes for construction vehicles, stockpiled excavated materials, and other construction loadings

6. Anticipated difficulties and proposed resolutions.

F. Movement monitoring plan shall address the following topics:

1. Survey control

2. Location of monitoring points

3. Plots of data trends

4. Interval between surveys

1.2 SUBMITTALS

A. Submit excavation plans for worker protection in pipe trenches and other excavations. Submittal of excavation plans shall be for records only. Submittals will not be reviewed as they are the sole responsibility of the Contractor and the registered engineer who signs and seals said plans.

1.3 QUALITY ASSURANCE

A. Provide surveys and competent persons to monitor movements of critical facilities and areas of anticipated difficulties.

PART 2 - MATERIALS (NOT USED)

PART 3 - EXECUTION

3.1 EXCAVATION SUPPORT

A. Provide, and maintain shoring, sheeting, and sloping as necessary to support the sides of excavations, to protect workers and other people on the site, and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

B. Take necessary measures to protect excavations and adjacent improvements from running, caving, boiling, settling, or sliding soil resulting from high groundwater table, surcharge, or other problems associated with the soil excavated.

C. Install shoring, sheeting, and sloping for trench and structure excavation progressively with the removal of excavated material. Erect sheeting or lagging to exclude groundwater and prevent fines from migrating into the excavation. In soft, wet ground, drive sheeting to a lower elevation level as excavation progresses so that sheeting is embedded in undisturbed earth. Bracing or sheet piling may be permitted to penetrate structural concrete only as approved in advance by the Engineer.

D. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting, and bracing shall be carefully removed so no voids shall be created and no caving, lateral movement, or flowing of the subsoils shall occur.

E. Withdraw the shoring and sheeting members as the backfill is raised, maintaining sufficient support to protect the work and workers. Remove bracing completely. Where unstable conditions may occur in the underlying strata, and withdrawal of the excavation support system may endanger the work, portions of the sheeting and bracing, including pressure

treated lagging, may be left in place with approval of the Engineer. Remove all wood within a zone extending 5 feet below finished grade.

F. Any damage resulting from improper installation or inadequate maintenance shall be the responsibility of the Contractor.

G. Nothing contained in this specification shall be construed as relieving the Contractor of the full responsibility for providing shoring, bracing, sloping, or other provisions which are adequate for the protection of people and property.

3.2 MOVEMENT MONITORING

A. This sub-section does not limit the Contractor's choice of construction methods based on the site conditions. It establishes minimum requirements for the Contractor to monitor the effects of construction on existing site features and to demonstrate a reasonable preparedness to meet potential contingencies and protect existing site features.

B. Where trenching or excavating are required within 50 feet of existing structures and aqueducts, the Contractor shall implement and maintain monitoring and contingency plans during the open excavation until completion of excavation operations.

C. Prepare a movement monitoring and contingency program for any permanent structure and any buried utilities larger than 12 inches in diameter, all natural gas pipelines, and any additional structures indicated which are within a horizontal distance of 50 feet from any excavation.

D. Perform a photographic survey of all structures that may be affected in the presence of the Engineer. Provide written monitoring and contingency program and site photos to Engineer prior to commencing excavation.

E. Where excavations are required within 50 feet of existing structures, aqueducts, and other pipelines, the Contractor shall implement and maintain monitoring and contingency plans until completion of excavation operations.

F. Establish a horizontal and vertical movement monitoring program and perform all survey and inspections necessary for monitoring existing site features. All surveys shall be performed under the direction of a licensed land surveyor. Set control for movement monitoring in a location that will not be subject to ground movement or construction disturbance.

G. Set at least two survey monuments on each existing structure, a minimum of one survey monument within 10 feet of the excavation in the immediate vicinity of existing buried utilities, and a minimum of one survey target on existing structures, utilities or gas lines. The survey monuments and targets shall be spaced at least 50 feet apart on structures and 100 feet apart for all other conditions, when excavations parallel structures, utilities, or gas pipes.

H. The survey monuments shall consist of permanently installed metal plates scribed with an identification number, elevation and coordinate location. The method of installing survey monuments shall be as approved by the Engineer. The survey monuments shall consist of

permanently scribed elevation and coordinate location securely fastened to the structure. The Engineer shall be notified a minimum of one day prior to setting a survey monument and be given free access to confirm any survey information immediately after the Contractor has set the elevation and location.

I. Perform surveys of each monument at least once during every five vertical feet of excavation or prior to and after each blasting event. Surveys shall be performed more often during excavation if deemed necessary by the Engineer for any reason. Upon completion of the excavation, surveys shall be performed at least once a week, or more often if deemed necessary by the Engineer, until the Engineer determines that there is no risk of significant additional ground movement. If pumping or dewatering of excavations is interrupted or cannot be adequately maintained, the survey monuments shall be checked a minimum of once every 6 hours for as long as the conditions exist or as necessary for the protection of the site and worker's safety.

J. Immediately notify the Engineer of any cumulative change in elevation or location of any monument in excess of 1/4 inch.

K. Maintain the survey data taken on a daily basis for each monument or target in a log. A copy of the log shall be sent to the Engineer on a daily basis.

L. Perform, at a minimum, daily visual inspections of the perimeter of the excavation to identify any signs of excessive settlement or movement. The results from visual inspections shall be recorded with the daily survey log. Any area which appears to be excessively deformed or damaged shall immediately be brought to the attention of the Engineer and be corrected.

END OF SECTION

DIVISION 33
UTILITIES

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SECTION 33 05 07
POLYVINYL CHLORIDE PIPE (AWWA C-900, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install polyvinyl chloride pressure pipe (PVC) and appurtenant work, complete in place, in accordance with Contract Drawings and these Specifications.

B. PVC pipe and fittings shall be new without any defects when delivered to the job site.

1.2 RELATED SECTIONS

A. Section 31 23 00 – Earthwork

B. Section 33 13 00 – Water Pipeline Testing and Disinfection

1.3 DEFINITIONS

A. Gland or Follower Gland: Non-restrained, mechanical joint fitting.

B. Retainer Gland: Mechanically restrained mechanical joint fitting.

1.4 REFERENCE STANDARDS

A. ASTM International (ASTM) standards, most recent editions:

ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM D882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting
ASTM D1922	Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method
ASTM D2584	Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D4976	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

B. American Water Works Association (AWWA) standards, most recent editions:

ANSI/AWWA C104/A21.4	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile Iron Pipe
ANSI/AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings 3-in Through 48-in for Water and Other Liquids
ANSI/AWWA C153/A21.53	Ductile-Iron Compact Fittings
ANSI/AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
ANSI/AWWA C800	Underground Service Line Valves and Fittings
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe 4-in Through 12-in for Water Distribution

C. National Sanitation Foundation (NSF) standards, most recent edition:

NSF 61	Drinking Water System Components, Health Effects

D. Plastic Pipe Institute (PPI) standards, most recent editions.

TR2	PVC Range Composition Listing of Qualified Ingredients
TR3	Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data:
1. Manufacturer's technical data and installation instructions.
2. Manufacturer's data on coatings and linings.
3. Manufacturer's data on metallic locating tape.

C. Shop Drawings
1. Submit shop drawings of pipe and fittings in accordance with the requirements of the referenced standards and the following supplemental requirements, as applicable and as specified herein.
    a. Provide a marking plan with details showing standard pipe section, dimensions, pipe joints, fittings and special fittings, pressure rating, thickness, size, coating, and lining data.

b. Pipeline layout drawings showing the location of each pipe section, each special length, closure sections, location and angle of bends, outlets, location of valves, and other special fittings.

D. Certificates
1. Furnish an affidavit of compliance for all PVC pipe and other products or materials furnished under this Section, as specified in the referenced standards, and the following supplemental requirements:
a. Physical and chemical properties.
b. Hydrostatic Test Reports

E. Quality Control Tests
1. Submit certified inspection reports from the independent agency for witnessed tests within 10 days of the inspection. As a minimum, include the following:
a. Hydrostatic proof test.
b. Sustained pressure test.
c. Bursting strength test
2. Test results must show restrained joints in the sizes specified have been successfully tested to at least twice the specified pressure rating of the joint without leakage or failure.

1.6 QUALITY ASSURANCE

A. Qualifications
1. Manufacturers
a. Finished pipe and fittings shall be the products of a single manufacturer.
1) Change orders, specials, and field changes may be provided by a different manufacturer upon Engineer's approval.
b. Pipe manufacturing operations (pipe, lining, and coatings) shall be performed under the control of the manufacturer.
c. Manufacture PVC pipe in accordance with ANSI/AWWA C900
1) Perform quality control tests and maintain results as outlined within standard and as specified herein to assure compliance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

B. Storage And Handling Requirements
1. Handle and store PVC pipe materials in accordance with the guidelines in ANSI/AWWA C605.
2. Handle the pipe with devices acceptable to Engineer, designed and constructed to prevent damage to the pipe coating/exterior.
3. If possible, store pipe at the Site in unit packages provided by the manufacturer.
4. Avoid compression damage or deformation to bell ends of the pipe.
5. Support pipe uniformly to prevent sagging or bending and accidental rolling.
6. Protect from exposure to direct sunlight by covering it with an opaque material while permitting adequate air circulation above and around the pipe.
7. Store gaskets in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Restrained Joint Connectors:
      a. EBAA Iron Sales, Inc.: Megalug.
      b. Star Pipe Products: Stargrip.
      c. Tyler Union Waterworks: TUFGrip.
      d. Engineer-approved equal.

2.2 EQUIPMENT, PRODUCT TYPES, AND MATERIALS

A. Pipe
   1. Provide pipe in the diameter and pressure class specified or shown, complete with rubber gaskets, and all specials and fittings required in the Contract Documents.
   2. All pipe must be new and recently manufactured. Refurbished pipe will not be accepted.
   3. Manufacture PVC pipe with outside diameter dimension conforming to cast iron pipe (CIOD).
   4. Provide pipe with lay length of 20 feet, except for special fittings or closure pieces and as necessary to comply with the Contract Drawings. Shorter lengths greater than 10 feet long will be permitted when authorized by Engineer.
      a. Provide closures and correction pieces as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Contract Drawings.
      b. Field cut lengths of pipe used as closures may not be shorter than 2 feet long and must be approved by Engineer.
   5. Pipe Design
      a. Design and manufacture PVC pressure pipe in accordance with the requirements of ANSI/AWWA C900.
      b. Pipe must meet the requirements of NSF 61.
      c. Color
         1) White or Blue for pipe used in potable or culinary water systems, or directly attached to potable or culinary water systems.
         2) Purple for pipe used in irrigation, reuse, utility water, or any other non-potable system.
      d. Additives and Fillers
         1) Unless otherwise allowed in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 deg F and for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part A of PPI-TR2 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin).
         2) If requested by Engineer, determine the additive and filler content using the pyrolysis method as specified in ASTM D2584.
   6. Joint Design

a. Joints for buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing a rubber ring joint.
   1) The bell and coupling shall be the same thickness as the pipe barrel, or greater thickness.
   2) The sealing ring groove in the coupling shall be of the same design as the groove in ductile iron fittings and valves available from local distributors.
   3) When the spigot end of pipe is to be inserted into a mechanical joint fitting, remove the beveled end of the pipe prior to insertion.
   4) Solvent-weld joints are not permitted.

b. Seal joints with an elastomeric gasket meeting the requirements of ASTM F477 and ASTM D3139.
   1) Gaskets and lubricants shall be made from materials that are compatible with the plastic material and with each other when used together. They shall not support the growth of bacteria and shall not adversely affect the potable qualities of the water that is to be transported.
   2) Furnish one elastomeric gasket with each length of bell-end pipe.

c. Restrained Joint
   1) Permanent (primary) restraint for all buried PVC pipe fittings must be accomplished using concrete thrust blocks. Temporary (secondary) fitting restraint for testing of pipelines can be accomplished using mechanical thrust restraint. Temporary fitting restraint shall be in addition to permanent restraint.
   2) Mechanical Wedge Action Type Joint
      a) Use only where prior to purchase and installation, the type and application of this joint has been approved by Engineer.
      b) Restraint devices for nominal pipe sizes 3 inch through 36 inch, consisting of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.
      c) The devices shall have a working pressure rating that includes a minimum safety factor of 2:1 for all sizes.
      d) Not allowed for pipe diameters greater than 36 inches.

d. Joint Deflection
   1) Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer.
   2) No deflection of the joint will be allowed for joints which are over-belled or not belled to the stop mark.

B. Fittings
   1. Ductile Iron
      a. Provide ductile iron fittings meeting the requirements of ANSI/AWWA C110/A21.10 and/or ANSI/AWWA C153/A21.53.
      b. Wrap fittings in polyethylene encasement per ANSI/AWWA C105/A21.5.
         1) Virgin polyethylene raw material conforming to ASTM D4976.
         2) Elongation: 800 percent minimum, in machine and transverse directions per ASTM D882.
         3) Tensile Strength: 3,600 psi minimum.
         4) Dielectric Strength: 800 V per mil thickness, minimum.

5) Propagation Tear Resistance: 2,550-gram force minimum in machine and transverse directions per ASTM D1922.
6) Film Thickness: Minimum 0.008 in (8 mil) thickness.
7) Number of Film Layers: Two.

c. Coat all hardware with non-oxide grease.
d. Provide ductile-iron fittings with minimum rated working pressure of 250 psi.
e. Cement-mortar line all ductile-iron fittings conforming to the requirements of ANSI/AWWA C104/A21.4.

2. Fabricated PVC
a. Use only where specifically required.
b. Fittings (4-inch through 48-inch) shall conform to the applicable requirements of ANSI/AWWA C900 subject to additional requirements specified herein.
c. Fabricated PVC fittings 14-inch and larger shall include fiberglass reinforcement permanently bonded to the outside surfaces of the fitting.

3. Clearly label all fittings to identify size and pressure class.
4. Restrain all fittings and valves against thrust forces by installing concrete thrust blocks furnished and installed as indicated on the Contract Drawings.

C. Tracer Wire: Provide No. 12 AWG copper wire, PVC jacketed for underground service.

D. Service Saddles
1. Provide bronze bodied saddles with double bronze straps or full circle body clamp double bolted to each side of the saddle on pipe sizes 4 inch through 12 inch.
2. Saddle body shall be manufactured from cast bronze in accordance with ASTM B62 or B584 and ANSI/AWWA C800.
3. The single strap shall have double bolts on each end of the strap to connect it to the bronze saddle. The ears of the strap shall turn inward and rest against the inside of the strap. The gasket shall be Buna N. The saddle shall be threaded with 1-inch or 2-inch iron pipe threads

2.3 SOURCE QUALITY CONTROL

A. Factory Tests
1. General:
a. Complete testing in accordance with applicable ANSI/AWWA standards at no additional expense to Owner.
b. Engineer to have the right to witness all testing conducted by Contractor and manufacturer, provided that Contractor's schedule is not delayed for convenience of engineer.
c. Perform tests on pipe with wall thickness equal to that specified.

B. Preconstruction Testing
1. Owner may, at its own cost, subject additional pipe materials, including lining and coating, to testing by an independent laboratory for compliance with this Specification.
a. Submit the additional selected samples for testing at no additional cost to Owner.

b. Any visible defects or failure to meet the quality standards herein will be grounds for rejecting the entire order.

C. Inspections

1. All pipe materials are subject to inspection at the place of manufacture and in the field, in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.
2. Notify Engineer in writing of the manufacturing starting date, not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
3. During manufacture of the pipe, allow Engineer access to all areas where manufacturing is in process and permit inspections necessary to confirm compliance with the Contract Documents.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform operations of laying, jointing, testing for defects and for leakage in the presence of Engineer, and obtain approval. Material found to have defects will be rejected and must be promptly removed from the Site.

B. Install materials to conform to the requirements of ANSI/AWWA C605, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein.

3.2 EXAMINATION

A. Verify that excavation will allow a minimum pipe cover as shown on the Contract Drawings and described elsewhere in these Specifications. If existing pipelines are less than minimum cover, connect to existing pipeline and angle pipe as necessary to achieve cover requirements.

B. Verify that excavations are to the required alignment, grades, and are dry.

C. Examine pipe and fittings for defects or damage prior to installation. PVC pipe that has been gouged will not be allowed. PVC pipe with minor scratches may be used at the sole discretion of Engineer.

D. Do not install any pipe contaminated with petroleum products (inside or outside).

E. Do not install any pipe that shows evidence of exposure to sunlight, age, surface deterioration, or other physical damage. Decision of Engineer is final as to the acceptability of the pipe to be installed.

F. Verify all pipe, fittings, aggregates, and all other materials delivered to the Site meet the requirements of these Specifications.

G. Field verify existing pipe locations and structures where connections are to be made.

H. Field verify equipment locations and make modifications in piping to properly connect to equipment as necessary, prior to pipe fabrication.

3.3 PREPARATION

A. Trench Grade
   1. Grade bottom of trench by hand to specified line and grade with proper allowance for pipe thickness and pipe base. Grade to form a continuous and uniform bearing and support for pipe between bell holes.
   2. Before laying each section of pipe, check grade and correct irregularities found. Grade may be disturbed for removal of lifting tackle.

B. Bell (joint) Holes:
   1. At each joint, dig bell holes of ample dimensions in bottom of trench, and at sides were necessary, to permit joint to be made properly and to permit easy visual inspection of entire joint.

3.4 INSTALLATION

A. General
   1. Store and handle pipe, fittings, etc., carefully and protect against damage, impact shocks, and free fall. Use pipe handling equipment acceptable to Engineer.
   2. Replace or repair all pipe damaged prior to Substantial Completion to satisfaction of Engineer.
   3. Perform trench excavation and backfill conforming to the requirements of Section 31 23 00 – Earthwork. Excavate sufficiently in advance of pipe laying operations to enable the alignment and profile to be revised to clear existing utilities and to align with existing connection points. Ensure that pipe zone material is compacted and in full contact with the haunches of the pipe and that the pipe is fully supported.
   4. Clean Pipe
      a. Before placement of pipe in the trench, thoroughly clean each pipe or fitting to remove any foreign substance which may have collected thereon and keep clean thereafter. For this purpose, close the openings of pipes and fittings in the trench during any interruption to the Work.
      b. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

B. Laying Pipe
   1. Lay pipe directly on the pipe zone material. No blocking will be permitted.
   2. Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable grade, face bells upgrade at discretion of Engineer.
   3. Use short lengths of pipe in and out of each rigid joint or rigid structure. Replace pipe that does not allow sufficient space for proper installation of jointing material with pipe of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.
   4. Cut pipe by means of saws, power driven abrasive wheels, or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, bevel the end of the pipe using a beveling tool, portable type sander, or abrasive disc.
   5. Install PVC pipe such that the indelible identification strip markings on each pipe section are continuously aligned for the total length of the pipeline being installed. Orient the strip marking upward to the 12 o'clock position (top) of the trench opening.

6. Assemble the pipe joint using the NSF certified lubricant supplied by the manufacturer. Insert the spigot end into the bell or coupling to the proper insertion mark. Check that the elastomeric ring has not left the groove during assembly by passing a feeler gauge around the completed joint.
7. Prevent floating of pipe prior to completion of backfill operation.
8. When using movable trench shield, prevent pipe joints from pulling apart when moving shield ahead.
9. Do not allow foreign material to enter pipe while it is being placed in trench.
10. Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from Site.

C. Unforeseen Obstructions
1. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, Engineer may change the alignment and/or the grades. Make all such changes by the deflection of joints, or by using additional fittings. However, in no case shall the deflection in the joint exceed the maximum designed deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

D. Steep Grades
1. Except for short runs which may be permitted by Engineer, lay pipes uphill on grades exceeding 10 percent. Block pipe which is laid on a downhill grade to hold in place until sufficient support is furnished by the following pipe to prevent movement. Install all bends properly as shown on the Contract Drawings.

E. Cold Weather Protection
1. Do not install pipe 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. Do not install pipe unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

F. Tapping Saddles
1. Install tapping saddles a minimum of 5 feet from the edge of the saddle to any pipe joint or other saddle. Do not make multiple taps of 6 inches or larger in the same length of pipe without the approval of Engineer.

G. Tracer Wire
1. Provide Polyvinyl chloride pipelines with tracer wire secured to the pipe with surface connections provided at all valve boxes and hydrants, and as required to maintain a maximum distance between surface connections of 500 feet maximum.
2. Lay tracer wire along the top of the pipe and secure in place with ties or hitches, spaced not more than 10 feet apart.
3. The copper wire will be used in the future as a means of locating the pipe with an electronic pipe locator.

H. Metallic Locating Tape
1. For buried pipelines, provide a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade OR above top of pipe. Furnish

manufacturer's literature, completely describing the tape proposed to be furnished. Do not install tape prior to receipt of written approval of Engineer.

3.5 PIPE APPURTENANCES

A. Valve Installation:
1. Handle all valves in a manner to prevent any injury or damage to any part of the valve.
2. Clean and prepare all joints prior to installation.
3. Adjust stem packing and operate each valve prior to installation to assure proper operation.
4. Install all valves in the location shown on the Contract Drawings, with valve stems plumb.

3.6 CORROSION PROTECTION

A. Polyethylene Encasement
1. Encase ductile-iron fittings, and valves in accordance with ANSI/AWWA C105/A21.5, Method A.
2. Cut polyethylene tube approximately 2 feet longer than fitting length.
3. Slip tube around fitting, centering to provide 1-foot overlap on each adjacent pipe section.
4. Wrap and tape encasement snug around fittings and valves.

3.7 FIELD TESTS

A. Conduct testing and disinfection of the pipeline in accordance with Section 33 13 00 – Water Pipeline Testing and Disinfection as applicable.

3.8 CLEANING

A. As pipe laying progresses, keep the pipe interior free of all debris. Completely clean the interior of the pipe of all sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints, and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.9 PROTECTION

A. Protect the openings of all pipe and specials with suitable bulkheads to prevent unauthorized access by persons, animals, water, or any undesirable substance. At all times, provide means to prevent the pipe from floating.

END OF SECTION

SECTION 33 11 11
STEEL PIPE (AWWA C200, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. Provide mortar-lined steel pipe coated as specified herein, complete, in accordance with the Contract Documents.

B. Steel pipe and fittings shall be new without any defects when delivered to the job site.

1.2 REFERENCES

A. Commercial Standards, most recent editions: The following standards are listed for convenience only. All specified standards, whether listed or not, shall apply to the Work.

ANSI/ASTM A 20	General Requirements for Steel Plates for Pressure Vessels
ASTM E 165	Practice for Liquid Penetrant Examination
ASTM A 370	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 516	Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ANSI/AWWA C200	Steel Water Pipe 6 In and Larger
ANSI/AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In and Larger - Shop Applied
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service 4 in to 144 in
ANSI/AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
ANSI/AWWA C209	Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
ANSI/AWWA C214	Tape Coating Systems for the Exterior of the Steel Water Pipelines
ANSI/AWWA C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
ANSI/AWWA C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

ANSI/AWWA C218	Coating the Exterior of Above Ground Steel Water Pipelines and Fittings
ANSI/AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
ANSI/AWWA C602	Cement-Mortar Lining of Water Pipelines 4-In (100 mm) and Larger - In Place
ANSI/ASTM A 36	Carbon Structural Steel
ANSI/ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 570	Steel Sheet and Strip, Carbon, Hot-Rolled Structural Quality
ASTM A 572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM C 150	Portland Cement
ANSI/AWS D1.1	Structural Welding Code – Steel
API Standard 1104	Welding Pipelines and Related Structures
AWWA M-11	Steel Water Pipe - A Guide for Design and Installation
ASME	Boiler and Pressure Vessel Code

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 20 – Submittal Procedures, and the following supplemental requirements as applicable. Fittings and specials shall conform to Section 33 11 12 - Steel Pipe Fabricated Specials. Submittals for steel pipe and specials shall be coordinated between the sections.

B. Fabrication Information

a. Pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; manufacturing tolerances; maximum angular joint deflection limitations; and all other pertinent information required for the manufacture and installation of the product.

b. Welded joint details shall be submitted for all joint types, including beveled ends for alignment conformance and deep bell or butt strap joints required for control of temperature stresses.

c. Rubber gasket joint design and details complete with dimensions, tolerances, and performance or test data.

d. Pipe Fabricator's Credentials: Submit the credentials of the pipe manufacturer/fabricator. Credentials shall include reference names, telephone numbers, and descriptions of projects for pipe conforming to AWWA C200 that is of similar diameter, length, and wall thickness to the pipe

in this project. Project description shall include length, diameter, wall thickness, steel metallurgy, location of facility where pipe was manufactured/fabricated, and names of key plant personnel responsible for the manufacturing process. Submit names and qualifications of current plant personnel to be responsible for manufacture of the pipe in this project. To demonstrate ability to meet the schedule requirements of this project, submit project descriptions and manufacturing/fabrication schedules for other currently contracted pipe projects at the Fabricator's plant. The manufacturing / fabrication schedule for the pipe in this project shall be identified on schedule submittals under Section 01 32 16 – Construction Progress Schedule (CPM)

e. Manufacturer's Written Quality Assurance/Control Program.

f. ISO 9001:2000 Certification or Steel Pipe Fabricators Association (SPFA) certification, or Engineer approved equal.

2. Materials: Material lists and steel reinforcement schedules which include and describe all materials to be utilized. Metallurgical test reports for steel proposed for use on the project. Submit chemical and physical test reports from each heat of steel that indicate the steel conforms to the Project Specifications.

3. Line Layout Information

   a. Line layout and marking diagrams compatible with the requirements of AWWA Manual 11 (M-11) and which indicate the specific mark number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and centerline elevation at all changes in grade or horizontal alignment; the station and centerline elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment. The location of all mitered pipe sections, beveled ends for alignment conformance, and deep bell or butt strap joints for temperature stress control shall be clearly indicated on the diagrams.

   b. Dimensional drawings of all valves, fittings, and appurtenances as specified in Section 40 05 00 – Piping, General.

   c. Drawings showing the location and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.

   d. Details and locations of closures for length adjustment, temporary access manways, vents, and weld lead pass holes as indicated and as required for construction convenience.

4. Welding Information

   a. Information regarding location, type, size, and extent of all welds with reference called out for Welding Procedure Specifications (WPS) numbers shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them.

   b. Written welding procedures for shop and field welds, including Welding Procedure Specifications (WPS's) and Procedure Qualification Records (PQR's).

   c. Written nondestructive testing procedure specifications, and nondestructive testing personnel qualifications for shop and field welds.

d. Current welder performance qualifications (WPQ's) shall be submitted for each welder used prior to its performing any Work either in the shop or field. Qualification testing shall be as specified in Article 1.4 - Quality Assurance, Paragraph F, in this Section.
e. Submit the credentials of the certified welding inspectors (CWI's) and quality control specialist for review prior to starting any welding in the shop or field. The credentials shall include, but not be limited to, American Welding Society QC-1 Certification.
f. Submit all nondestructive testing (NDT) data for each shop-welded and field-welded joint. This data shall include all testing on each weld joint, including re-examination of repaired welds, using phased array ultrasonic, radiographic, magnetic particle, dye penetrant examination, ultrasonic, or air test examination methods specified. Test data shall be reviewed and signed by the welding inspector(s).
g. Submit a welder log for field and shop welding. Log shall list all welders to be used for the Work and the types of welds each welder is qualified to perform.
h. Submit a welding map showing the sequence of welds for all field welds.
i. Submit a written weld repair procedure for each type of shop and field weld proposed for use.
j. Submit a written rod control procedure for shop and field operations demonstrating the intent to maintain rods in good condition throughout the Work. The rod control procedure shall also demonstrate the intent to ensure that the proper rods are used for each weld.

5. Handling and Support Information: Detail drawings indicating the type, number and other pertinent details of the slings, strutting and other methods proposed for pipe support and handling during manufacturing, transport, and installation. Calculations supporting the handling and support system design shall be submitted. Drawings and calculations shall be sealed by a registered professional engineer.
6. Control of Temperature Stresses
   a. Submit proposed sequencing of events to control temperature stresses in the pipe wall during installation prior to starting of any field welding.
   b. Submit the proposed sequencing of events or special techniques to minimize distortion of the steel as may result from shop welding procedures.
   c. Submit plan for monitoring pipeline temperatures.
7. Field Lining
   a. Submit field lining credentials.
   b. Submit a description of lining equipment and personnel to be used.
   c. Submit written procedures for pipe surface preparation, lining application, and curing.
   d. Submit cement mortar mix design.

C. Certifications: Furnish a certified affidavit of compliance for all pipe and other products, materials, or related work provided under this Section, as specified in ANSI/AWWA C200, C205, C602, and C206, respectively, and the following supplemental requirements:
1. Compliance with the additional requirements included in these Contract Documents.
2. Physical and chemical properties of all steel.
3. Hydrostatic test reports.
4. Results of production weld tests.
5. Sand, cement, and mortar tests.
6. Rubber gasket tests.

7. All materials are NSF approved for use with potable water where applicable.
8. Pipe temperature complies with Contract Documents prior to pouring pipe zone material, during and between periods of CLSM placement, and prior to and during welding temperature control joints (including supporting data).
9. All welds were performed in conformance with these documents.

D. All expenses incurred in making samples or collecting data for certification of tests shall be borne at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe, linings, welds, coatings, and related work shall be subject to inspection at the place of manufacture and/or the place the Work is performed in accordance with the provisions of ANSI/AWWA C200, C205, C206, C602, C209, C214, C215, and C222 as applicable, as supplemented by the requirements herein. Notify the Engineer in writing not less than 14 calendar days prior to the start of any phase of the pipe manufacture, welding, lining, coating, testing, or field operations.

B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of ANSI/AWWA C200, C205, C206, and C602, as applicable.
1. After the joint configuration is completed and prior to lining with cement-mortar, if applicable, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 75 percent of the minimum yield strength of the pipe steel. Test pressure shall be maintained for a sufficient time to observe the weld seams. There shall be no leaks. Any leaks shall be repaired and the pipe retested.
2. Production weld tests as required in ANSI/AWWA C200, except weld tests shall be conducted on each 5,000 feet of production welds at a minimum, and at least one set of tests per operator per work shift shall be performed.

C. Perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted; provided, the schedule is not delayed for the convenience of the Engineer.

D. In addition to those tests specifically required, the Engineer may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

E. Welding Procedure Specifications: All welding procedures used to fabricate and install pipe shall be in accordance with the ASME Boiler and Pressure Vessel Code (BPVC) and C200 for shop welds and ANSI/AWS D1.1 and C206 for field welds. Written welding procedures shall be required for all welds, both shop and field. Welds qualified per the ASME BPVC shall include Supplementary Essential Variables for notch-tough welding. All provisions of ANSI/AWS D1.1 pertaining to notch-tough welding shall apply.

F. Welder Performance Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ASME BPVC and C200 for shop

welds and ANSI/AWS D1.1 and C206 for field welds. Furnish all material and bear the expense of qualifying welders.

G. Shop Nondestructive Testing: Nondestructive testing shall be performed for various weld categories as specified below. Testing shall include submitting written documentation of procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
   1. Butt Joint Welds: Spot radiographically examine pipe in accordance with Paragraph UW-52 of the ASME Boiler and Pressure Vessel Code Section VIII, Division 1 or provide phased array ultrasonic testing in accordance with the guidelines of AWS D1.1 Annex H. If, in the opinion of the Engineer, the butt joint welds cannot readily be radiographed or phased array tested, they shall be 100 percent ultrasonically examined.
   2. Fillet Welds: 100 percent examine all fillet welds using the magnetic particle inspection method.
   3. All Welds: Certified welding inspector shall 100 percent visually examine all welds as a minimum.
   4. In addition to weld tests hereinbefore specified, double pads shall be air tested as stated in AWWA C200.
   5. Refer to Section 33 13 00 – Water Pipeline Testing and Disinfection for field nondestructive testing.

H. Onsite Observation: The pipe fabricator shall provide an experienced staff member to review and when requested train the installation crews regarding pipe handling, jointing, and backfilling. Training shall be provided as needed during construction. The staff member's duties shall include, but not be limited to, the following:
   1. Observe the installation and welding of the pipe and fittings.
   2. Report any concerns to the Engineer's onsite observer.
   3. Answer questions and provide assistance to the Engineer and the Contractor.

I. Certified Welding Inspector (CWI): Furnish the services of a certified welding inspector(s) for all shop and field welding as specified in AWWA C200 and C206. The certified welding inspector(s) shall 100 percent visually inspect all welds, verify proper procedures are being followed using qualified welders, supervise Contractor's non-destructive testing, and witness Engineer's non-destructive testing. The welding inspector(s) shall submit written certification that all welds were performed in conformance with these documents. All shop weld tests shall be reviewed and signed by the inspector(s).

J. Pipe Manufacturer/Fabricator: The manufacturer or fabricator of the pipe shall be experienced in fabricating pipe of similar diameters and wall thicknesses required for this Work and shall have the manufacturing capability to meet the schedule requirements of this project. Experience shall include successful fabrication to AWWA C200 standards of 33-inch and larger pipe with wall thicknesses 0.375- inch or larger within the 4-year period preceding the bid date. This experience requirement shall apply to the fabrication plant facility and responsible personnel, not to the firm which owns the facility or employs the personnel.

K. Single Manufacturer: A single manufacturer shall be made responsible for coordination of design, fabrication, testing, and furnishing of mainline pipe and fabricated specials. Separate suppliers for mainline pipe and specials will not be allowed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, steel pipe, linings and coatings shall conform to ANSI/AWWA C200, C205, C602, C209, C214, C215, C216, and C222, as applicable, subject to the following supplemental requirements. The pipe shall be of the diameter and wall thickness shown, shall be furnished complete with welded or gasket joints, as indicated in the Contract Documents, and all specials shall be provided as required in Section 33 11 12 - Steel Pipe Fabricated Specials. For pipe larger than 24 inches in diameter, the inside diameter after lining shall not be less than the nominal diameter indicated unless otherwise shown. Pipe 24 inches in diameter and smaller may be provided in standard outside diameters.

B. Markings: Legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word "top" shall be painted or marked on the outside top spigot of each pipe section.

C. Handling and Storage: The pipe shall be handled by use of wide slings, padded cradles, or other devices, designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 1 inch in diameter. The ends of all pipe shall be securely bulkheaded or otherwise sealed during transport to the jobsite. All pipe handling equipment and methods shall be acceptable to the Engineer.

D. Pay the cost of replacement or repair of pipe which is damaged at no increased cost to the Owner.

E. Strutting: Adequate strutting (stulling) shall be provided on all specials, fittings, and straight pipe so as to avoid damage or distortion to the pipe and fittings during handling, storage, hauling, and installation of backfill to the top of pipe. The following requirements shall apply:
   1. The strutting shall be placed as soon as practicable after the pipe is fabricated or the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed and backfilled at the jobsite.
   2. The strutting materials, size and spacing shall be the responsibility of the Contractor. One strut shall be placed vertical oriented with the top of pipe. One set of struts shall be set 2 feet from each end of each pipe section and at a maximum interval of 15 feet in-between
   3. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

F. Laying Lengths: Maximum pipe laying lengths shall not be limited unless specifically required by the Drawings. Select lengths to accommodate the operations.

G. Lining: The pipe lining shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.

H. Cathodic Protection System: Cathodic protection systems shall be applied to pipelines as shown in the Contract Documents. Refer to Section 13 – Special Construction.

I. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of correction pieces and closure assemblies shall be shown on the pipe layout diagrams and shall be subject to review. Any change in location or number of said items shall be approved by the Engineer.

J. Shop-Welded Surfaces: All weld seams on pipe surfaces that will have a flexible tape or polyolefin coating in accordance with Section 09 97 10 – Pipeline Coatings and Linings. Seams shall be ground such that the maximum weld bead height will not exceed 1/16 inch. All ground weld seams shall be smooth and free of all burrs. Do not grind into, or gouge, the adjacent pipe wall material.

2.2 MATERIALS

A. Cement: Cement for mortar shall conform to the requirements of ANSI/AWWA C205; provided, that cement for mortar coating shall be Type V or Type IL (10HS), and mortar lining shall be Type II, Type V, or Type IL (10HS), per ASTM C 150 and ASTM C 595. Fly ash or pozzolan shall not be used as a cement replacement.

B. Steel: Provide steel coils for spiral welded steel pipe or steel plate for straight seam welded steel pipe per AWWA C200 and as follows:

1. Minimum Yield Strength: 40,000 psi . Measured yield strength shall not exceed 85% of measured tensile strength.
2. Minimum Tensile Strength: 60,000 psi
3. Coils: Steel coils shall be in accordance with AWWA C200 and made from the continuous cast process or continuous cast slabs, fully killed, fine-grain practice conforming to the physical and chemical characteristics of ASTM A1011/A1011M or ASTM A1018/A1018M, Grade 40. For sheet steel, the maximum allowable thickness variation shall be 0.010 inch under the nominal thickness.
4. Plate: Steel plate shall be fully killed and be manufactured to fine-grain practice conforming to the physical and chemical characteristics of ASTM A516, A36 or ASTM A572/A572M, A572 Grade 50.

C. Pipe shall be manufactured as fabricated pipe per AWWA C200 as modified herein. Outlets 14-inch and smaller shall be fabricated from ASTM A 53, Type E or S, Grade B, standard weight steel pipe in the standard outside diameters, i.e., 14, 12-3/4-inch, 10-3/4-inch, 8-5/8-inch 6-5/8-inch, and 4-1/2-inch. Wall thickness and collar reinforcing shall be as shown. Pipe sections shall be fabricated by either of the following methods:

1. Pipe sections may be spirally welded or fabricated from short cylindrical courses joined circumferentially by complete penetration butt joint welds with not more than two longitudinal seams per course. Longitudinal seams shall be staggered on both sides of the pipe.
2. Pipe sections may be rolled or pressed from no more than three sheets the full length of the pipe and welded with no more than three longitudinal seams. Patching inserts, overlays, or pounding out of dents will not be permitted. Repair of notches or laminations on second ends will not be permitted. Damaged ends shall be removed

as a cylinder and the section end properly prepared. Distorted or flattened lengths shall be rejected. A buckled section shall be replaced as a cylinder.

D. Charpy Tests

1. Charpy V-Notch tests shall be conducted on all steel used in fabricating pipe and reinforcement materials 0.5-inch or greater in thickness. Test outside diameter wrap of two coils minimum per heat lot. Charpy V-Notch tests per ASTM A 370. The test acceptance shall be 25 foot-pounds at a test temperature of 30 degrees F.
2. The Owner may elect to increase the Charpy testing to include more steel than indicated above at a negotiated price.

2.3 SPECIALS AND FITTINGS

A. Unless otherwise required, all specials and fittings shall be in accordance with Section 33 11 12 - Steel Pipe Fabricated Specials and shall conform to the dimensions of ANSI/AWWA C208.

2.4 DESIGN OF PIPE

A. General: The pipe shall be steel pipe, mortar-lined and flexible or mortar-coated as shown on the Drawings, with field welded joints or gasket as indicated. The pipe shall consist of a steel cylinder, lined with cement-mortar as indicated, with an exterior coating as indicated in Section 09 97 10 – Pipeline Coatings and Linings. Field lining will only be allowed where specifically indicated on the Drawings.

B. The pipe shall be manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C200.

C. Pipe Dimensions: The pipe shall be of the diameter and wall thickness shown on the Drawings. The minimum steel cylinder thickness for each pipe size shall be as indicated.

D. Specials Dimensions: The specials shall be of the diameter and wall thickness indicated on the Drawings, or as specified in Section 33 11 12 - Steel Pipe Fabricated Specials.

E. Joint Design: Unless otherwise shown on the Drawings, the standard field joint for steel pipe shall be single-welded (fully circumferential) lap joint. Mechanically coupled, or flanged joints shall be required where indicated on the Drawings. Butt-strap joints shall be used only where required for closures or where indicated. The joints furnished shall have the same or higher pressure rating as the abutting pipe. Provide air test tapped holes for each double welded lap joint as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection.

F. Lap joints prepared for field welding shall be in accordance with ANSI/AWWA C200. The method used to form, shape and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by the pipe being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. The ends shall not be rolled. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.

G. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths of pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels and maximum joint deflections are not exceeded. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be 75 percent of the manufacturer's recommendations or the angle which results from a ¾-inch pull out from normal joint closure, whichever is less. In no case shall pulled joints result in a gap between the bell and spigot at the weld location that exceeds 1/8 inch. All horizontal deflections or fabricated angles shall fall on the alignment, as shown.

H. All vertical deflections shall fall on the alignment within laying tolerance as described in Section 3.1.

I. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated or as otherwise acceptable to the Engineer. Holdback areas shall be coated as hereinafter specified.

J. Temperature Control Lap Joint: A special longer bell end (temperature control lap joint) shall be provided at a maximum spacing of 400 feet to account for movement of the installed pipe due to temperature changes. The pipe manufacturer shall determine the length required for the longer bell as defined by the pipe laying procedures and the location of the special bell. Minimum temperature control lap joint length shall be as shown on the Drawings.

K. Joint Shop Coating: All holdback areas for welded joints, all butt straps, and all bell and spigot joint rings for rubber-gasketed joints shall be thoroughly cleaned and given a shop coat of rust-inhibitive primer. The surface preparation and primer shall be compatible with the intended finish coating as specified in Section 09 90 00 – Painting and Coatings and Section 09 97 10 – Pipeline Coatings and Linings, as applicable.

L. The pipe ends shall be match marked after shop assembly.

2.5 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Unless otherwise indicated on the Contract Documents, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C205. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at the delivery site, or after installation, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Contract Documents at no additional cost to the Owner.

B. The minimum lining thickness shall be as follows, with a tolerance of plus 1/8-inch or minus 1/16-inch:

1.

Nominal Pipe Diameter (in)	Lining Thickness (in)
4 - 10	1/4

11 - 23	5/16
24 – 36	3/8
over 36	1/2

C. The pipe shall be left bare where field joints occur as indicated. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.

D. Defective linings, as determined by the Engineer, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with cracks wider than 1/16 inch shall be rejected or repaired per AWWA C205 at the discretion of the Engineer.

E. The progress of the application of mortar lining shall be regulated in order that all hand work, including the repair of defective areas is cured in accordance with the provisions of ANSI/AWWA C205. Cement-mortar for patching shall be the same materials as the mortar for shop or machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

F. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied cement-mortar linings, provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 EXTERIOR COATING OF PIPE

A. Exterior Coating of Steel Pipe: The exterior coating of all steel pipe shall be in accordance with Section 09 97 10 – Pipeline Coatings and Linings.

2.7 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of Section 40 05 00 – Piping, General.

2.8 PIPELINE MARKING TAPE

A. Metallic tape: HyTech Detectable Tape manufactured by NorthTown Pipe Protection Products; or approved equal, having the following essential characteristics:
   a. Aluminum foil encased in high visibility inert polyethylene jacket.
   b. Total thickness: 5.0 mils, minimum.
   c. Width: 6 inches, minimum.
   d. Imprinted on one side, 1-inch-tall, permanent black lettering.
   e. Color: as listed below.
   f. Joining clips shall be manufacturer's standard.
   g. Tape shall read for example “Client’s Name-Buried Pipeline Below”.

B. Plastic tape: Terra Tape manufactured by Reef Industries, Inc., 9209 Alemeda Genoa Road, Houston, TX 77075, www.reefindustries.com; or equal, having the following essential characteristics:
   a. Polyolefin or similar chemically inert material unsusceptible to alkalies, acids, and chemicals and solvents likely in the soil.
   b. Thickness: 4.0 mil, minimum.
   c. Width: 12 inches minimum.
   d. Color: as listed in below.
   e. Imprinted on one side, 1-inch-tall, permanent black lettering on a colored background.
   f. Tape shall read for example "Client's Name-Buried Pipeline Below".

2.9 MARKERS

A. Provide pipeline markers at the locations indicated. Markers in open areas shall be High Visibility Tri-View Utility Marking Posts as manufactured by Rhino Marking and Protection Systems (www.rhinomarkers.com). Coordinate color and lettering with Owner prior to installation. Markers shall be provided at the following locations:
   1. Both sides of street and canal crossings.
   2. At locations of cathodic protection test stations (see test station table).
   3. At the beginning and end of open areas and at a maximum interval of 500-ft.

B. Brass Caps: Caps shall be 2-1/2-inch diameter brass caps with posts set by epoxy into holes drilled into the curb adjacent to the pipeline. Brass caps and monuments shall be provided in locations as described in the plans. Caps shall be stamped as shown on the details and shall be provided at the following locations:
   1. Fittings, bends, deflections or elbows.
   2. Both sides of street and canal crossings.
   3. Within deck of concrete structures (manholes, vaults, etc.)
   4. Minimum distance of 1,000LF along pipeline

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, and specials shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. Pipe shall be handled and stored at the trench site in accordance with the requirements stated below. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks or other damage that may be harmful as determined by the Engineer. Such damaged lining and coating/interior and exterior surfaces, shall be repaired to the satisfaction of the Engineer, or a new undamaged pipe shall be furnished.

B. All pipe damaged prior to Substantial Completion shall be repaired or replaced at no additional cost to the Owner.

C. Inspect each pipe and fitting to ensure that there are no damaged portions of the pipe. Remove or smooth out any burrs, gouges, weld splatter or other small defects prior to laying the pipe.

D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.

E. Lifting points shall be no closer than the 1/3 and 2/3 points along the length of the Section. Be responsible for selecting lifting points that when used, do not result in damage to the pipe.

F. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, short lengths of pipe, by the use of beveled joint rings, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer or the amount that results in more than a 1/8-inch gap at the weld location, whichever is less. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.

H. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.

I. Pipe struts shall be left in place until backfilling operations to the top of pipe have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying, provided, that the deflection of the pipe during and after backfilling does not exceed that specified. After the backfill has been placed to a minimum of 3-feet, the struts shall be removed and shall remain the property of the Contractor. Struts shall not be removed with a torch or any other method that may damage the pipe lining or coating. The parent pipe material shall not be nicked, gouged, or damaged during strut removal. All repairs of gouges or nicks in the parent material shall be made using 3/32-inch maximum diameter E-6010 welding electrodes with a maximum heat input of 5.6 kj per inch. Tack welds, stull metal, weld splatter, slag, and burrs that remain attached to the parent metal surface after cutting shall be ground to within 1/32 inch of the parent metal. Grinding shall not penetrate the parent metal. Notify the Engineer prior to grinding. Following grinding, all pipe surfaces at the tack weld shall be visually inspected for defects. All defects deeper than 1/16 inch shall be repaired by welding in accordance with ANSI/AWSD.1.1 and AWWA/ANSI C206. All inspection work shall be performed by a certified welding inspector.

J. For pipe backfilled with CLSM, the pipe shall be laid directly on moist sandbags or other suitable supports approved by the Engineer in preparation for CLSM pipe zone material.

Sandbags shall be placed to provide at least 6 inches of CLSM below the bottom of the pipe. Sandbags shall be spaced at a maximum interval of 8 feet and one set shall be placed within 3 feet on both sides of each joint. Provide additional sandbags as needed to support the pipe on line and grade. For pipe bedded in granular material, no blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

K. At all times, means shall be provided to prevent the pipe from floating. Take all necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. Assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

L. Bulkheads
   1. Prior to shipment of pipe with cement mortar lining the lining shall be wetted then a suitable bulkhead shall be attached to each end of the pipe section. This bulkhead shall remain in place and in good condition through transit to the Project.
   2. During construction the openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe. Introduce water into the pipe as needed to keep the mortar moist where moisture has been lost due to damaged bulkheads.

M. Pipe Cleanup: As pipe laying progresses, keep the pipe interior free of all debris. Completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

N. Installation Tolerances: Each section of pipe shall be laid in the order and position shown on the laying diagram and the following requirements:
   1. Each section of pipe having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1 inch vertical deviation.
   2. Each section of pipe having nominal diameter 48 inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.
   3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.
   4. Pipe deflection, after backfill but prior to installation of field-applied cement mortar lining, if applied, shall not exceed 2.25 percent for flexible coated pipe and 1.5 percent for cement mortar coated pipe. Deflection shall be measured by the difference in vertical inside diameter in the installed pipe and the manufactured pipe.

5. Pipe not conforming to these criteria or which otherwise impact the ability to complete the Work shall be removed and reinstalled in full conformance with the Contract Documents at no additional cost to the Owner.
6. For each section of pipe, record the invert elevation at the lower end and incorporate the data on the Record Drawings.

O. Protection of Pipe: At locations where the Contractor proposes to cross the installed pipeline with heavy equipment, precautions as approved by the Engineer shall be taken to protect the pipe from damage. Acceptable precautions include: backfilling the pipe trench as necessary to protect the pipe, concrete encasing the pipe, and placing steel plating over the pipe. Any damage to the pipe caused by operation or equipment shall be repaired at no additional cost to the Owner.

3.2 WELDED JOINTS

A. Welding Procedures, Welding Qualifications, and Testing:
1. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.
2. For field welding, the welder qualification testing shall be performed at the site. Previous qualifications will not be accepted. Obtain the services of an independent testing laboratory to perform the welder qualification onsite. Copies of all test data and certifications shall be provided to the Engineer. All costs for welder qualification testing shall be at no increased cost to the Owner.
3. Upon completion of each field-welded joint, the welding operator shall mark his regularly assigned identification number and the last two numbers of the year in which the Work was completed, or the Contractor may have a records system that traces a welder's work completion to a specific joint. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round nose types, are used.
4. All single welded lap joints will be inspected in the presence of the Engineer using magnetic particle or dye penetration methods. Field butt welds will be inspected by the Contractor in accordance with the requirements of API 1104 by the radiographic or phased array ultrasonic testing method and the acceptance criteria of API 1104 or AWS D1.1 Annex H. Magnetic particle testing is not required for seal welds.
5. All double welded lap joints and butt strap joints shall be air tested in the presence of the Engineer in accordance with Section 33 13 00 - Water Pipeline Testing and Disinfection. Repairs and retesting shall be required if any loss of pressure occurs. All double welded lap joints will also be inspected in the presence of the Engineer using magnetic particle or dye penetration methods.
6. Inform the Engineer before completed weld joints are to be backfilled so that the joint may be inspected. Assume all costs of exposing backfilled joints for inspection when backfilling preceded the inspection.
7. Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.

a. The Engineer may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein. Except as otherwise specified herein, all costs for the independent testing laboratory to inspect and test field welds will be paid for by the Owner. If the weld is defective, the inspection costs shall be paid for by the Contractor. Defective welds shall be repaired and retested at the Contractor's expense.

b. Test reports of all laboratory tests shall be submitted as provided in the quality control section.

B. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.

C. Lap Welded Joints: During installation of welded steel pipe in either straight alignment or on curves, the pipe shall be laid so that at any point around the circumference of the joint there is a minimum lap as shown on the Drawings.

D. Butt Straps: Where used or required, shall be as shown on the Drawings.

E. After the pipe and pipe joint are properly positioned in the trench, weld and provide external joint protection for all joints except the special temperature control lap joint hereinafter specified. The length of pipe between special temperature control joints shall be backfilled to at least one foot above the top of the pipe as hereinafter specified. The special temperature control joints shall be welded after the pipe is backfilled to at least one foot above the top of the pipe for the full distance between the temperature control joints upstream and downstream. Joint protection shall be provided for special temperature control joints after completion of the joint welds and tests as specified. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the special temperature control joint.

F. Control of Temperature Stresses

1. Control temperature stresses in accordance with AWWA C206, the approved temperature stress control submittal, and these Contract Documents. Provide special temperature control lap joints at intervals of 400 feet or less, unless otherwise approved by the Engineer.
2. To control temperature stresses, the unbackfilled special temperature control joint areas of all pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The "temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the pipe backfill between it and the other control joints in each direction. The term "special temperature control joint area" is defined as the entire length of pipe left exposed near a control joint after placing the backfill between it and the other control joints in each direction. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.
3. At intervals not exceeding 400 feet along welded reaches of the pipeline, at the first regular lap-welded field joints outside concrete encasements and structures, and where shown, the pipe shall be supplied with a special temperature control lap joint and laid with an initial lap of not less than 3 inches greater than the typical lap joint.

Where temperature control lap joints occur in a traveled roadway or other inconvenient location, the location of the joint may be adjusted, as acceptable to the Engineer.

4. Provide and install thermocouple temperature gauges to monitor the temperature of the steel pipe wall on the inside top of the pipe as it lays in the trench. All pipe temperature requirements specified herein shall be measured at the top inside of the steel cylinder. Specific temperature requirements for the pipeline steel cylinder shall be met prior to installation of the controlled low strength material (CLSM), during and after placement of CLSM, and during welding of the special temperature control joints. If atmospheric conditions do not allow the conditions to be met, supplemental cooling shall be required. The following outlines the specific temperature control requirements.
   a. Prior to and during placement of the CLSM, the pipeline steel temperature shall be at or below 90 degrees F. The specified temperature shall be maintained for at least three hours after the placement of CLSM. The specified temperature shall be maintained until the line is fully backfilled. Provide supplemental cooling as required.
   b. Placement of CLSM shall proceed in the direction of pipe laying from one special temperature control joint to the next. During placement of CLSM, the lead end of the pipe section (toward the next special temperature control joint) shall be left unbackfilled or otherwise unrestrained such that the end of the pipe is free to move in response to expansion or contraction due to temperature changes. CLSM shall not be placed in a direction which would result in CLSM placement proceeding in a direction toward previously or simultaneously placed CLSM without the written permission of the Engineer. The direction of CLSM placement will not be limited for placement at the short unbackfilled section immediately adjacent to the special temperature control joints.
   c. During periods between CLSM placement operations, any section of pipeline that is backfilled with CLSM shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials until the pipe is backfilled at least 1 foot over the top of the pipe. The temperature of the partially backfilled pipe shall not be allowed to exceed 110 degrees Fahrenheit at any time. Provide supplemental cooling as required. Shading materials shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the partially backfilled pipe need not be performed when it can demonstrate to the satisfaction of the Engineer, using thermocouple data, that shading is not necessary to meet the specified temperature requirement.
   d. Prior to welding the special temperature control joints, the pipeline extending 400 feet each direction from the joint shall be maintained at or below 85 degrees F. Additionally, the pipeline extending 400 feet each direction from the joint shall be backfilled with CLSM to at least one foot over the top of the pipe. At the specified temperature, the special temperature control joints can be welded. Begin and complete the weld during the coolest interval of suitable length within a 24-hour day. Use the thermocouple temperature data to demonstrate to the Engineer the coolest interval of the day.
   e. After welding any temperature control joint, the pipe temperature for 150 feet in each direction from the control joint shall be maintained below 110 degrees F for a minimum of 24 hours after the temperature control joint

area has been backfilled to at least 1 foot over the top of the pipe. This requirement is in addition to the shading and CLSM placement temperature requirements indicated herein.

G. Prior to the beginning of pouring CLSM or beginning the welding procedure, any tack welds or joint stops used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with ANSI/AWWA C206. Where more than one pass is required, all dirt, slag, and flux shall be removed before the succeeding bead is applied.

H. Testing of Joints: The pipeline joints shall be tested as specified herein and in Section 33 13 00 - Water Pipeline Testing and Disinfection.

I. Following tests of the joint, the exterior joint spaces shall be coated in accordance with these Specifications after which backfilling may be completed.

J. Joints: The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as indicated.

K. Repair of Welds: All welds that are defective shall be repaired to meet the requirements of this Section at no additional cost to the Owner. Defects in welds or defective welds shall be removed, and that section of the joint shall then be rewelded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.

3.3 JOINT COATING AND LINING

A. General: The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe. The grout for joint coating and lining shall be cement grout in accordance with Section 03 60 00 - Grouting, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency

B. Joint Coating: In accordance with the requirements of Section 09 97 10 – Pipeline Coatings and Linings.

C. Joint Lining:
1. Clean joint to remove dirt, debris, and other contaminants.
2. Apply a single application of NSF approved acrylic latex bonding admixture (Flex-Con, or equal) to wet out joint for the promotion of adhesion.
3. The grout for joint lining shall be cement grout in accordance with Section 03 60 00 – Grouting, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency. NSF approved acrylic latex admixture shall be added to develop a dough like consistency.
4. Mortar mixture is hand packed into the joint area.
5. Joint is troweled smooth to create a uniform transition between existing mortar lined pipe.
6. Joint area is swept clean of debris.

7. After the backfill has been completed to final grade, the interior joint recess of shop-lined pipe shall be filled with grout, tightly packed into the joint recess and troweled flush with the interior surface. All excess shall be removed. At no point shall there be an indentation or projection of the grout exceeding 1/16 inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout containing one part cement to two parts sand. The spigot end then shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.

3.4 CEMENT-MORTAR LINING, FIELD-APPLIED

A. Cement-Mortar Lining: Unless otherwise indicated, all steel pipe shall be mortar-lined. The materials and design of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602 and the following supplementary requirements:
   1. Pozzolanic material shall not be used in the mortar mix.
   2. Admixtures shall contain no calcium chloride.
   3. The minimum lining thickness shall be as indicated for shop-applied cement-mortar lining and finished inside diameter after lining shall be as indicated.
   4. Temperature and shrinkage cracks in the mortar less than 1/16 inch wide need not be repaired. Pipe, specials, or fittings with mortar cracks wider than 1/16 inch shall be rejected or repaired at the discretion of the Engineer.
   5. Field applied mortar lining shall meet the requirements of this Subparagraph F.
   6. Grout mixture for field applied joint lining shall include two parts sand to one part cement by volume and potable water. NSF approved acrylic latex admixture (Flex-Con, or equal) shall be added to mortar as needed to make dough like consistency for hand packing into joint area.

B. Unless otherwise indicated, construct the cement-mortar lining in-place after the pipeline is backfilled to approximate finished grade. The application of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602.
   1. The lining machine shall be of a type that has been used successfully for a similar size of pipe. Perform all Work in a thorough and workmanlike manner by trained personnel, under the supervision of experienced personnel skilled in machine application of cement-mortar lining to pipelines of size comparable to this Work.
   2. Curing of the in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602, except the Contractor shall be responsible for curing and maintaining the lining until final acceptance by the Owner. Provide a system to maintain a suitably moist environment within the pipe to properly cure and maintain the lining. Provide additional protective devices as required to ensure that the airtight covers, which maintain a moist condition in the pipeline, are not damaged.
   3. Defective areas encompassing the full diameter of the pipe shall be replaced by machine wherever the length measured along the pipe centerline is greater than 5 feet; otherwise defective areas may be replaced by hand.

3.5 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is concrete or coated with cement mortar, buried appurtenances shall be coated with a minimum thickness of one inch of cement mortar having one part cement to not more than two parts plaster sand. Following

coating with cement mortar, the appurtenances shall be coated with a protective overcoat in accordance with the paragraph entitled "Protective Coating."

B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. Adjust all stem packing and operate each valve prior to installation to insure proper operation. Valves (body and seat) shall not be subjected to test pressures greater than manufacturer's recommendation. In some cases this may require an increase in the valve pressure class.

C. All buried valves shall be coated and protected in accordance with Section 09 97 10 - Pipeline Coatings and Linings.

D. All valves shall be installed so that the valve stems are plumb and in the location indicated.

E. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved and calibrated torque wrench. All clamping torque shall be applied to the nuts only.

F. All buried flanges shall be coated and protected in accordance with Section 09 97 10 - Pipeline Coatings and Linings.

G. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.

H. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable, approved and calibrated torque wrench set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.

I. Upon completion of the coupled joint, the coupling and bare metal of the pipe shall be cleaned, primed and protected in accordance with the requirements of Section 09 97 10 - Pipeline Coatings and Linings.

3.6 CORROSION CONTROL

A. Cathodic Protection: Corrosion mitigation and testing materials shall be provided where indicated and in accordance with Division 13.

3.7 MARKING TAPE INSTALLATION

A. As shown on the Drawings.

B. Per specification 31 23 00 – Earthwork.

3.8 PIPELINE TESTING

A. The steel pipe shall be hydrostatically tested as specified in Section 33 13 00 – Water Pipeline Testing and Disinfection.

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SECTION 33 11 12
STEEL PIPE FABRICATED SPECIALS (AWWA C200, MODIFIED)

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all bends, reducers, wyes, tees, crosses, outlets, manifolds and other steel plate specials, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards, most recent edition

ASME B 16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASTM E 165	Practice for Liquid Penetrant Examination
ANSI/AWWA C200	Steel Water Pipe 6 In and Larger
ANSI/AWWA C205	Cement Mortar Lining and Coating – Shop Applied
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks
ANSI/AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
ANSI/AWWA C602	Cement-Mortar Lining of Water Pipelines - 4 In (100 mm) and Larger - In Place
ASTM A234	Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ANSI/AWS D.1.1	Structural Welding Code - Steel
API Standard 1104	Welding Pipelines and Related Structures
AWWA M-11	Steel Water Pipe - A Guide for Design and Installation
ASME	Boiler and Pressure Vessel Code

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings including line and layout diagrams of all steel pipe fabricated specials in accordance with the requirements in Section 01 33 20 – Submittal Procedures. All submittals required for steel pipe and related work as listed in Section 33 11 11 – Steel Pipe, shall also be required for specials. Shop drawings shall indicate the type, size, and location of all reinforcement pieces.

B. Design calculations shall be submitted to the Engineer for review prior to manufacture of steel pipe fabricated specials.

C. Certifications: A certified affidavit of compliance with referenced Specifications and these Contract Documents shall be furnished for all steel pipe fabricated specials and other products or materials provided under this Section.

1.4 QUALITY ASSURANCE

A. Inspection: All specials shall be subject to inspection at the place of manufacturer/ fabrication as outlined in Section 33 11 11 – Steel Pipe.

B. Shop Testing of Steel Pipe Fabricated Specials:

1. If steel pipe fabricated specials have been fabricated from untested straight pipe, they shall be hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure shown in the Contract Documents. If steel pipe fabricated specials have been fabricated from successfully tested straight pipe, no hydrostatic test shall be required unless otherwise indicated. In no case shall shop test pressure be less than 150 psi. All tees with crotch plates shall be hydrostatically tested as indicated regardless of whether or not the straight pipe sections used were previously tested.

2. All welds shall be non-destructive tested at the specials fabricator's facility as specified below for various weld categories and in accordance with shop nondestructive testing specified in Section 33 11 11 – Steel Pipe. Testing shall include submitting written documentation of procedures per Section V, and acceptance criteria shall be in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.

3. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with all finished plate edges ground smooth, straight, recoated and prepared for the field joint.

4. Testing shall be performed before pipe and joints have been coated or lined.

5. Perform tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted, provided that the schedule is not delayed for the convenience of the Engineer.

6. In addition to those tests specifically required, the Engineer may request additional samples of any material including mixed concrete and lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

C. Field Testing: Field testing shall conform to the requirements of Section 33 13 00 – Water Pipeline Testing and Disinfection.

D. Welding Procedure Specifications: All welding procedures used to fabricate pipe shall be in accordance with Section 33 11 11 – Steel Pipe.

E. Welder Performance Qualifications: All welder performance qualifications shall be in accordance with Section 33 11 11 – Steel Pipe.

F. Certified Welding Inspector: A certified welding inspector shall be provided for shop fabricated work and shall have the responsibilities outlined in Section 33 11 11 – Steel Pipe.

G. Fittings and Specials Fabricator:
   1. Experienced in fabrication of fittings and specials of similar diameters and wall thickness required for the Work.
   2. Demonstrate current production capability for volume of Work required for the Project.
   3. Experience shall be for project requiring fabrication to AWWA C200/208 standards of at least 25 fittings 36-inch or larger pipe, with wall thickness 0.375-inch or larger within the 5-year period preceding the bid date.
   4. Experience requirement shall apply to the fabrication plant facility and responsible personnel, not the firm which owns the facility or employs the personnel.
   5. See Section 33 11 11 – Steel Pipe for qualifications for steel pipe fabricators.

H. Fabrication: All specials shall be fabricated in the shop. No field fabrication of specials will be allowed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Steel pipe fabricated specials (specials) are defined as fittings, closure pieces, bends, elbows, reducers, wyes, tees, crosses, outlets, manifolds, steel pipe wall sleeves, and other steel plate specials wherever located, and all piping above ground or in structures.

2.2 DESIGN

A. Design: Except as otherwise provided herein, specials shall be fabricated from materials or straight pipe in full conformance with the requirements of Section 33 11 11 - Steel Pipe, ANSI/AWWA C200, AWWA M11 and the dimensions of ANSI/AWWA C208. All fittings and specials shall be properly reinforced to withstand the internal pressure, with circumferential and longitudinal, or external loading conditions, whichever is greater. The minimum thickness of plate for pipe from which specials are to be fabricated shall be no less than the thickness of the adjacent mainline pipe, the thickness shown, or the following, whichever is thicker:

Nominal Pipe Diameter (in)	Pipe Manifolds, Piping Above Ground, and Piping in Structures	Elbows, Bends, and Reducers
30 and under	Standard Weight	Standard Weight
Over 30	3/8-inch	Same as Adjacent Pipe

B. Joints: All joints and related work for field assembly of the pipe and specials shall conform to Section 33 11 11 – Steel Pipe. All shop joints shall be complete penetration butt-welds unless otherwise shown.

2.3 FABRICATION AND MATERIALS

A. General: Reinforcement for wyes, tees, outlets, and nozzles shall be as shown. Shop welding shall conform to the applicable provisions of AWWA C200 and the ASME Boiler and Pressure Vessel Code. Field welding shall conform to ANSI/AWS D1.1 and ANSI/AWWA C206. Specials

and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees resulting in a maximum deflection angle of 22.5 degrees per miter weld as recommended in AWWA C208.

B. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application, using the same materials as are used for the pipe and in accordance with the applicable AWWA or ASTM Standards, and as modified in Section 09 97 10 - Pipeline Coatings and Linings, or by other applicable sections in these Specifications. Coating and lining applied in this manner shall provide thickness and protection equal to that specified for the pipe. Fittings may be fabricated from pipe that has been mechanically lined and/or coated. Areas of lining and coating that have been damaged by such fabrication shall be removed and reapplied by hand-applications.

C. Access manholes with covers shall be as indicated. All threaded outlets shall be forged steel suitable for 3,000-psi service, and shall be as manufactured by Vogt or equal.

D. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths or pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels and maximum joint deflections are not exceeded. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be 75 percent of the manufacturer's recommendations or the angle which results from a 3/4-inch pull out from normal joint closure, whichever is less. In no case shall pulled joints result in a gap between the bell and spigot at the weld location that exceeds 1/8 inch. All horizontal deflections or fabricated angles shall fall on the alignment, as shown.

E. All vertical deflections shall fall on the alignment and at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures, the pipe angle points shall match the angle points indicated.

F. Outlets, Tees, Wyes, and Crosses
   1. Outlets 14-inch and smaller shall be fabricated from ASTM A 53, Type E or S, Grade B, standard weight steel pipe in the standard outside diameters, i.e., 14, 12-3/4-inch, 10-3/4-inch, 8-5/8-inch, 6-5/8-inch, and 4-1/2-inch. Wall thickness and collar reinforcing shall be as shown.
   2. In lieu of collar reinforcement as shown, pipe or specials with outlets may be fabricated in their entirety of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.
   3. Where required by Manual M-11 or other industry standard, the design procedure for crotch plate reinforcement, such reinforcement shall be required.

G. Steel Welding Fittings: Steel welding fittings for pipe spools and fittings smaller than 24 inches in diameter shall be in accordance with ANSI B16.9 conforming to ASTM A 234. Use standard weight. Taper pipe wall at welds at 4:1 for connection to pipe of different wall thicknesses. Be fully responsible for coordinating the difference in diameter convention between these specials and AWWA C200/C208 pipe and fittings to provide complete piping systems as shown.

H. Ends for Mechanical-Type Couplings: Except as otherwise indicated, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved.

I. Lining: All requirements pertaining to thickness, application and curing of cement mortar lining indicated for straight pipe shall apply to specials, with the following provision. If the special cannot be lined centrifugally or with field lining equipment, it shall be lined by hand. In such case, the lining shall be reinforced with welded wire fabric positioned approximately in the center of the lining and in accordance with AWWA C205 for lining of specials.

J. Coating: All requirements pertaining to thickness, application and curing of coating indicated for straight pipe shall apply to specials. Unless otherwise indicated the coating on the buried portion of a pipe section passing through a structure wall shall extend 4" into the vault. Pipe above ground or in structures shall be shop primed and field-painted in accordance with Section 09 90 00 – Painting and Coatings.

K. Marking: A mark indicating the true vertical axis of the special shall be placed on the top and bottom of the special.

L. Shop Welded Surfaces: All weld seams on pipe surfaces that will have a flexible tape or polyolefin coating in accordance with AWWA C209, C214, C215, or C216 shall be ground such that the maximum weld bead height will not exceed 1/32 inch. All ground weld seams shall be smooth and free of all burrs.

M. Portions of wall sleeves that penetrate into hydraulic structures and will be embedded into concrete shall be shop lined and coated in accordance with requirements for submerged conditions as outlined in Section 09 90 00 – Painting and Coatings.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all fittings, closure pieces, elbows, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other steel plate specials, bolts, nuts, gaskets, jointing materials, and all other appurtenances as indicated to provide a complete and workable installation. Where pipe support details are indicated, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically indicated. Where indicated, concrete thrusts blocks and welded joints shall be provided. At all times when the Work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals and foreign materials.

B. Take all necessary precautions to prevent the pipe from floating due to water entering the trench or from backfilling with CLSM. Assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe to its specified condition and

grade if it is displaced due to floating. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

C. Unless otherwise indicated, all specials shall be installed in full conformance with Section 33 11 11 – Steel Pipe, and other applicable sections of these Contract Documents.

END OF SECTION

SECTION 33 13 00
WATER PIPELINE TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Perform flushing and testing of all pressure pipelines and appurtenant piping and disinfection of all pipelines and appurtenant piping for potable and fire water, complete.

B. This applies to all pipelines requiring hydrostatic tests (water medium) regardless of the pipeline service medium.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C651	Disinfecting Water Mains

1.3 SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval a minimum of 7 days before testing is to start.

B. A copy of a Pollutant Discharge Elimination System permit application, from the State where the work is taking place, shall be submitted a minimum of 30 days prior to the proposed date to start testing. A copy of the approved pollutant discharge permit shall be submitted prior to the start of testing.

C. Chlorine residual test data and bacteriological test data shall be submitted to document the results of the pipeline disinfection. Tests shall be conducted 24 hours after the start of disinfection.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

B. Used pressure gauges shall be recertified prior to testing.

C. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

D. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301. Liquid chlorine shall be used only:
   1. In combination with appropriate gas flow chlorinators and ejectors;
   2. Under the direct supervision of an experienced technician;
   3. When appropriate safety practices are observed.

E. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300 - Hypochlorite.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting water pipelines shall be furnished by the Contractor. Make all necessary provisions for conveying the water from the source to the points of use, and disposal of the water (and dechlorinating - where applicable).

B. All pressure pipelines shall be tested. Disinfection shall be accomplished by chlorination for all pipelines providing potable water or connected to a potable water system. All chlorinating and testing operations shall be performed in the presence of the Engineer.

C. Disinfection operations shall be scheduled as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Samples for bacteriological testing shall be collected by the Contractor, and testing shall be performed by the Owner laboratory and at the expense of the Contractor. Results of the bacteriological testing shall be satisfactory with the State Department of Health or other appropriate regulatory agency.

D. Pipeline pressure tests will include the following tests:
   1. Air test of double welded lap joints.
   2. Hydrostatic pressure test of the complete pipeline, in segments as required to match pipe pressure class.
   3. Conduct the discharge in accordance with the Pollutant Discharge Elimination System permit from the Environmental Quality Division where the work is taking place. Apply a reducing agent to the discharged water to neutralize the chlorine residual and meet the chlorine residual limit required under the permit. The Owner shall conduct the water quality sampling of the discharge as required by the permit. Notify local agencies, secure appropriate other permits and approvals, and provide erosion control measures for any releases as appropriate. Release of water after pipeline testing and disinfection have been completed shall be only if acceptable to the Owner/Engineer.

E. Notification: Notify the Owner/Engineer at each of the following stages:
   1. Three working days prior to the start of filling the pipeline with water.

2. Three working days prior to the start of chlorination.
3. Twenty-four hours before withdrawing samples for bacteriological testing.
4. Three working days prior to the start of flushing.

3.2 VISUAL INSPECTION

A. All welds shall be 100% visually inspected in accordance with ANSI/AWS D1.1, Table 6.1; Visual Inspection Acceptance Criteria for Statically Loaded Non-Tubular Connections.

3.3 AIR TEST

A. All double welded lap joint or double gasket Carnegie joint shall be pressure tested to a minimum of 40-psi air pressure for a period of 10 minutes per AWWA C206. No air leakage will be allowed.

B. If the test pressure drops below 40 psi, paint the welds with a soap solution. Mark any leaks indicated by the escaping gas bubbles.

C. Any joints which leak shall be repaired and retested.

3.4 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. Test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all 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 temporary bulkheads in the pipe and filling the line slowly with water. Be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Any 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. Provide sufficient temporary air tapping in the pipelines to allow for evacuation of all entrapped air in each pipe segment to be tested. In sections tested where no air valves exist, provide temporary air valves for the automatic venting of air and vacuum protection. After completion of the tests, such taps shall be permanently plugged. Care shall be taken to see that all air vents are open prior to and during filling.

B. The pipeline shall be filled at a rate not to exceed 2-feet per second as calculated by using the cross-sectional area based on the inside diameter of the pipe and which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. 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 what water it will and to allow the escape of air from any air pocket. No personnel shall be within or enter any vault or confined space subject to flooding during the initial filling and for a 24 hour period. After the 24 hour period bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

C. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for distribution and transmission pipelines shall be 150 percent of the working pressure in the pipeline measured at the lowest point of the pipeline section

being tested, or as noted on the drawings. The test pressure for yard piping shall be as indicated on the Piping Schedule measured at the lowest point of the pipeline section being tested. No pressure test will be required for a reservoir overflow line. All visible leaks shall be repaired.

D. The maximum allowable leakage for distribution and transmission pipelines shall be 10 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 40-foot or greater lengths between joints and with rubber-gasketed joints and 20 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 20-foot or less lengths between joints and with rubber-gasketed joints. The maximum leakage for yard piping shall be as shown on the Piping Schedule. Pipe with welded joints shall have no leakage.

E. In the case of pipelines that fail to pass the prescribed leakage test, determine the cause of the leakage, take corrective measures necessary to repair the leaks, and again test the pipelines at no additional cost to the Owner.

F. The pipeline shall be drained after successful completion of the hydrostatic test.

3.5 DISINFECTING PIPELINES

A. General: All potable water pipelines shall be disinfected in accordance with the requirements of ANSI/AWWA C651 - Disinfecting Water Mains as modified herein.

B. Prior to disinfecting the pipeline for potable water services and before placing into service for other water pipelines, flush the pipeline to remove any debris, rocks, or other foreign material that may have entered the pipe. Flushing shall be carried out such that the velocities in the pipe exceed 2.5 feet per second. Provide all required material, labor and equipment to complete flushing. Contractor shall provide the water for flushing. Make appropriate provision and preparations for disposal of flushing water, satisfying all local, state and federal rules, laws, regulations and ordinances.

C. Continuous Feed Method: Disinfect in accordance with ANSI/AWWA C651 except that:
   1. The water in the pipe shall contain 50 mg/l free chlorine.
   2. After 24 hours of disinfection, the residual free chlorine shall be at least 25 mg/l at the pipeline extremities.

D. Slug Feed Method: Disinfect in accordance with ANSI/AWWA C651.

E. Chlorinating Valves: During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

F. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize thoroughly the chlorine residual remaining in the water. See the appendix of AWWA C651 for acceptable neutralization methods for heavily chlorinated water.

G. Sampling Ports: Provide sampling ports along the pipeline as defined in AWWA C651. Taps may be made at manways and air valves to help facilitate the spacing requirement.

H. Bacteriological Testing: After final flushing and before the pipeline is placed in service, two consecutive sets of samples shall be collected at least 24 hours apart by the Contractor from the end of the line and at other locations as designated by the Owner/Engineer, and shall be tested by the Owner for bacteriological quality in accordance with the requirements of AWWA C651. For this purpose, the pipe shall be refilled with fresh potable water and left for a period of 24 hours before any samples are collected. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained – that being two consecutive sets of acceptable samples taken 24 hours apart. Owner laboratory testing is available Monday through Thursday only. If testing is needed on other days contractor must use accredited lab and pay associated costs.

I. Coliform bacteria and e. Coli tests must be run and must be negative for both total coliforms and e. Coli (P/A Method is acceptable). Heterotrophic plate counts also need to be run on each sample (Simplate Method is acceptable) with results of less than 30 MPN/mL.

3.6 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 they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

END OF SECTION

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SECTION 33 13 01
HYDRAULIC STRUCTURES TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. Perform cleaning, flushing, disinfection and testing of all hydraulic structures and appurtenant piping, including conveyance of test water from Owner-designated source to point of use, and including all disposal of testing and disinfection water, complete and acceptable, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE STANDARDS

A. Commercial Standards:

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C651	Disinfecting Water Mains
ANSI/AWWA C652	Disinfection of Water-Storage Facilities
ANSI/AWWA C653	Disinfection of Water Treatment Plants
APHA/AWWA/WPCF	Standard Methods for the Examination of Water and Wastewater (16th edition)

1.3 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection, shall be submitted in writing for approval a minimum of 7 days before testing is to start.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All temporary valves, bulkheads, or any other control equipment shall be as determined by the Contractor subject to the Engineer's review.

B. Chlorine for disinfection shall be in the form of liquid chlorine or sodium hypochlorite solution. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301; sodium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300. Liquid chlorine shall be used only (1) in combination with appropriate gas flow chlorinators

and ejectors; (2) under the direct supervision of an experienced technician; and (3) when appropriate safety practices are observed.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting will be furnished by the Owner; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use. The Contractor shall be responsible for all costs associated with retesting. Water supplied by the Owner for retesting will cost the Contractor $150 per acre foot for water used.

B. All hydraulic structures and appurtenant pressure piping shall be tested; those for potable water shall also be disinfected. Disinfection shall be accomplished by chlorination. All chlorinating and testing operations shall be done in the presence of the Owner/Engineer. In the case of a reservoir, testing and disinfecting operations shall be combined.

C. Disinfection operations shall be scheduled as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Release of water from structures, after testing and disinfecting have been completed, shall be acceptable to the Owner/Engineer.

3.2 PRELIMINARY CLEANING AND FLUSHING

A. Prior to both testing and disinfecting, all hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle. All water, dirt, and foreign material accumulated in this cleaning operation shall be removed from the structure. The water supply for the washdown system is supplied by Owner. The Owner will pay for water for the initial cleaning and flushing. Any additional cleaning and flushing shall be at the Contractor's expense.

3.3 TESTING OF HYDRAULIC STRUCTURES AND PIPELINES

A. General: Testing shall be performed prior to backfilling. Testing shall be performed no sooner than 14 days after all portions of structure walls and associated roof systems have been completed. The structure shall be filled with water to the maximum operating water surface. All leakage shall be repaired. In general, it is expected that hydrostatic testing will be completed concurrently with disinfection procedures, so that when the reservoir passes the leakage and disinfection testing, the water is immediately available for use. If hydrostatic testing is completed separately from disinfection, or if disinfection testing fails, water will need to be drained and disposed by the Contractor in a manner acceptable to the Owner.

B. Leakage Test Requirements: After the structure has been filled, the water loss leakage test shall be performed as follows: an initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure, after allowance is made for evaporation loss. If intermediate readings or observed

leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period. Should the structure fail to pass the test, the test shall be repeated for up to 3 additional 7-day test period. If, at the end of 28 days, the structure still fails to pass the leakage test, empty the structure as acceptable to the Owner/Engineer and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage.

C. Piping shall be tested as specified in Section 33 13 00 - Water Pipeline Testing and Disinfection.

D. Structural Repairs and Visible Leakage: Repair any cracks. Cracks shall be grooved and sealed with Xypex in accordance manufacturer's instructions and Contract Drawings. Any evidence of leakage shall be repaired. Following these operations, again test the hydraulic structure. The structure will not be accepted as completed until the water loss leakage test is passed and all visible leakage repaired. In the case of a reservoir, the retesting shall again be combined with disinfection.

3.4 DISINFECTION OF HYDRAULIC STRUCTURES AND PIPELINES

A. General: Hydraulic structures which store or convey culinary potable water shall be disinfected by chlorination. Chlorination of hydraulic structures shall be performed in accordance with the requirements of ANSI/AWWA C652 using a combination of chlorination Methods 2 and 3 as modified within this Section. All piping shall be disinfected as specified in Section 33 13 00 - Water Pipeline Testing and Disinfection.

B. Chlorination: A chlorine solution (about 200 mg/l) shall be sprayed on all interior surfaces of the structure. The structure shall then be partially filled with water to a depth of approximately one-foot. During the partial filling operation, a chlorine-water mixture shall be injected by means of a chlorinating device in such a way as to give a uniform chlorine concentration during the entire filling operation. The point of application shall be such that the chlorine solution will mix readily with the inflowing water. The dosage applied to the water shall be sufficient to provide a chlorine residual of at least 50 mg/l upon completion of the partial filling operation. Attention is directed that all precautions shall be taken to prevent the chlorine solution from flowing back into the inlet water supply lines. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the lines with the chlorinated water.

C. Retention: Chlorinated water shall be retained in the partially filled structure and appurtenant piping long enough to destroy all non-spore-forming bacteria, and in any event, for at least 24 hours. After the chlorinated water has been retained for the required time, the free chlorine residual in the structure and appurtenant piping shall be at least 25 mg/l. All valves shall be operated while the lines are filled with the heavily chlorinated water.

D. Final Filling: After the chlorine residual has been checked, and has been found satisfactory, the water level in the structure shall be raised to its working water level elevation by adding potable water. Before final filling is commenced, the quantity of chlorinated water remaining in the structure after filling the piping shall, unless otherwise acceptable to the Owner/Engineer, be sufficient, when the water level is raised to its final elevation to produce

a free chlorine residual of between 1 and 2 mg/l. After the structure has been filled, the chlorine residual of the water shall be determined. If the chlorine residual is less than 1 mg/l, an additional chlorine dosage shall be added to the water in the structure. If the chlorine residual is greater than 2 mg/l, the structure shall be partially emptied and additional potable water added. In no case shall water be released prior to the expiration of the required retention period.

3.5 BACTERIOLOGIAL SAMPLING AND TESTING

A. Disinfected water storage facilities shall be sampled and tested in accordance with ANSI/AWWA C652. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner and paid for by the Contractor. Results of the testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.

3.6 CONNECTIONS TO EXISTING WATER 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 they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until all discolored water is eliminated.

END OF SECTION

DIVISION 40
PROCESS INTEGRATION

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SECTION 40 05 00
PIPING, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, seismic restraints, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. Develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D 2000	Classification System for Rubber Products in Automotive Applications

1.3 SUBMITTALS

A. Submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 01 33 20 – Submittal

Procedures, and as indicated in the individual piping sections. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports and seismic restraints necessary to accommodate the equipment and valves provided in a complete and functional system.

B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

C. Submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes fabricated will be subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

B. Tests: Except where otherwise indicated, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. Perform all tests at no additional cost to the Owner.

C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing Work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. Furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

E. NSF/ANSI 61 for Drinking Water System Components: All materials that will contact potable water shall comply with the requirements of the NSF/ANSI 61 Standard.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, furnish such assistance at no additional cost to the Owner.

1.6 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation

caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.7 CLEANUP

A. After completion of the Work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipes, fittings, and appurtenances shall be furnished in accordance with the requirements of the applicable Sections of Division 33 and this Section.

B. Miscellaneous Small Pipes: Miscellaneous small pipes and fittings shall be provided in accordance with the requirements of Section 40 05 10 - Mill Piping - Exposed and Buried.

C. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 40 05 07 - Pipe Supports, and as indicated.

D. Lining: All requirements pertaining to thickness, applications, and curing of pipe lining, are in accordance with the requirements of the applicable Sections of Division 33, unless otherwise indicated.

E. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable Sections of Division 33, unless otherwise indicated. Pipes above ground or in structures shall be field-painted in accordance with Sections 09 90 00 – Painting and Coatings or 09 97 10 - Pipeline Coatings and Linings.

F. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 33 13 00 - Water Pipeline Testing and Disinfection, or as indicated on the piping schedule.

G. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided, if approved by the Engineer, in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping above and below ground within the property limits of pump stations, and similar installations. All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. Make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.

2.2 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Insulating Flange
      a. JM Red Devil, Type E

b. Maloney Pipeline Products Co., Houston
c. PSI Products, Inc., Burbank, California
d. Engineer approved equal.

2. Flange Gasket Manufacturers
   a. Garlock, Style 3760 (NSF 61 approved)
   b. Garlock, GYLON Style 3505
   c. John Crane, Style 2160.
   d. TEADIT, Style 1161/1082 San
   e. Engineer approved equal.
3. Mechanical Type Couplings for Steel Pipe
   a. Victaulic Style 44 with Type D Heavy Duty Grooved Adaptor Ends
   b. Victaulic AGS W77 (14-inches and larger)
   c. Engineer approved equal.
4. Mechanical Type Coupling Ductile Iron Pipe Couplings
   a. Gustin-Bacon
   b. Victaulic Style 31 (flexible or rigid grooving)
   c. Engineer approved equal.
   d. Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets
5. Mechanical Type Coupling for PVC Pipe
   a. Gustin-Bacon.
   b. Victaulic Style 775.
   c. Engineer approved equal.
   d. Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends. Grooved end couplings shall be used on PVC pipe only for Schedule 80 vent piping at the vaults. Grooved end couplings shall not be used for PVC C905 water pipe.
6. Sleeve Type Couplings
   a. Dresser, Style 38.
   b. Ford Meter Box Co., Inc., Style FC1 or FC3.
   c. Smith-Blair, Style 411.
   d. Baker, Series 200
   e. Engineer approved equal.
7. Flanged End Connectors
   a. Smith-Blair, Style 972 or 975
   b. Baker, Series DJ
   c. Engineer approved equal.
8. Air and Gas Traps
   a. Armstrong Machine Works
   b. Spirax Sarco, Inc.
   c. Engineer approved equal.

2.3 PIPE FLANGES

A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall

conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. Flange Bolts: Supply all bolts and nuts in conformance with Section 05 50 00 – Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

E. Insulating Flanges and Flange Sets: Refer to Section 13 11 40 – Corrosion Monitoring and Cathodic Protection.

F. Flange Gaskets: Provide flange gaskets for all pipe flanges. Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of asbestos-free aramid fiber base, with nitrile binder and nonstick coating, suitable for temperatures to 400 degrees F, a pH of 1 to 11, and pressures to 500 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

2.4 THREADED INSULATING CONNECTIONS

A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other nonconductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.5 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. Construction: Cast mechanical-type couplings shall be provided where shown.
   1. The couplings shall conform to the requirements of ANSI/AWWA C606.
   2. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal Fabrications.
   3. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations.
   4. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure.

5. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means.
6. The coupling Manufacturer's service representative shall verify the correct choice and application of all couplings and gaskets, and the workmanship, to ensure a correct installation.

2.6 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where shown.
1. The couplings shall conform to the requirements of ANSI/AWWA C219 unless otherwise indicated.
2. Coupling shall be steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings. Bolts and nuts shall conform to the requirements of Section 05 50 00 – Metal Fabrications.
3. The middle ring shall be not less than 1/4 inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings.
4. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket.
5. Buried sleeve-type couplings shall be epoxy-coated at the factory.

B. Pipe Preparation: The ends of the pipe, where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for potable water applications shall be NSF 61/600 approved.
1. The rubber in the gasket shall meet the following specifications:
a. Color - Jet Black.
b. Surface - Nonblooming.
c. Durometer Hardness - 74 " 5.
d. Tensile Strength - 1,000 psi Minimum.
e. Elongation - 175 percent Minimum.
2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.

2.7 FLANGED END CONNECTORS

A. Flanged coupling adapters, shall be in accordance with AWWA C219.

B. Dismantling joints for connecting flanged pipe shall be AWWA C219 compliant. Provide studs and nuts to seal gasket separate and independent from tie-bar restraint system.

C. All dismantling joints shall be the restrained type per AWWA M-11. Tie-bar restraint system shall conform to ASTM A193-B7 per AWWA M-11 and be designed to withstand the test pressure shown on the Drawings.

D. All dismantling joints shall use standard flanges in accordance with AWWA C207. The thickness of the dismantling joint flanges shall be equal to or greater than the class of flange that is connected to as required by the test pressure as shown on the drawings. Buried flanges shall be wrapped with petroleum was tape per AWWA C217.

2.8 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown.

B. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application.

C. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown.

D. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown.

E. The final material selection shall be approved by the manufacturer. Submit manufacturer's shop drawings and calculations.

2.9 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. Submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings.

2.10 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1.

2.11 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shutoff valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

PART 3 - EXECUTION

3.1 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Division 33. The lining manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints at screwed flanges shall be epoxy-coated, to assure continuous protection.

B. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways, conduits, and rebars.

C. Flanges shall be installed at least 6-inches from a wall. Fittings shall be installed with sufficient clearance for maintenance and removal and reinstallation.

3.2 FIELD TESTING

A. All piping shall be tested in accordance with applicable standards and the contract documents.

END OF SECTION

SECTION 40 05 07
PIPE SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide pipe supports, seismic restraints, hangers, guides, and anchors, complete, in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrication

B. Section 40 05 00 – Piping, General

1.3 REFERENCES

A. Most recent edition:

ANSI/ASME B31.1	Power Piping
ANSI/MSS SP-58	Pipe Hangers and Supports
ASTM A53/A53M	Standard Specification for Pipe, Steel Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

1.4 SUBMITTALS

A. General: Submittals shall be in accordance with Section 01 33 20 – Submittal Procedure.

B. Shop Drawings: Shop drawings shall include the following information:
1. Drawings of pipe supports, restraints, hangers, anchors, and guides.
2. Calculations for special supports and anchors.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance: Piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. Supports and parts thereof shall conform to the requirements of ASME B31.1 – Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided at no additional cost to the Owner. All

supplementary members shall be in accordance with the requirements of the latest edition of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.

C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. Hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. Hanger rods shall be subject to tensile loading only.

D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. Spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least four times the maximum travel due to thermal expansion.

F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. Components shall be structurally suitable to withstand loads imposed.

G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. Materials of Construction:
   1. General: Pipe support assemblies, including framing, hardware, and anchors, shall be steel construction, galvanized after fabrication, unless otherwise indicated.
   2. Submerged Supports: Submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, shall be supported with

support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.

3. Corrosive: Piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

K. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. Noise Reduction: To reduce transmission of noise in piping systems, copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Manufactured Supports
   a. Basic Engineers Inc., Pittsburgh, PA.
   b. Bergen-Paterson Pipesupport Corp., Woburn, MA.
   c. Grinnell Corp. (Supply Sales Company), Cranston, RI
   d. NPS Products, Inc., Westborough, MA.
   e. Power Piping Company, Pittsburgh, PA.
   f. Engineer approved equal.

2.3 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1 – 1/4	8
1 – ¼ and 1 – 1/2	10
2	10
3	12
4	14

6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe

Maximum Spans for Pipe Supported in Minimum **120 degree** contact saddles (feet)

Nominal Pipe Diameter (inches)	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	40	43	45	47	--	--	--	--
26	33	37	41	43	45	47	--	--	--	--
28	33	38	41	44	46	48	--	--	--	--
30	34	38	42	44	47	49	--	--	--	--
32	34	38	42	45	47	50	--	--	--	--
34	34	38	42	45	48	50	--	--	--	--
36	34	39	42	45	48	50	55	--	--	--
38	34	39	43	46	49	51	55	--	--	--
40	34	39	43	46	49	51	56	--	--	--
42	35	39	42	46	49	51	56	--	--	--
45	--	39	43	47	50	52	56	--	--	--
48	--	40	44	47	50	53	57	61	--	--
51	--	40	44	47	50	53	58	61	--	--
54	--	40	44	47	51	53	58	62	--	--
57	--	40	44	48	51	54	58	62	--	--
60	--	40	44	48	51	54	59	63	66	69
63	--	40	44	48	51	54	59	63	67	70
66	--	40	45	48	52	54	59	64	67	71
72	--	41	45	49	52	55	60	64	68	72
78	--	41	45	49	52	55	61	65	69	72
84	--	41	45	49	53	56	61	66	70	73
90	--	41	45	49	53	56	61	66	70	74
96	--	41	46	50	53	56	62	67	71	75

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \frac{7500td}{32t + D}$$

Where: t = Thickness (inches)
D = Diameter (inches)
L = Maximum span (feet)

Maximum deflection of pipe shall be limited to $1/360^{th}$ of the span.

4. Support Spacing for Ductile-Iron Pipe:

Normal Pipe Diameter (inches)	Maximum Span (feet)
All diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Normal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1 - 1/2	6
2 to 4	10
6 and greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4
1	5
1 - 1/4	5
1 - 1/2	5
2	6
3	7
4	8
6	10
8	11
10	12
12	13

7. Support Spacing for Schedule 80 Polypropylene Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	3
3/4	3
1	3
1 - 1/4	4
1 - 1/2	4
2	4
3	5
4	6

6	7
8	8
10	8
12	9

8. Support Spacing for Fiberglass Reinforced Plastic (FRP) Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
2	8
3	10
4	11
6	12
8	13
10	14
12	15
14	16
16	17
18 and Greater	18

2.4 MANUFACTURED SUPPORTS

A. Stock Parts: Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

2.5 COATING

A. Galvanizing: Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. Other Coatings: Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 09 90 00 – Painting and Coating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Pipe supports, seismic restraints, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ASME B31.1 - Power Piping. Concrete inserts for pipe hangers and supports shall be coordinated with the form work.

B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. Hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

3.2 FABRICATION

A. Quality Control: Pipe hangers, supports, and seismic restraints shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

END OF SECTION

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SECTION 40 05 10
MILL PIPING – EXPOSED AND BURIED

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all exposed and buried mill piping (pipe diameter 6 inches and less) as shown and in accordance with Contract Documents. This section applies to all mechanical Work and associated piping systems.

B. All work shall be in strict accordance with the International Plumbing Code, and codes of the State of Utah, the municipality in which the work is taking place, and any other authorities having jurisdiction. Obtain required certifications and be thoroughly familiar with the local codes. Obtain and pay for all necessary permits.

C. This section outlines requirements the following small (pipe diameter 6 inches and less) mechanical piping and associated accessories:
1. Small steel pipe
2. Solvent welded PVC pipe and Valves
3. CPVC pipe and Valves
4. PVDF pipe

D. Furnish hoses, hose racks and signage where indicated on the Drawings and as indicated herein.

1.2 REFERENCE STANDARDS

A. Commercial Standards

ANSI/ASME B16.3	Malleable Iron Threaded Fittings
ANSI/ASME B16.4	Gray Iron Threaded Fittings,
ASMEB16.5	Pipe Flanges and Flanged Fittings,
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ANSI B16.12	Cast-Iron Threaded Drainage Fittings
ANSI/ASME B16.15	Cast Bronze Threaded Fittings, Classes 125 and 250
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASTM A 53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 74	Specification for Cast Iron Soil Pipe and Fittings
ASTM A 105	Specification for Carbon Steel, Forgings for Piping Applications
ASTM A 106	Specification for Seamless Carbon Steel Pipe for High Temperature Service
ASTM A 312	Specification for Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A 518	Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM B 43	Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B 88	Specifications for Seamless Copper Water Tube
ASTM C 599	Specification for Conical Process Glass Pipe and Fittings.
ASTM D 1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2996	Specification for Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D 3222	Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding, Extrusion, and Coating Materials
ASTM D 4101	Specification for Propylene Plastic Injection and Extrusion Materials
ASTM F 441	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

B. Chlorine Institute Pamphlet 6 Piping Systems for Dry Chlorine

1.3 SUBMITTALS

A. For the materials and equipment items supplied under the provisions of this Section, submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01 33 20 - Submittal Procedures.

B. Product information for all valves shall be submitted in accordance with Section 40 05 51 – Valves, General.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Small Steel Pipe Unions
      a. Henry Valve Company
      b. Vogt Valve Company
      c. Engineer approved equal.
   2. Hose bib vacuum breaker
      a. American Standard
      b. Engineer approved equal.
   3. Hose Valves (HB-3)
      a. Heavy duty bronze hydrant, with composition disc, handwheel, cap and chain.
      b. Sizes 1 1/2-inch and 2 1/2 inch.
         1) Fire-End and Croker Corp, Model 180
         2) Watts Regulator Company, Nos. J-383 and J-344
         3) Engineer approved equal.
      c. Size 1-inch, without cap and chain.
         1) Apollo (Conbraco Industries, Inc.), Model 70-805
         2) Fire-End and Croker Corp, Model 180
      d. Size ¾-inch, without cap and chain.
         1) Apollo (Conbraco Industries, Inc.), Model 70-804 or 78-104
         2) Chicago Faucet
         3) Ford Meter Box Company, Model B8H-233HB2
         4) Woodford Mfg. Company, Model Y24 or 24P
         5) Engineer approved equal.
   4. Hose Nozzles
      a. W.D. Allen Mfg. Co., Illinois
      b. Fire-End and Crocker Corp., New York
      c. Halprin Supply Co., Illinois
      d. Western Fire Equipment Co., California
      e. Engineer approved equal.

2.2 SMALL STEEL PIPE (SYSTEMS 1, 2, 3, AND 6)

A. Unless otherwise indicated, galvanized steel pipe and black steel pipe in sizes 6 inches in diameter and smaller shall conform to the requirements of ASTM A 53 or ASTM A 106, as called out in the piping schedule and shall be Schedule 40 or 80 as indicated. Galvanized steel pipe shall not be cement mortar lined unless otherwise indicated. Fittings for galvanized steel pipe shall be of galvanized malleable iron, with NPT or grooved ends. Black pipe may have welded joints, with standard or extra strong welding fittings, or fittings indicated. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
   2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
   3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.

4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.3 STAINLESS STEEL PIPE (SYSTEM 14)

A. Unless otherwise indicated, stainless steel pipe shall be Type 316 Schedule 40 threaded pipe conforming to ASTM A 312 with stainless steel threaded fittings, or with stainless steel welding fittings, where indicated.

2.4 HOSE BIBBS AND HYDRANTS

A. All hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs "DO NOT DRINK," in clearly legible letters, and permanently attached at the hose bibb. Hose bibbs shall be provided with vacuum breakers.

2.5 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact Class 12454-B, Schedule 80, conforming to ASTM D 1785, unless otherwise indicated. Fittings shall be of the same material as the pipe. Unless otherwise indicated, joint design shall be for solvent-welded construction to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.

2.6 PE (POLYETHYLENE) TUBING

A. Chemical Service:
1. Polyethylene tubing, for all analyzers, turbidimeters, chemical conveyance, and testing apparatus shall be linear high density polyethylene tubing. All tubing shall have a minimum working pressure of 150 psi at 75 deg F.

B. Potable Water Service
1. Polyethylene tubing potable water service shall be multiple-layered, UV-protected, chlorine resistant cross-linked polyethylene. Tubing supplied shall have nominal CTS (copper tube size) outside diameter. The SDR rating shall be 9. The pressure rating of the tubing shall be 200 psi at 75 degrees. Potable water service tubing shall be Vanex Ultra Pex tubing or Engineer approved equal.

2.7 HOSES AND NOZZLES

A. Furnish the following lengths of hose:
1. 2 - 100 ft lengths of 1-1/2-inch diameter fire hose

B. Each length of hose shall be provided with male and female connectors and nozzle. Hoses shall be fire hose designed for a working pressure of at least 200 psi.

C. Nozzles shall be brass fire hose nozzles.

2.8 GASKETS AND BOLTS

A. Except as otherwise indicated, gaskets for flanged joints shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

B. Except as otherwise indicated, bolts shall conform to the requirements of Section 05 50 00 – Metal Fabrications.

2.9 PIPE SUPPORTS

A. Pipe Supports, hangers, anchors, seismic restraints, and guides shall be in accordance with the requirements of Section 40 05 07 - Pipe Supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Small Steel Pipe: Buried galvanized or black steel pipe shall be coated as specified in Section 09 90 00 – Painting and Coatings or provided with an extruded high density polyethylene coating with minimum thickness of 35 mils.

B. Plastic Pipe: PVC pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise indicated. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. Obtain the services of the pipe manufacturer, to instruct the pipe fitters in the correct way of making solvent welded and threaded joints. Only clean, fresh primer and solvent shall be used at all times at the recommended temperatures.

C. Drain Traps: Drain traps shall be installed at low points in air and gas lines or elsewhere where indicated. Liquid outlets shall be piped to the nearest floor drain or open sump.

D. Couplings: Pipe couplings shall be installed in strict accordance with the manufacturer's printed recommendations, using the correct style coupling and gasket for any given application.

E. Gaskets for Flanged Joints: Gaskets shall be in accordance with the requirements of Section 40 05 00 - Piping, General.

F. Insulating Connections: All insulating connections shall be installed in accordance with manufacturer's printed instructions. Care shall be exercised to prevent damage to insulating fittings, while making up the joints.

END OF SECTION

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SECTION 40 05 50
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General, apply to this Section.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Combination Air Valves
      a. APCO (Valve and Primer Corporation) – For 4-inch air valves and larger
      b. Aquestia (A.R.I. Air Valves) – For 1-inch air valves and smaller
      c. Val-Matic
      d. Engineer approved equal.
   2. Solenoid Valves
      a. For general duty
         1) ASCO Valve Warehouse, Model RED HAT
         2) Skinner Valve (Parker Hannifin Corporation)
         3) Magnatrol Valve Corporation
         4) J. D. Gould Company
         5) Engineer approved equal.

2.2 AIR-VACUUM AND AIR-RELEASE VALVES

A. All air valves provided for this project shall be combination air release and vacuum valves.

B. All air valves provided for this project shall be outfitted with low durometer seating to provide drop tight seating at pressure as low as 2.9-psi.

C. All air valves provided for this project shall be capable of vertically fitting within the allowable pipe cover depth shown on the plans.

D. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of either fusion bonded high-strength cast iron or 304 stainless steel. The

floats and moving parts shall be constructed of Type 316 or Type 304 stainless steel, HDPE, or Buna-N and be capable of sealing to the pressures specified. Seat, washers, O-rings, and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated. The valve shall be equipped with an integral surge alleviation mechanism that automatically dampens surge pressures due to rapid air discharge or subsequent rejoining of separated water columns. The manufacturer shall have ISO-9001, and third-party vacuum testing to certify sizing and performance. CFD, FEA or other types of theoretical modeling are not acceptable. Valve shall have a 2-year in-service warranty for all internal components, include top and bottom flushing ports.

E. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

F. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.

2.3 SOLENOID VALVES

A. Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled. Unless otherwise indicated, for chemicals and corrosive fluids, solenoid valves with PVC, polyvinylidene fluoride (PVDF), or Teflon (PTFE) materials of construction, suitable for the specific application shall be provided. Enclosures shall be NEMA rated in accordance with the area designations of Section 26 00 00 – Electrical General Provisions. Coil ratings shall be for continuous duty. For electrical characteristics see the electrical Drawings or Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Backflow preventers shall be installed in utility water lines where required by applicable codes or regulations, and where indicated on Contract Drawings.

B. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 40 05 51 – Valves, General.

C. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

END OF SECTION

SECTION 40 05 51
VALVES, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

C. Unit Responsibility: A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, be responsible to the Owner for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.

D. Single Manufacturer: Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 - Submittal Procedures.

B. Shop Drawings: Shop Drawings shall contain the following information:
   1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.
   2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.
   3. Cavitation limits for control valves.
   4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
   5. Data in accordance with Section 40 05 52 – Valve and Gate Actuators for electric motor-actuated valves.
   6. Complete wiring diagrams and control system schematics.
   7. Valve Labeling: A schedule of valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Technical Manual: The Technical Manual shall contain the required information for each valve.

D. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. General: Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.

B. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 40 05 52 - Valve and Gate Actuators.

C. Protective Coating: The exterior surfaces of all valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 09 90 00 – Painting and Coating. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

D. Valve Labeling: Except when such requirement is waived by the construction manager in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 41 05 02 - Identification for Piping and Equipment, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the construction manager.

E. Valve Testing: As a minimum, unless otherwise indicated or recommended by the reference Standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. Hydrostatic Testing: Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valves rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.
2. Seat Testing: Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

3. Performance Testing: Valves shall be shop operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.

F. Certification: Prior to shipment, submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

G. Valve Marking: Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. General: Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:
   1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
   3. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.
   4. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.
   5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
   6. PVC: Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.
   7. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.
   8. NSF Standard 61: Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

A. Bodies: Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections: Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.

C. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.

D. Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Bronze valve stems shall conform to ASTM B 584, except that zinc content shall not exceed 16 percent.

E. Stem Guides: Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 316 stainless steel.

F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

G. Nuts and Bolts: Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 – Metal Fabrications.

2.4 VALVE ACCESSORIES

A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. Furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. Also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.6 MANUFACTURERS

A. Manufacturer's Qualifications: Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. General: Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. Access: Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

END OF SECTION

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SECTION 40 05 52
VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section apply to valves and gates except where otherwise indicated in the Contract Documents.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrications

B. Section 09 90 00 – Painting and Coating

C. Section 26 00 00 – Electrical General Provisions

D. Section 40 05 51 – Valves, General

1.3 REFERENCES

A. American Water Works Association (AWWA) standards, most recent editions:

ANSI/AWWA C500	Metal-Seated Gate Valves for Water Supply Service
ANSI/AWWA C504	Rubber-Seated Butterfly Valves
ANSI/AWWA C540	Power-Actuating Devices for Valves and Slide Gates

B. National Fire Protection Association (NFPA) standards, most recent editions:

NFPA 70	National Electrical Code (NEC)

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 20 – Submittal Procedures and Section 40 05 51 – Valves, General.

B. Shop Drawings
   1. Submit shop drawing information for actuators together with the valve and/or gate submittals as a complete package.

C. Calculations
   1. Submit calculations showing dynamic seating and unseating torque versus output torque of the actuator.

1.5 OPERATION AND MAINTENANCE DATA

A. Furnish technical manuals for the butterfly valves, butterfly valve manual actuators, and butterfly valve electric motor actuators under one cover as operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Unit responsibility
   1. Be responsible to Owner for compliance of the valves, gates, and actuators with the Contract Documents.
   2. Make the valve or gate manufacturer responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates.

B. Single manufacturer required
   1. Where two or more valve or gate actuators of the same type or size are required, provide actuators produced by the same manufacturer.

C. Where applicable, coordinate the products specified in this Section with the electrical requirements of Section 26 00 00 – Electrical General Provisions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 25 10 - Products, Materials, Equipment and Substitutions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide shut-off and throttling valves and externally actuated valves and gates with manual or power actuators.

B. Unless otherwise indicated, and wherever applicable, provide actuators in accordance with AWWA C540.

C. Furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable.

D. Provide actuators with torque ratings equal to or greater than required for valve seating and dynamic torque, whichever is greater, and capable of holding the valve in any intermediate position between fully open and fully closed without creeping or fluttering.

E. Determine actuator torque ratings for butterfly valves in accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Identify wires of motor-driven actuators by unique numbers.

F. Securely mount actuators by means of brackets or hardware specially designed and sized for this purpose and of ample strength. Cast the word "open" on each valve or actuator with an arrow indicating the direction to open in the counterclockwise direction. Equip gear and power actuators with position indicators. Where possible, mount manual actuators between 48 and 60 inches above the floor or the permanent working platform.

G. Coordinate electric, pneumatic, and hydraulic actuators with the power requirements of Division 26 and instrumentation equipment indicated in Division 40 of these Specifications.

H. Fasteners
1. Provide fasteners in accordance with Section 05 50 00 – Metal Fabrications.

I. Protective coatings
1. Provide protective coatings in accordance with Section 09 90 00 – Painting and Coating.

2.2 MANUFACTURERS

A. Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, coordinate selection to have the fewest number of manufacturers possible.

B. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Manual worm gear actuator
a. Auma Riester, GmbH; GS Series
b. Flowserve Corporation; Limitorque HBC Series
c. No equal.
2. Electric motor actuator (AC Reversing (Open/Close) Control Type)
a. Auma Riester, GmbH;
1) SA Series for valves 12 inches and smaller.
2) SA Series with GS worm gear for valves 14 inches and larger.
b. Auma, SIPOS SEVEN with worm gear.
c. Flowserve Corporation:
1) Limitorque LY Series for valves 12 inches and smaller.
2) Limitorque L-120 with HBC worm gear for valves 14 inches and larger.
d. Rotork Corporation:
1) IQ with worm gear.
e. No equal.
3. Electric motor actuator (AC Modulating Control Type)
a. Auma Riester, GmbH;
1) SA Series for valves 12 inches and smaller.
2) SA Series with GS worm gear for valves 14 inches and larger.
b. Auma, SIPOS SEVEN with worm gear.
c. Flowserve Corporation:
1) Limitorque LY Series for valves 12 inches and smaller.
2) Limitorque L-120 with HBC worm gear for valves 14 inches and larger.
d. Rotork Corporation:
1) IQ with worm gear.
e. No equal.
4. 120 VAC Quarter-Turn and Multiturn Electric Valve Operators
a. Asahi/America; Quarter Master
b. RCS
c. Engineer approved equal.

2.3 MATERIALS

A. Furnish current models of actuators, fabricated from commercial quality materials.

B. Liberally size for the required torque.

C. Materials to be suitable for the environment in which the valve or gate is to be installed.

2.4 MANUAL ACTUATORS

A. General
   1. Unless otherwise indicated, furnish valves and gates with manual actuators.
   2. Furnish valves in sizes up to and including 4 inches with direct acting lever or handwheel actuators of the manufacturer's standard design.
   3. For larger valves and gates, furnish gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel.
   4. For buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 24-inches in diameter and larger, and where so indicated, furnish worm gear actuators, hermetically sealed watertight and grease packed.
   5. Other valves, 6-inches to 20-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves
   1. Unless otherwise indicated, furnish buried valves with extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys.
   2. Where indicated, install buried valves in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Permanently label covers of valve boxes as required by the Owner, local Utility Company or Engineer. Furnish with wrench nuts that comply with AWWA C500.

C. Chain actuator
   1. For manually activated valves with the stem located more than 7-feet above the floor or operating level, provide with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, all provided by the valve manufacturer.
   2. Fabricate the wheel and guide of ductile iron, cast iron, or steel, and the chain of hot-dip galvanized steel or stainless steel
   3. Extend 5’-6” above the operating floor level.
   4. The valve stem of chain-actuated valves shall be extra strong to allow for extra weight and chain pull. Provide hooks for chain storage where chains interfere with pedestrian traffic.

D. Floor stands
   1. Valve actuator floor stands shall be cast iron or fabricated steel pedestals. The centerline of the actuator shall be approximately 42 to 48 inches above the base of the pedestal.

E. Floor boxes

1. Provide hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

F. Tee Wrenches
1. Furnish buried valves with floor with 2 operating keys or 1 key per 10 valves, whichever is greater. Size tee wrenches so that the tee handle will be 2 to 4 feet above ground and fit the operating nuts.

G. Manual worm gear actuator
1. The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel.
2. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing.
3. The actuator shall consist of spur or helical gears or worm gearing with self-locking gear ratio to prevent "back-driving". Fabricate the spur or helical gears from hardened alloy steel and the worm gear from alloy bronze.
4. Fabricate the worm gear shaft and the handwheel shaft of 17-4 PH or similar stainless steel.
5. Accurately cut gearing with hobbing machines.
6. Use ball or roller bearings throughout.
7. Provide output shaft end with spline to allow adjustable alignment.
8. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator.
9. Design gearing for a 100 percent overload.
10. The entire gear assembly shall be sealed weatherproof.
11. Locate worm gear actuators for submerged valves above concrete deck. Locate worm gear actuators for valves in vaults at the valve.
12. Worm gear actuators must be rated for outdoor temperature service in enclosed box.

H. Traveling-nut actuator
1. The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel.
2. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition.
3. Fabricate the screw and gear from hardened alloy steel or stainless steel, and the nut and bushings from alloy bronze.
4. Grease-lubricate the bearings and gear by means of nipples.
5. Design gearing for a 100 percent overload.

2.5 ELECTRIC MOTOR ACTUATORS

A. General
1. Where electric motor actuators are indicated, attach an electric motor-actuated valve control unit to the actuating mechanism housing by means of a flanged motor adapter piece.
2. The motor actuator includes the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly.

3. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. Fabricate the spur or helical gears from hardened alloy steel and the worm gear from alloy bronze.
4. Accurately cut gearing with hobbing machines.
5. Lubricate power gearing with grease or oil in sealed housing.
6. Use ball or roller bearings throughout.
7. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.
8. Except for modulating valves, design the unit so that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
9. Switches
    a. Furnish limit switches to sense valve position at each end of travel.
    b. Limit switch adjustment shall not be altered by manual operation.
    c. Furnish one set of normally open and one set of normally closed contacts at each end of travel.
    d. Provide contacts of silver, capable of reliably switching the source power from the control system as shown on the Contract Drawings.
    e. Furnish a torque sensor.
    f. The torque limit shall be adjustable from 40 to 100 percent of rating in 1 percent increments. The motor shall be de-energized if the torque limit is exceeded.
    g. A boost function shall be included to prevent torque trip during initial valve unseating, and a "jammed valve" protection feature with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs.
    h. Valve actuators with limit switches shall be as manufactured by Auma or Rotork.
10. Handwheel operation
    a. Provide a permanently attached handwheel for emergency manual operation.
    b. The handwheel shall not rotate during electrical operation.
    c. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb.ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb.
    d. Cast or permanently affix an arrow and either the word "open" or "close" on the handwheel to indicate the appropriate direction to turn the handwheel.
    e. Provide a clutch lever to put actuator into handwheel operation.
    f. For valves with electric motor actuators having stems more than 7 feet above the floor, provide chain activator handwheels. Provide clutch lever with a cable secured to the chain to allow disengagement for manual operation.
11. Motor
    a. Provide motors of the totally enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. Design motor to use stator and rotor as independent components from the valve operation such that the failure of either item does not require actuator disassembly or gearing replacement.
        1) Power for operation: 480 volt, 3-phase, 60 Hz current (unless noted otherwise on Contract Drawings).

2) Insulation: Class F insulation.
3) Frame: Provide frame dimensions in accordance with the latest revised NEMA MG Standards.
4) Temperature rise: Maximum observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out.
5) Bearings: Supply bearings of the ball type, with thrust bearings where necessary. Provide bearings with suitable seals to confine the lubricant and prevent the entrance of dirt and dust.
6) Motor conduit: Provide watertight conduit connections.
7) Motor contacts: Provide two Class B thermal contacts or solid state thermistors embedded with the motor windings to protect against over-temperature damage.
8) Heater: Provide the motor with a space heater suitable for operation on 120-volt, single phase, 60 Hz circuit unless the entire actuator is a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.
9) Disconnect: Provide each electric motor actuator with a local disconnect switch or circuit breaker to isolate power from the motor and controller during maintenance activities.

12. Cycle time: Size open-close/throttling service valve motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes unless otherwise indicated elsewhere in the specifications.
13. Schedule for Electric AC Actuator Type: For a complete schedule of electric actuators required on project valves (4-inch diameter and larger), refer to Contract Drawings.
    a. Provide all electric actuators identified as "OPEN/CLOSE ELECTRIC" on the Contract Drawings, with AC Reversing type actuators with an open to close and close to open speed time of 60 seconds and 60 seconds, respectively.
    b. Provide all electric actuators identified as "MODULATING ELECTRIC" on the Contract Drawings, with AC Modulating type actuators with an open to close and close to open speed time of 60 seconds and 60 seconds, respectively
14. Remote Actuator Control Station. For valves with electric motor actuators where the valve is located in the lowest level of a multi-level vault with a mezzanine, provide a remote actuator control station at the mezzanine level.
    a. Provide conduit and wiring between the actuator controls and the valve actuator for these applications.
    b. Mount the actuator controls on the guardrail above the valve at a location approved by Engineer.
15. Configure all electric motor actuators for Modbus TCP/IP communication protocol.

B. Electric motor actuators (AC Reversing (Open/Close) control type)
1. General: Where indicated, provide electric motor actuators of the AC reversing type, complete with local control station with open / stop / close and local/off/remote selector switches on the actuator local control station. Valves shall be capable of stopping at operator-controlled set point.

2. Open/Close operating speed: Unless otherwise indicated, electric actuators shall provide a full close to full open or full open to full close operating time range from 30 to 60 seconds.
3. Actuator Appurtenances: Provide the actuator for each valve with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at mezzanine elevation and within sight of the valve actuator. Provide conduit and wiring between the actuator controls and the valve actuator for these applications.
4. Starter: Provide suitably sized amperage rated reversing starter with its coils rated for operation at 480 volt, 3-phase, 60 Hz current (unless otherwise noted on the Contract Drawings.
    a. Include a control power transformer to provide a 120-volt source, unless otherwise indicated.
    b. Equip the starter with 3 overload relays of the automatic reset type, with its control circuit wired as indicated.
    c. Provide the integral weatherproof compartment with a suitably sized 120-volt ac, single phase, 60 Hz space heater to prevent moisture condensation on electrical components.
    d. Provide a local power disconnect switch with each actuator.
    e. Provide a close-coupled, padlockable switch with each actuator.
5. Local Control Station: Provide each actuator with a local control station with the valve actuator assembly. The station shall include open, close, and stop push buttons, and a local/remote selector switch.

C. Electric Motor Actuators (AC Modulating Control Type)
1. General: Where indicated, provide modulating electric motor actuators of the AC modulating type complete with a local control station with power disconnect switch or circuit breaker, provided with open/stop/close and local/off/remote selector switches on the actuator local control station, and open/close status lights.
2. Actuator Appurtenances: Provide the actuator for each valve with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at mezzanine elevation and within sight of the valve actuator. Provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Control Module: Provide electronic solid-state AC type control module with control outputs for positioning the valve via 4 - 20 ma input signals.
4. Starter: Provide actuator to control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes and rated for continuous modulating applications.
    a. Power supply: 480 volt, 3 phase, 60 Hz.
    b. Supply a disconnect switch with each actuator.
5. Construction:

a. Provide microprocessor-based control with an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and pushbutton calibration elements for field setup.
b. Potentiometer adjustments shall contain a PID control function internally.
c. As a standard feature, supply controller with a loss of command signal protection, selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 - 20 ma.
d. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate of 600 starts per hour at the 50 percent to 85 percent travel range of the valve.
e. The system shall allow control of the open, close, or percent open function when the local/off/remote switch is in the remote position.
f. Provide each actuator with a frequency shut down system which when pre-programmed, functions as directed upon receipt of an ESD signal.

D. 120 VAC Quarter-Turn and Multiturn Electric Valve Operators on Isolation Valves 3-inch Diameter and Smaller
1. General: Where indicated on Contract Drawings, and primarily on vendor supplied equipment skids and control packages, 120 VAC electric actuators may be supplied on smaller valves of 3-inch diameter and smaller, as follows:
2. Provide 120 VAC, 1-phase motor-operated valve operator suitable for use with quarter-turn ball valves, multiturn diaphragm valves, and multiturn globe valves with the following operator characteristics and features:
a. Reversing capacitor-start motor rated for operation on 120 VAC, 60 Hz, single phase. Output torque as required for valve application and pressure differential.
b. Integral motor overload protection, with auto reset.
c. Permanently lubricated gear train.
d. For open/close control, provide four single pole, double throw cam actuated limit switches (2 OPEN, 2 CLOSED). One set of limit switches shall be used for both motor control and local indication. The other set shall be available for connection to remote monitoring. Limit switch contacts shall be adjustable and rated for not less than 5 amps at 120 VAC.
e. Local Control Station: Open/Close: Corrosion-resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection and 2 pushbuttons, OPEN and CLOSE. In addition, provide OPEN and CLOSE indicating lights operating at 120 VAC for connection to valve control limit switches.
f. For modulating control, provide an electronic positioner and feedback potentiometer. The positioner shall utilize a 4 - 20 ma signal to adjust the valve opening. Feedback potentiometer shall be 0 - 1000 ohms.
g. Local Control Station Modulating: Corrosion resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection, one OPEN and one CLOSE push buttons, a resistance to current converter with 4 - 20 ma output, and a 0 to 100 percent electronic valve position indicator.
h. Local power disconnect switch (NEMA 4X) for disconnecting 120 V ac power to valve. Install disconnect in the field within sight of the valve actuator, in accordance with the requirements of NPFA 70.

3. Refer to Contract Drawings for control diagram wiring interface.
4. Two-wire control systems are not required for these actuators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valve and gate actuators and accessories in accordance with Section 40 05 51 - Valves, General.
   1. Locate actuators to be readily accessible for operation and maintenance without obstructing walkways.
   2. Do not mount actuators where shock or vibrations will impair their operation.
   3. Do not attach actuator support systems to guardrails, process piping, or mechanical equipment.

3.2 INSPECTION, STARTUP, AND FIELD ADJUSTMENT

A. An authorized representative of the manufacturer visit the Site and witness the following activities. Provide the minimum time specified.
   1. Installation of the equipment for not less than one Work Day.
   2. Inspection, checking, and adjusting the equipment for not less one Work Day.
   3. Startup and field-testing for proper operation for not less than one Work Day

3.3 CLOSEOUT ACTIVITIES

A. Instruction of Owner's Personnel: The authorized service representative to visit the Site for not less than 1 Day to instruct Owner's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

END OF SECTION

SECTION 40 05 61
GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide gate valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

C. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedure and Section 40 05 51 – Valves, General.

PART 2 - PRODUCTS

2.1 GENERAL

A. Buried valves shall be of the inside screw, non-rising stem type. The valve actuators shall be as indicated, with counter-clockwise opening stems, in accordance with Section 40 05 52 - Valve and Gate Actuators.

B. Gate valves 18-inches and larger shall be provided with a bypass line and isolation valve.

2.2 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Resilient-Seated Gate Valve
      a. Mueller Company
      b. M & H
      c. Clow
      d. Engineer approved Equal
   2. Gate Valves (Smaller than 3-inch)
      a. Crane Company
      b. Milwaukee Valve Company
      c. Wm. Powell Company
      d. Stockham Valves and Fittings
      e. Walworth Company
      f. Engineer approved Equal

2.3 RESILIENT-SEATED GATE VALVES

A. General: Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the Engineer.

B. Construction: Resilient-seated gate valves shall conform to AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service. The valves shall be suitable for a minimum design working water pressure of 150 psig see NTS, above, with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber-coated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 1 of AWWA C515. The stem, stem nuts, glands, and bushings shall be bronze, with the stem seal per AWWA C515.

C. Pressure Ratings:
   1. AWWA C515 valves 3- through 36-inch with outside screw-and-yoke (OS&Y) rising stem and 3- through 16-inch for non-rising-stem (NRS), shall be rated for 200 psig minimum design working water pressure.

D. Protective Coating: Valves shall be factory coated in accordance with Section 09 90 00 - Painting and Coating. Submit a test report from a coating inspector that the coating is holiday-free. Be aware that it may retain the services of a third party coating applicator to achieve the holiday-free requirement.

E. Actuators: Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 40 05 52 – Valve and Gate Actuators.

PART 3 - EXECUTION

3.1 GENERAL

A. Gate valves shall be installed in accordance with the provisions of Section 40 05 51 – Valves, General. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 40 05 63
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

C. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures and 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Stainless Steel Ball Valves (3-inches and Smaller)
      a. Conbraco Industries, Inc. (Apollo)
      b. ITT Engineered Valves
      c. Neles-Jamesbury, Inc.
      d. Watts Regulator
      e. Worcester Controls
      f. Engineer approved Equal
   2. Metal Ball Valves (3-inches and Smaller)
      a. Conbraco Industries, Inc. (Apollo)
      b. ITT Engineered Valves
      c. Neles-Jamesbury, Inc.
      d. Watts Regulator
      e. Worcester Controls
      f. Engineer approved Equal
   3. Plastic Ball Valves (1 ½ inch or Smaller)
      a. ASAHI-America
      b. George Fischer, Inc.
      c. NIBCO Inc., (Chemtrol)
      d. Plast-O-Matic Valves, Inc.
      e. Spears Mfg. Co.
      f. Watts Regulator
      g. Engineer approved Equal

2.2 STAINLESS STEEL BALL VALVES (3-INCHES AND SMALLER)

A. General: Unless otherwise indicated, general purpose stainless steel ball valves in sizes up to 3-inches shall have actuators in accordance with Section 40 05 52 - Valve and Gate Actuators.

B. Body: Ball valves up to and including 1.5-inches in size shall have 316 stainless steel 2 or 3 piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 3-inches in size shall have 316 stainless steel 2 or 3 piece bodies with threaded ends for a pressure rating of 300 psi unless otherwise indicated.

C. Balls: The balls shall be 316 stainless steel, with standard port (single reduction) or full port openings.

D. Stems: The valve stems shall be of the blow-out proof design, of stainless steel, or other acceptable construction, with reinforced teflon seal.

E. Seats: The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

2.3 METAL BALL VALVES (3-INCHES AND SMALLER)

A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 3-inches shall have actuators in accordance with Section 40 05 52 - Valve and Gate Actuators.

B. Body: Ball valves up to and including 1.5-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 3-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

C. Balls: The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

D. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.

E. Seats: The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

2.4 PLASTIC BALL VALVES (1.5-INCHES AND SMALLER)

A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific fluid application. Valves shall have manual actuators in accordance with Section 40 05 52 - Valve and Gate Actuators, unless otherwise indicated.

B. Construction: Plastic ball valves shall have true-union ends or flanged. The balls shall have full size ports and teflon seats. Body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. Ball valves for sodium hypochlorite solution service shall be drilled through the ball or body per valve manufacturer recommendation to relieve off gas

and equalize pressure across the valve. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.

PART 3 - EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with Section 40 05 51 – Valves, General. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

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SECTION 40 05 64
BUTTERFLY VALVES (DOUBLE OFFSET)

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. Provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Valves, General apply to this Section.

C. The requirements of Section 40 05 52 – Valve and Gate Actuators apply to this Section.

D. Valves shall be of the body type, pressure class, end joint, and actuator type as indicated on the valve schedules on Contract Drawing M-01.

E. Valves shall be NSF 61 certified for use in drinking water.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Valves, General.

B. Shop Drawings
   1. Complete Shop Drawings of butterfly valves and actuators.
   2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.
   3. Certification of proof-of-design test from the valve manufacturer.
   4. Certification: Obtain written certification from the butterfly valve manufacturer, addressed to the Owner, stating that the butterfly valves and the valve operators will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all butterfly valves and valve operators, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. Submit all such certificates to the construction manager.
   5. Testing and certifications shall be reviewed by the Engineer prior to shipping.
   6. Technical Manuals: Furnish technical manuals for the butterfly valves, manual operators, and electric motor valve operators under one cover and in accordance with the requirements of Section 01 33 20 – Submittal Procedures.
   7. Valve Labeling: Submit a schedule of butterfly valves to be labeled indicating in each case the valve location and the proposed wording for the label.
   8. Field Procedures: Written instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to delivery of the butterfly valves and valve operators.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504. Tests shall be completed and submitted to Engineer for review prior to shipping. All valves shall be factory and field tested.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Butterfly Valves (4-inches and Larger) – Class 150B and 250B
      a. VAG Armaturen, EKN Double Offset
      b. AV-Tek Dex Double Offset
      c. No Equal

2.2 BUTTERFLY VALVES 4-INCH AND LARGER – CLASS 150B AND 250B

A. General: The butterfly valve shall be designed expressly for waterworks applications and shall be of the double offset design whereby the elastomeric seal is not compressed with the valve in the open position. Zero, single and API based triple offset butterfly valve designs are not acceptable. Butterfly valves for water working pressures up to 150 psi shall conform to ANSI/AWWA C504 Class 150B. Butterfly valves for water working pressures greater than 150 psi shall conform to the design requirements of ANSI/AWWA C-504, Class 250B. Valves shall be of the size and class indicated in the valve schedule or in the plans. All valves, unless noted otherwise, shall be sized for bi-directional water service, full rated pressure and a line velocity of 16 feet per second and suitable for higher linebreak velocities of 50 fps. Lifting lugs will be provided for all valves 24" and larger.

B. Flanges: Class 150B flanged valves shall have ANSI B16.1 Class 125-pound flanges. Class 250B flanged valves shall comply with ANSI B16.1 Class 250 up through 48-inch unless otherwise noted or if mating to ductile iron pipe. Above 48-inch, flange outside diameter, number of bolts, diameter of bolt circle, and diameter of bolts shall comply with ANSI/AWWA C 207 Class E.

C. Body: Valve bodies shall be ductile iron, ASTM A536 65-45-12 or A536 60-40-18. Cast gray iron is not allowed due to near zero elongation and as it vulnerable to shear stress. The valve body shall include integrally cast support feet top and bottom. It shall be mechanically equipped with a fastened stainless steel stamped or engraved tag indicating manufacturer and reference build data. Valves 54-inch and larger shall include two tags diametrically opposed. The valve build data shall be made available upon request by the customer and shall be retained by the manufacturer for no less than 20 years unless noted longer. The entire valve body and flanges shall be epoxy corrosion coat protected except for the valve shaft bores.

D. Disc: The disc shall be ductile iron ASTM A536 65-45-12 or ASTM A536 60-40-18. The entire disc and all its wetted surfaces shall be coated without exception. The disc's elastomeric seal retainer shall be 304 or 316 stainless steel. Neither bronze nor carbon steel

is acceptable. Both the disc and elastomeric seal retainer shall have recesses designed to retain a dual shouldered seal under extreme localized velocities, at full differential opening and/or linebreak closing. The disc shall be mechanically fastened to the valve shaft by using Polygon "no fail" connection or equivalent stainless steel key connection or the disc shall be mechanically fastened to the valve shaft using tangential stainless steel shaft pins of type 316 or higher alloy. Disc pins shall extend completely through the valve and shall be mechanically fastened. The disc shall be completely coated except for the disc shaft bores.

E. Shaft: Valve shafts shall be dual stub shafts of stainless steel ASTM A240 or A276, Type 316, 304, 431 or 420. The valve shaft material and thickness shall be suitable for the applications pressure and velocity without the use of its safety factors. Shafts may not be turned down to fit drive splines without accompanying torsional strength reduction calculations and its effect on the safety factor.

F. Elastomeric Seal and Seal Ring: Valve seals shall be EPDM, secured to a completely coated valve disc by a 316 stainless steel, continuous non-segmented seal ring and secured by 316 stainless steel fasteners. The seal shall not scallop, cold flow or tear at localized velocities less than 300 fps. The elastomeric seal shall not be penetrated by fasteners. The valve shall be bi-directionally leak free. The elastomeric seal shall be double shouldered and extend no greater than 0.25 inches past the disc edge to seat the valve. The seal shall be designed to flex in either flow direction. The elastomeric seal shall be field replaceable and adjustable in line. It shall not require special skills or tools to replace the seat. Seat methods which do not comply or use either irreplaceable vulcanized seals or which use hardened epoxy or grout in a dovetailed groove are not acceptable.

G. Metallic Seat: The metallic valve seat shall be located in the valve body. It shall be a highly wear resistant stainless steel alloy. There shall be no gap between the valve body and metallic body seat and consequently no potential for corrosion or lifting of the seat. The seat shall be applied through a high alloy weld overlay process or other manufacturing technique. Metallic seats shall not be mechanically retained by fasteners.

H. Shaft Seals: Shaft seals shall not need periodic manual adjustment. They shall be multi-O-ring seals protecting both the OD and ID of the shaft bearings. They shall prevent pressurized system water from entering the uncoated valve disc hub and valve body shaft bore. The valve shaft shall remain non-wetted and unpressurized. The non-wetted shaft shall allow the actuator to be removed without dewatering the pipeline. It shall prevent debris and system pressurized water from entering into the uncoated valve body shaft bore. It shall prevent waters or contaminated media, external to the valve, from entering through the valve shaft under vacuum/ negative pressure conditions in the pipeline, or hydrostatic pressure conditions external to the valve. Neither manual pulldown packing glands nor braided packing are allowed. The outer shaft seals shall be a replaceable cartridge type, bolted to the valve body. Packing shall not be held in place with an adapter plate or by the valve actuator.

I. Shaft Bearings: Valve shaft bearings shall be corrosion resistant, self-lubricating sleeve type made of bronze, stainless steel or stainless steel backed PTFE. Bearing choice and consequent bearing friction shall be correctly added to valve input torque requirements.

J. Strength: The proportion and dimensions of all parts of the valve and actuator shall be designed to withstand, without failure, the stresses occurring under the testing and operating conditions. The maximum allowable stress in any material shall not exceed 1/5 of the

ultimate tensile strength or 1/3 of the minimum yield strength. Class 150B valves shall be rated to 150 psi and Class 250B valves shall be rated to 250 psi applied to one side of the disc with zero pressure applied to the other side of the disc while in the closed position, without damage or permanent deformation to any part of the valve, seat, disc or shaft. The valve shall be capable of withstanding such pressures in both directions.

K. Safety Disc Pinning: Where noted herein, where noted on the plans or in the bid documents, an integrated safety locking device shall be incorporated. The valve shall have an externally lockable disc in the closed position. Calculations shall be provided to verify that the disc cannot rotate even with the full stall output torque of the actuator. The disc shall remain in the zero leak sealed closed position even if the entire actuator is removed for safety or maintenance. With the actuator and or the adapter plate removed, the valve will not leak through the stem. The locking device shall be handwheel operated; stainless steel wetted construction, pad lockable and suitable for lockout/tag out safety procedures.

L. Manual Actuators: Actuators shall conform to Section 40 05 57 – Valve and Gate Actuators and to ANSI/AWWA C 540, subject to the following requirements. All actuators shall be self-locking and shall hold the valve disc in the closed, open and any intermediate position without creeping or fluttering. All actuators shall incorporate a mechanical stop-limiting device to prevent over travel of the disc. Unless direct buried or otherwise indicated, all manually actuated butterfly valves shall be equipped with a handwheel and external position indicator. The number of turns for direct buried valves shall be a minimum of 1.4 times the nominal valve size with no fewer than 25 turns. The valve manufacturer shall be responsible for mounting and testing the actuator. Screw-type (traveling nut) actuators are not permitted due to their inconsistent output torques through the 90 degree stroke. All manual direct buried service actuators shall be designed for a 300 foot-pound input torque against the closed and open travel stops. The owner reserves the right to field verify.

M. Worm-Gear Actuators: All valves including submerged and buried valves, shall be equipped with top tier AWWA worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing. Buried service valves shall be 90% or greater, grease packed. Submerged service valves in potable water applications shall be 100% grease filled with FDA approved food grade grease. Documentation for the selected grease for submerged service valves shall accompany submittals. The owner reserves the right to field verify grease levels. Non-complying gears shall be remedied by the factory, verified by the customer and signed off by both parties. Gears are recommended to be Auma and are required to be of an equal or better quality. No name or unbranded actuators will not be accepted.

N. Hardware: All fasteners and hardware in non-wetted areas shall be type 316 Stainless Steel.

O. Coatings and Linings: The manufacturer is required to have and follow a system of valve preparation and coating which assures a quality, holiday free application and which maximizes the available multi-decade protection the coating offers. Submit holiday test prior to shipment. Products for linings to be NSF 61 certified.

P. The manufacturer must provide their written system of valve preparation and coating. This document shall include the methodologies used (quality compliance, QC) as well as post application review (quality assurance, QA).

1. Valves 48-inch and smaller: All external and internal surfaces except for the seating surface shall be 400 degree F plus, heat bonded fusion coated. Coating damaged in

shipping or installation shall be noted and properly repaired to the satisfaction of the utility or its authorized agent.

2. Valves 54-inch and larger shall be epoxy lined and coated in accordance with System No. 1. per Specification Section 09 90 00 – Painting and Coatings. Coating damaged in shipping or installation shall be noted and properly repaired to the satisfaction of the utility or its authorized agent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 40 05 51 – Valves, General.

B. Use the provided lifting lugs to move all project valve(s). The use of chains, lifting straps, rope or any type other strapping through the valve body is strictly prohibited. Provide correct lifting procedures when moving and installing the valves. As necessary, consultation with the valve manufacturer is recommended. Be responsible for all damage and project delays resulting from improper lifting and moving procedures, these shall include but shall not be limited to pulling the valve body out of round, gouges, scratches, displacing the gear box, etc.

C. Butterfly valves 36-inch and larger must be inspected and certified by the manufacturer that the final installation meets all the manufacturers requirements, and that the actuator and disc have not changed positions from that as successfully tested at the factory.

D. Strict care shall be taken to ensure valves are not installed under stress. In no instance shall adjacent mating flanges be forced into position. A progressive and proper star cross pattern shall be used to tighten valve flange mating bolts

END OF SECTION

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SECTION 40 05 65
VALVES FOR PUMP CONTROL AND CHECK SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Valves, General. For valves 16-inch or greater, submit the flow versus head loss curve for the full range of flow from 0 to maximum operating flow.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Rubber Flapper Swing Check (2-inch to 48-inch)
      a. APCO
      b. Valmatic
      c. Engineer approved Equal
   2. Plastic Ball Check Valves
      a. ASAHI-AMERICA
      b. George Fischer, Inc.
      c. NIBCO Inc. (Chemtrol Division)
      d. Spears Mfg. Co. (PVC, CPVC, AND PP only)
      e. Engineer approved Equal

2.2 RUBBER FLAPPER SWING CHECK VALVES (2-INCH TO 48-INCH)

A. General: Rubber flapper swing check valves for water, sewage, gas, oil features a flapper that does not swing from a hinge pin, but flexes open with one moving part. Valve is suitable for a working pressure of 150 psi up to 250 psi (depending on body type). Units shall have a flanged cover piece to access the rubber flapper from the top. The valves shall be designed, manufactured, tested and certified to American Water Works Association Standard ANSI/AWWA C508.

B. Body: The valve body and cover shall be of Ductile Iron ASTM A536 Grade 65-45-12 for sizes 2-24” (50-600mm) and Cast Iron ASTM A126 Grade B for sizes 30” (750mm) and larger for 150 psi. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. (100mm) valve shall be capable of passing a 3 in. (75mm) solid. The valves shall have flanges with drilling to ANSI B16.1, Class 125.

C. Rubber flapper: The rubber flapper to have a steel disc encapsulated with Acrylonitrile-Butadiene (NBR), Chloroprene (CR), Terpolymer of Ethylene Propylene and A Diene (EPDM), or Fluoro Rubber (FKM). The flapper is captured between the body and valve cover to permit the disc to flex open and closed. An integral "o-ring" shall be molded onto the face of the rubber flapper for positive sealing. The flex portion of the shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and provide a cracking pressure of 0.25 psig.

D. No Flow Actuator Option: A screw-type backflow actuator shall be provided, when specified, to allow opening of the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a Lead-Free bronze bushing. The backflow device shall be of the rising-stem type to indicate position. A stainless steel T-handle shall be provided for ease of operation. 6.2

E. Mechanical Indicator Option: A mechanical indicator shall be provided, when specified, to provide disc position indication on valves 3" (80 mm) and larger. The indicator shall have continuous contact with the disc under all operating conditions to assure accurate disc position indication.

F. Limit Switch Option: A pre-wired limit switch will be provided , when specified, to indicate open/closed position to a remote location. The mechanical type limit switch shall be activated by the mechanical indicator. The switch shall be rated for NEMA 4, 6, or 6P and shall have U.L. rated 5 amp, 125 or 250 VAC contacts.

G. Oil Cushion Option: An oil cushion device shall be provided , when specified, to provide hydraulic control of the final 10% of valve closure and reduce valve slam and water hammer normally associated with rapid flow reversal conditions on pump shut down. The oil cushion device shall consist of a high pressure hydraulic cylinder, adjustable external flow control valve, oil reservoir, pressure gauge, stainless steel air inlet valve, and piping designed to control the closing speed of the last 10% of travel in 1-5 seconds. A threaded lead-free bronze dashpot bushing unit with a grease fitting for lubrication shall connect the cylinder to the valve and shall have an air gap to prevent hydraulic fluid from entering the valve and contaminating the water system. A snubber rod fitted with O-ring seals and rod wiper scrapers shall make contact with the lower portion of the disc's stainless steel strike plate.

H. Non-Slam Option: Externally Adjustable Spring Return shall be used (when specified) to accelerate flapper closure before flow reversal can occur. The 302 stainless steel helical compression spring shall be adjustable externally without removing the cover from the valve and without removing the valve from service. The adjustment shall be made by means of an external sealed screw which provides infinite adjustment to the internal spring compression.

2.3 PLASTIC BALL CHECK VALVES

A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inches, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. Construction: The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections or flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged

Fittings, class 150. Seals shall have Viton O-rings, and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

PART 3 - EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 40 05 51 - Valves, General.

END OF SECTION

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SECTION 40 05 74
DIAPHRAGM VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide manually operated diaphragm valves including appurtenances and accessories, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 - Valves, General apply to this Section.

C. The requirements of Section 40 05 52 - Valve and Gate Actuators apply to this Section.

1.2 SUBMITTAL PROCEDURES

A. Furnish submittals in accordance with Section 01 33 20 – Submittal Procedures and 40 05 51 - Valves, General.

PART 2 - PRODUCTS

2.1 GENERAL DIAPHRAGM VALVE REQUIREMENTS

A. Construction: Diaphragm valves shall be of the weir type, unless otherwise indicated, and be of the material combination best-suited for each individual application. They shall be suited for bi-directional throttling service and installation in any position, with bubble-tight shut-off. Valves on outlets and drain nozzles of storage tanks shall be lined metal bodies.

B. Actuators: Unless otherwise indicated, all diaphragm valves shall have manual hand-wheel actuators with position indicators and transparent plastic stem covers of clear acrylic, polycarbonate, or similar material. Valve actuators shall be in accordance with Section 40 05 52 – Valve and Gate Actuators. The handwheels shall be of cast-iron, aluminum, or polypropylene.

2.2 PLASTIC BODY DIAPHRAGM VALVES

A. Construction: Unless otherwise indicated, valve bodies shall be of PVC construction with union ends, screwed ends, socket-welded ends, or flanged ends to ANSI/ASME B16.1 - drilled to 125-pound dimensions, as indicated. The valve bonnets shall be flanged and of PVC construction. The valve stem shall be of carbon steel or stainless steel with brass, bronze, or cast-iron sleeve and a compressor of aluminum, brass, bronze, or cast-iron. The bolts, nuts, and washers shall be of stainless steel and the stem and bonnet seals of Viton or Buna-N O-rings. Valves in sizes 1/2-inch through 4-inch shall have a pressure rating of 150 psi at 104 degrees F.

B. Diaphragm: Unless otherwise recommended by the manufacturer, the diaphragm material shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or approved equal
   1. ASAHI/America
   2. George Fisher, Inc. (+GF+)
   3. ITT Dia-Flo (Grinnell)
   4. McCanna, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with Section 40 05 51 - Valves, General. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

B. Install diaphragm valves in all chlorine solution and chemical feed lines, between the appropriate storage tanks and points of application, and where indicated, in strict accordance with the manufacturers published recommendations.

END OF SECTION

SECTION 40 71 13
FLOW-MAGNETIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments shall be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Section 01 33 20 – Submittal Procedures.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.
   3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. Manufacturer's representative shall be responsible for proving flow meter operation and 4-20 ma loop accuracy.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide a spare pipe spool for each meter size to be used in the event the meter tube must be removed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the follow Manufacturers are acceptable:
   1. Manufacturers:
      a. Endress+Hauser Promag W400 (zero up, zero down), with Heartbeat technology.
      b. No Equal.

B. Hardware Commonality:
   1. All instruments, which utilize a common measurement principle, for example, d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, shall be furnished by a single Manufacturer.
   2. All panel-mounted instruments shall have matching style and general appearance.
   3. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single Manufacturer.

2.2 MANUFACTURED UNITS

A. Flow Meters:
   1. Magnetic Flow Meters.
      a. General:
         1) Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC-pulsed linear signal which is directly proportional to the liquid flow rate.
         2) Complete zero stability shall be an inherent characteristic of the flowmeter system.
         3) Each magnetic flow metering system shall include:
            a) A metering tube.
            b) Signal cable.
            c) Transmitter.
            d) Flow meter grounding rings.
         4) Meter shall be NSF 61/600 approved for use in potable water.
      b. Source quality control.
         1) Shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
      c. Metering tube:
         1) Constructed of 316 stainless steel
         2) Utilize a minimum of 2 bullet-nosed, self-cleaning electrodes.
         3) Liner in conformance with:
            a) As identified on the instrument data sheet.
            b) Manufacturer's recommendations for the intended service.
            c) Whichever is the more stringent.
         4) Electrodes in conformance with:
            a) As identified on the instrument data sheet.
            b) Manufacturer's recommendations for the intended service.

c) Whichever is the more stringent.

5) Meter housing NEMA 4X corrosive conditions.

6) Meter coating consisting of epoxy painted finish.

7) Two grounding rings:

a) Which are in conformance with the Manufacturer's bore and material recommendation for the meter's intended service.

b) Designed to protect and shield from abrasion the liner's edge interface at the meter's end.

d. Transmitter.

1) Microprocessor-based signal converter/transmitter.

2) Utilize DC-pulse technique to drive flux-producing coils.

3) Contain a 6-digit display for flow rate, percent of span, and totalizer.

4) Operator interface consisting of keypads which respond to English text entry.

5) Integral zero return to provide a consistent zero output signal in response to an external dry contact closure.

6) Integral low flow cut-off zero return.

7) Automatic range change.

8) Programmable parameters including:

a) Meter size.

b) Full scale flow rate.

c) Magnetic field frequency.

d) Time constant.

9) Data retention for a minimum of 5 years without auxiliary main or battery power.

10) Self-diagnostics and automatic data checking.

11) Protected terminals and fuses in a separate compartment which isolates field connection from electronics.

12) Ambient operating temperature limits of -29 to 60 °C (-20 to 140 °F).

13) Transmitter shall be configured for Modbus TCP/IP communications protocol.

e. Performance requirements:

1) Time constant:

a) 0.5 to 1,000 seconds.

2) Accuracy:

a) 0.25 percent of flow rate from 10 to 100 percent of full scale for velocities over 3 ft per second.

3) Repeatability:

a) 0.25 percent of full scale.

4) Isolation:

a) Galvanic or.

b) Optical.

5) Power supply:

a) 120 VAC ± 10%.

b) 60 Hz.

c) 30 Watts Max.

6) Output/Input signal:

a) Ethernet TCP/IP

f. Factory testing:

1) Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the National Institute of Testing Standards.
2) The calibration procedure shall conform to the requirements of MIL-STD-45662A.
3) A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 20%, 40%, 60%, 80% and 100% of the calibrated range shall be submitted to the Engineer at least thirty (30) days prior to shipment of the meters to the project site.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated 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, flowrates, and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances. Weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
   1. Be responsibility to install all instruments in conformance with manufacturer's recommendations.
   2. Be responsibility to notify the Engineer of any installation conditions that may be shown at variance with the manufacturer's recommendations

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged prior to commissioning.

B. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 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. Provide documented evidence for a differential plus or minus that results from these changes.

B. Supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 71 79
FLOW-SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments shall be performed by the Instrumentation and Control Systems Contractor.

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.
   3. Manufacturer's installation instructions.

C. Shop Drawings
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As identified on the instrument list in Section 40 75 01.

2.2 MANUFACTURED UNITS

A. As identified on the instrument list in Section 40 75 01.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated 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 insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture'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

3.4 FIELD QUALITY CONTROL

A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the Engineer prior to commissioning.

B. All instrument calibration shall be witnessed by the Owner's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the Owner's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The Contractor shall replace any instruments damaged prior to commissioning.

B. The Engineer shall be the sole party responsible for determining the corrective measures.

3.9 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 in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 71 80
ROTAMETERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide rotameters and appurtenant work, complete and operable, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. All meters shall be suitable for the service and chemicals conveyed at process temperatures. Refer to materials list in Section 46 33 00 – Chemical Feeding Equipment, General for suitable materials.

B. Basic Design: Unless otherwise indicated, rotameters in chemical solution lines and where indicated shall have vertical bottom inlets and top outlets with ANSI 150-lb flanged ends, for vertical mounting. Meters in gas, air, and pump seal flushing lines shall be of the modified rotameter design with screwed ends, spring-loaded pistons, and union bodies for mounting in any position. Rotameters shall be rated for a minimum working pressure of 150 PSI.

2.2 BASIC MATERIALS

A. Flanged Meters for Chemical Solutions: Flanged rotameters for chemical solutions and other service where indicated, shall be calibrated in gallons per minute. The meters shall have 10-inch long scales (unless otherwise noted), and a range of 10:1 with an accuracy of ± 2%. Scales shall be suitable for a capacity range of 0 - 50 GPM, unless otherwise indicated. The following body materials shall be used:
   1. Chlorine Service - cast iron ends, Teflon-lined, or PVC ends, with heavy borosilicate glass tubes and packing glands.
   2. Activated carbon solution - Type 316 stainless steel construction with magnetically actuated float and scale.
   3. Other chemicals - Type 316 stainless steel ends with heavy borosilicate glass tubes and packing glands, or other best suitable material. All materials including wetted parts and floats shall be suitable for designated service.

B. Screwed Meters for Water, Air, and Fuel Gas: Rotameters with NPT screwed ends for water, air, and fuel gas service shall be calibrated in gallons per minute or cubic feet per minute. The bodies shall have union ends for ease of maintenance, polysulphone tubes, aluminum or brass end fittings, Type 316 stainless steel internal parts, and scales suitable for the capacity range in the schedule above. The meters shall have an accuracy of ±5% over the capacity range.

C. Manufacturers, or Equal
   1. Water Meters
      a. Blue-White Industries, Ltd.

b. Or, Engineered Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Rotameters shall be installed in chemical solution lines, in dilution water lines, in pump seal flushing lines, in gas and air lines, and where indicated.

B. Rotameters shall be installed in strict accordance with the manufacturer's printed instructions.

END OF SECTION

SECTION 40 73 13
PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society..

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20 – Submittal Procedures.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.
   3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.
   2. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated storage structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.10 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Gauges General

a. Ashcroft; Model 1279 with Performance Plus.
b. No equals

2.2 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 4-1/2-inch dial.
2) 1/2-inch threaded connection.
3) A block and bleed valve - 1/2 inch national pipe thread process connection and bleed/calibrate valve between block valve and outlet port.
e. Gages 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. Diaphragm seals:
a. Gauges attached to system involving chemical solutions, corrosive fluids, sludge, sewage, or other liquids containing solids shall be equipped with diaphragm seals.
b. In addition diaphragm seals shall be provided and included at the locations shown.

c. Seals shall have clamped housings.
d. All seals shall have 1/2 inch NPT flushing connection and fluid fill connection.

2.3 ACCESSORIES

A. Gauges shall be liquid filled or have some equivalent anti-vibration/-bounce 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 insure that the mechanical system has all necessary appurtenances. Weld-o-lets, valves, orientation, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture's recommendations.
1. Be responsibility to install all instruments in conformance with manufacturer's recommendations.
2. Be 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 manufacturers 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 ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

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. 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. Provide documented evidence for a differential plus or minus that results from these changes.

B. Supply complete instrument data sheets for each and every instrument and submit this information in accordance with Paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

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SECTION 40 74 63
TEMPERATURE-TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Instruments for instrumentation and control systems that are to be permanently installed.

B. Related Sections
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to insure a complete and coordinated project.

1.2 REFERENCES

A. All instruments shall comply with the latest edition and standards of the Instrumentation Systems and Automation Society.

1.3 DEFINITIONS

A. Definitions of terms and other electrical considerations as set forth in the:
   1. NEC: National Electrical Code.
   2. IEEE: Institute of Electrical and Electronic Engineers.
   3. ISA: Instrumentation Systems and Automation Society.
   4. NFPA: National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

A. Furnish all instruments as identified on the P&IDs, instrument lists, and instrument data sheets.

B. Install and connect all instruments as per the manufacturer's recommendations for the particular installation.

C. Calibration of instruments will be performed by the Instrumentation and Control Systems Contractor (ICSC).

1.5 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01 33 20.

B. Product Data:
   1. Complete manufacturer's brochures identify instrument construction, accuracy, ranges, materials, and options.
   2. Completed instrument data sheets including catalog number and source for determining catalog number.
   3. Manufacturer's installation instructions.

C. Shop Drawings:
   1. Mechanical connection diagrams.
   2. Sensor transducer mounting requirements with dimensions and elevations.
   3. Electrical connection diagrams.

D. Test Reports:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Including factory calibration for each instrument with stated accuracy.

E. Operating Manuals:
   1. Certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
   2. Including factory calibration for each instrument with stated accuracy.
   3. Complete installation, calibration, and testing manuals.

F. Record Drawings:
   1. Complete field calibration sheets, including range, span, PLC/PAC I/O address, register, and scaling coefficients.

1.6 QUALITY ASSURANCE

A. All instruments of similar nature must be furnished by the same manufacturer.

B. Manufacturer's representative shall be responsible for proving all 4-20ma loops.

C. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated van or structure with space conditioning to meet the recommended storage requirements provided by the manufacturer.
   1. Any instruments that are not stored in strict conformance with the manufacturer's recommendation shall be replaced at no additional costs to the OWNER.

1.8 PROJECT/SITE CONDITIONS

A. All instruments must be compatible for the installed site conditions including but not limited to material compatibility, site altitude, installed temperature and humidity conditions.

1.9 SEQUENCING AND SCHEDULING

1.10 WARRANTY

A. Furnish manufacturer's standard warranty, modified to agree with the Contract Documents.

1.11 MAINTENANCE

A. Provide all necessary materials, fluids, etc. for calibration purposes.

PART 2 - – PRODUCTS

2.1 MANUFACTURERS

A. As identified on the instrument list in Section 40 75 01.

2.2 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.
   2. Provide 3 copies of calibration curve – One with the instrument, one to the engineer and a third copy in the O&M located with its corresponding ISA data sheet. Calibration curve shall be matched by instrument tag.

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 insure that the mechanical system has all necessary appurtenances, weld-o-lets, valves, upstream diameters, downstream diameters, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacture'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

3.4 FIELD QUALITY CONTROL

A. The ICSC shall calibrate all instruments in the field during the Calibration and Loop Validation Tests.

3.5 ADJUSTING

A. All instruments shall be field calibrated to match the installed conditions.

3.6 CLEANING

A. All instrument enclosures shall be vacuumed clean after calibration and before commissioning.

3.7 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

B. All instrument calibration shall be witnessed by the OWNER's Representative.

C. Each and every instrument shall be tested during the Loop Validation Tests and the OWNER's Representative shall witness the response in the PLC/PAC control system and associated registers.

3.8 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged prior to commissioning.
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.9 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 in accordance with paragraph 1.5 of this section.
   1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 75 01
INSTRUMENT LIST

PART 1 - GENERAL

1.1 INSTRUMENT LIST

A. Instrument list is shown in the attached table following this section.

PART 2 - PRODUCTS

2.1 COMMUNICATIONS PROTOCOL

A. All instruments shall be configured for Modbus TCP/IP communications protocol.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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Instrument List			
Tag	**Location**	**Device**	**Description (See notes at bottom of document)**
SE_FW_AIT3202_TB_PV	Valve Vault - 1 MG Effluent Sample Water	Turbidity Monitor	Hach (TU5 Series, TU 5300) Laser Turbidimeter with Hach (Series SC 4500) controller (reuse existing 1 MG Sample Turbidimeter)
SE_FW_AIT3206_TB_PV	Valve Vault - 3 MG Effluent Sample Water	Turbidity Monitor	Hach (TU5 Series, TU 5300) Laser Turbidimeter with Hach (Series SC 4500) controller
SE_FW_AIT3203_PH_PV	Valve Vault - 1 MG Effluent Sample Water	pH Monitor	Hach (Series PD1P1) pH Sensor, Hach (Series SC 4500) controller
SE_FW_AIT3206_PH_PV	Valve Vault - 3 MG Effluent Sample Water		
SE_FW_AIT3203_CL2_PV	Valve Vault - 1 MG Effluent Sample Water	CL2 Monitor	ATI Q46H Residual Chlorine Monitor
SE_FW_AIT3206_CL2_PV	Valve Vault - 3 MG Effluent Sample Water		
SE_AUX_SAMP_FS3203_F_SW	Valve Vault - 1 MG Effluent Sample Water	Flow Switch	McDonnell & Miller, Series FS6 Water Flow Switch, 1" NPT
SE_AUX_SAMP_FS3206_F_SW	Valve Vault - 3 MG Effluent Sample Water		
SE_FW_AIT3203_T_PV	Valve Vault - 1 MG Effluent Sample Water	Temperature Transmitter	Rosemount 3144S Temperature Transmitter
SE_FW_AIT3206_T_PV	Valve Vault - 3 MG Effluent Sample Water		
SE_FW_AIT3203_COND_PV	Valve Vault - 1 MG Effluent Sample Water	Conductivity Monitor	ATI Q46-1-C1-AC-5-A-1 4E Conductivity Monitor
SE_FW_AIT3206_COND_PV	Valve Vault - 3 MG Effluent Sample Water		
SE_FW_AIT3203_FM_F	Valve Vault - 1 MG Effluent Sample Water	Rotameter	Blue-White Industries, F-410 Acrylic Flow Meter (Rotameter)
SE_FW_AIT3206_FM_F	Valve Vault - 3 MG Effluent Sample Water		
SE_FW_PIT3203_P_PV	Valve Vault - 1 MG Effluent Sample Water	Pressure Gauge	Ashcroft 1279 with Performance Plus. Range 0 to 50 feet.
SE_FW_PIT3206_P_PV	Valve Vault - 3 MG Effluent Sample Water		
DS_WM_DC_FIT03803_F_PV	WaterPro Meter Vault	Flow	Endress+Hauser Promag W 400, 5W4C6H, DN600, Zero up Zero down. Remote transmitter. Modbus TCP/IP communications. Provide potting kit for meter.

Notes: All instruments to be configured for Modbus TCP/IP communications protocol (where available).
Substitutions allowed with written approval of Owner and Engineer only.

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SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide all tools, supplies, materials, equipment, and all labor necessary for furnishing, constructing, installing, terminating, and testing fiber optic (FO) system.

B. Route FO system as shown on Drawings. Install conduits straight, within the tolerances called for in Drawings and Specifications.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM: F2160 Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
2. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
3. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
4. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
5. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
6. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
8. QuEST Forum (QF): TL 9000, Quality Management Systems.
9. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
10. Telecommunications Industry Association (TIA):
    a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
    b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
    c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
    d. 568-C.3, Optical Fiber Cabling Components Standard.
    e. 598, Optical Fiber Cable Color Coding.
    f. 606, Administration Standard for Commercial Telecommunications Infrastructure.
11. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.

b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
k. 942, Telecommunications Infrastructure Standard for Data Centers.
l. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.

12. UL: 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. AUI: Attachment Unit Interface.

C. dB: Decibel.

D. EMB: Effective Modal Bandwidth.

E. ETL: Electrical Test Laboratories.

F. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

G. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

H. FOS: Fiber Optic System.

I. Hybrid Cable: Cable containing more than one type of fiber.

J. LAN: Local Area Network.

K. LIU: Lightguide Innerconnect Unit (patch panel).

L. m: Micrometer.

M. Mbps: Megabits per Second.

N. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

O. Megahertz (MHz): One million cycles per second.

P. MHz: Megahertz.

Q. micro: x 10^{-6}.

R. Micron: Micrometer or one millionth meter.

S. MIS: Management Information System.

T. n, nano: x 10^{-9}.

U. N: Newton.

V. nm: Nanometer—unit of measure equal to one billionth meter.

W. OFNP: Nonconductive Optical Fiber Plenum Cable.

X. OFNR: Nonconductive Optical Fiber Riser Cable.

Y. OLTS: Optical Loss Test Sets.

Z. OTDR: Optical Time Domain Reflectometer.

AA. PIC: Process Instrumentation and Control.

BB. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

CC. UPC: Ultra Physical Contact.

DD. UPS: Uninterruptible Power Supply.

EE. V ac: Volts Alternating Current.

FF. WAN : Wide Area Network.

1.04 SUBMITTALS

A. Action Submittals:

1. Component Data:
   a. Manufacturer and model number.
   b. General data and description of each component.
   c. Engineering specifications and data sheet for each component including:
      1) Duct, connectors.
      2) Duct sealing devices.
      3) Duct sealants.
      4) Closures.
      5) Pull rope.
      6) Identification tape.
      7) Pulling equipment.
      8) Testing equipment.
      9) Splicing hardware and equipment.

B. Informational Submittals:

1. Testing and acceptance plan, 30 days prior to beginning of testing.
2. Fiber test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing:
   a. Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
   b. Attenuation of each fiber upon delivery to Site.

c. Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
d. Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.

3. Manufacturer's Certificate of Compliance.
4. Manufacturer's suggested installation practice.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:
1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:
1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.06 QUALITY ASSURANCE

A. Contractor Qualifications:
1. Use qualified personnel, possessing the necessary equipment and having experience in similar installations. Evidence of qualification shall include the following:
a. Written evidence that the Contractor has a minimum of 3 consecutive years' recent experience with all aspects of the fiber optic cable system as specified, including the installation of conduit and pull boxes, pulling of fiber optic cable in conduit, splicing and testing of fiber optics, and the installation and testing of all other components of the fiber optic cable system. Such experience shall include a minimum of three projects with installation and testing of no less than 5,000 feet of continuous fiber optic cable. Retain specialty workers or subcontractors meeting this experience requirement.
b. Provide a list of completed installations similar to this Project including the name, address, and phone number of the owner, the name of the project, type of cable with model number, and the date of completion. Provide separate lists for the Contractor, supplier, and cable manufacturer.
c. The name and qualifications of the supervisory personnel that will be directly responsible for the installation of the fiber optic duct system.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. As shown on Drawings.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 24 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results: Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
    a. Field test instrument shall be within calibration period recommended by manufacturer.
    b. Optical Loss Test Set (OLTS):
        1) Multimode Optical Fiber Light Source:
            a) Provide dual LED light sources with central wavelengths of 850 nm (plus or minus 30 nm) and 1,300 nm (plus or minus 20 nm).
            b) Output Power: Minus 20 dBm minimum.
            c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap, as described in Clause 11 of TIA 568-C.3, with Category 1 light source.
            d) Manufacturer: Fluke Networks.
        2) Power Meter:
            a) Provide 850 nm and 1,300 nm wavelength test capability.
            b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
            c) Store reference power measurement.
            d) Save at least 100 results in internal memory.
            e) PC interface (serial or USB).
            f) Manufacturer: Fluke Networks.
        3) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.
3. Optical Time Domain Reflectometer (OTDR):
    a. Bright, color transmissive LCD display with backlight.
    b. Rechargeable for 8 hours of normal operation.

c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
e. Serial and USB ports to transfer data to PC.
f. Multimode OTDR:
1) Wavelengths: 850 nm (plus or minus 20 nm) and 1,300 nm (plus or minus 20 nm).
2) Event Dead Zone: 1 meter maximum at 850 nm and 2 meters maximum at 1,300 nm.
3) Attenuation Dead Zone: 6 meters maximum at 850 nm and 15 meters maximum at 1,300 nm.
4) Distance Range: 2,000 meters minimum.
5) Dynamic Range: Minimum 10 dB at 850 nm and 1,300 nm.
g. Manufacturer: Fluke Networks.

4. Integrated OLTS, OTDR, and Fiber Microscope:
a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
b. Manufacturer: Fluke Networks.

C. Conduit Test:
1. Test and seal spare conduits.
2. Conduit and Innerduct Testing:
a. Blow full-diameter mouse through each spare conduit and innerduct to verify they are unrestricted over full length.
b. If conduit is restricted over full length, advise Engineer.
3. Documentation: Confirm conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.

D. Cable Testing:
1. Test procedures and field test instruments shall comply with applicable requirements of:
a. LIA Z136.2.
b. TIA/EIA 455-78.
c. TIA/EAI 455-133.
d. TIA 526-7.
e. TIA 526-14.
f. TIA 568-C.1.
g. TIA 568-C.3.
h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:

a. OLTS dual wavelength attenuation measurements for multimode links and channels.
b. OTDR traces and event tables for multimode links and channels.

E. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone Multimode Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Multimode 62.5/125 µm	850	3.5	1,300	1.5
Multimode 50/125 µm	850	3.5	1,300	1.5

   b. OTDR Testing:
      1) Reflective Events: Maximum 0.75 dB.
      2) Nonreflective Events: Maximum 0.3 dB.
   c. Magnified Endface Inspection:
      1) Visually inspect fiber connections for end-face quality.
      2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

H. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
      1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.

c. Perform Testing:
    1) On each cabling segment (connector to connector).
    2) On each cabling channel (equipment to equipment).
    3) Using high-quality test cords of same fiber type as cabling under test.
        a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
        b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.

2. Optical Loss Testing (OLTS):
    a. Backbone Link:
        1) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
        2) Perform tests in both directions.

3. OTDR Testing:
    a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
        1) Multimode: 850 nm and 1,300 nm.
    b. Test each fiber link and channel in one direction.
    c. Install launch cable between OTDR and first link connection.
    d. Install receive cable after last link connection.

4. Length Measurement:
        1) Record length of each fiber.
        2) Measure optical length using OLTS or OTDR.

5. Polarity Testing:
    a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
    b. Verify polarity of paired duplex fibers using OLTS.

6. Test Results Documentation:
    a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
    b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
    c. Database for Project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.
    d. Circuit IDs reported by test instrument shall match specified label identification.
    e. Provide in electronic database for each tested optical fiber with the following information:
        1) Identification of Site.
        2) Name of test limit selected to execute stored test results.
        3) Name of personnel performing test.
        4) Date and time test results were saved in memory of tester.

5) Manufacturer, model, and serial number of field test instrument.
6) Version of test software and version of test limit database held within test instrument.
7) Fiber identification number.
8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
11) Length for each optical fiber as calculated by the OTDR.
12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

I. Test Reports:

1. Provide submittal of all completed test reports in PDF format.

3.02 SUPPLEMENTS

A. Supplements listed below, following "End of Section," are part of this Specification.

1. As-Built Fiber Optic Cable Installation Form.
2. As-Built Conduit/Innerduct Installation Form.

END OF SECTION

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PROJECT: [*INCLUDE YOUR PROJECT'S NAME HERE*]

Contractor:

Signed by:

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Sheet 1 of 1

Cable Identification:
Routing: From: In:
(Identify field panel, control room, and others in building)

Through: 1
(Identify access hole, building, gallery, etc.)
Through: 2 Through: 5
Through: 3 Through: 6
Through: 4 Through: 7
To: In:
See As-Built Conduit/Innerduct Installation forms for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:
Multimode Fibers

		cable length*	
850 nm:	3.5 dB/km x	km + 1.5 dB =	dB
1300 nm:	1.0 dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		850 nm	1,300 nm	850 nm	1,300 nm

PROJECT: [*INCLUDE YOUR PROJECT'S NAME HERE*]

Contractor:

Signed by:

AS-BUILT CONDUIT/INNERDUCT INSTALLATION

From: To:

(Identify building, access hole, field panel, etc.) Sheet 1 of 1

Conduits:
Used: 4 inches; 2 inches
Spare: 4 inches; 2 inches Confirm all spares unrestricted: Yes/No
(Provide number of conduits in each category)

Innerducts:

Conduit ID*	Innerduct ID	Cable ID / Spare

(Continued overleaf delete if not applicable)

*Provide conduit ID if required to identify innerduct uniquely in the access hole, if for example, color-coded innerduct is used in more than one conduit. If innerducts are tagged uniquely, leave this column blank.

END OF SUPPLEMENT

DIVISION 43
GAS, LIQUID, AND STORAGE

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SECTION 43 20 10
PUMPS, GENERAL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.

D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01 33 20 - Contractor Submittals.

B. Shop Drawings: Shop drawings shall contain the following information:
   1. Pump name, identification number, and specification Section number.
   2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable frequency drive.
   3. The Contractor shall require the Manufacturer to indicate on the performance curves the limits recommended for stable operation without surge, without cavitation, and without vibration (except vibration within specified allowable limits). The stable operating range shall be as wide as possible based on actual hydraulic and mechanical measurements taken during the factory performance tests of the pumps.
   4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
   5. Data, in accordance with Section 26 20 00 Low Voltage AC Induction Motors OR, for the electric motor proposed for each pump.
   6. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel,

and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.

7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
8. Complete electrical schematic diagram.

C. Operation and Maintenance Manual: The Manual shall contain the required information for each pump Section.

D. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.

E. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

F. Certifications
1. Manufacturer's certification of proper installation.
2. Contractor's certification of satisfactory field testing.

1.3 QUALITY ASSURANCE

A. Warranty: Unless otherwise specified, each pump shall be supplied with manufacturer's standard warranty of one (1) year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.

B. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine, or encroach on the service factor.

C. No cavitation shall be allowed in pumps operating within the stable operating range for the specified operating conditions. For the purposes of this provision, cavitation shall be recognized and accepted as being present in a pumping unit if cavitation noise can be perceived either by the human ear or by acoustic instruments or devices. The presence or absence of cavitation noise shall be verified by the Owner during both the factory performance tests of the pumps and during operation of the pumps up to the end of the warranty period. To assist in revealing potential cavitation during the factory performance tests, in addition to all other required tests, the Manufacturer shall force the pumps to operate at the specified minimum net positive suction head available for each of the following conditions: minimum flow rate, design flow rate and head, and maximum flow rate.

D. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms,

couplings, electric motors, variable frequency controls if required, necessary mountings, and appurtenances.

2.2 MATERIALS OF CONSTRUCTION

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of austenitic ductile iron, conforming to ASTM A 439 - Specification for Austenitic Ductile Iron Castings, or equal.
2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 05 50 00 – Metal Fabrications.

2.3 PUMP COMPONENTS

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings Dimensions.

B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for other process fluids shall be lubricated as indicated.

C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

E. Drains: All gland seals, air valves, cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

G. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For drainage and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.

1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
   a. Shaft speeds - up to 2500 rpm
   b. Temperature - up to 500 degrees F
   c. pH range - 0 to 14.
2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Type	Manufacturer
Water Pumps Hot and Cold	Single seals: John Crane, Type I, 21; Borg-Warner Type L; Chesterton

I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.

J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number. Dimension and flow information shall be in metric units, followed by English units in parentheses.

B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

C. Gauges: all pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
   1. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
   2. Pressure and compound gauges shall be provided in accordance with Section 17205 – Pressure Gauges.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of the equipment.
2. Inspection, checking, and adjusting the equipment.
3. Startup and field testing for proper operation.
4. Performing field adjustments to ensure that the equipment installation and operation comply with the specified requirements.

B. Instruction of the Owner's Personnel

1. Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
2. The representative shall have at least two years' experience in training. A resume for the representative shall be submitted.
3. Training shall be scheduled a minimum of three weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The Owner may videotape the training for later use with the Owner personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.

B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Materials and equipment shall be coated as required in Section 09 90 00 – Painting and Coating.

3.4 FIELD TESTS

A. Where required by the individual pump Sections, each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.

B. The following field testing shall be conducted:
   1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
   2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
   3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
   4. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is indicated.

C. Field testing will be witnessed by the Engineer. The Contractor shall furnish 5 days advance notice of field testing.

D. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the Owner will bear. If available, the Owner’s operating personnel will provide assistance in field testing.

END OF SECTION

SECTION 43 23 10
REGENERATIVE TURBINE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide regenerative turbine pumps, with horizontal electric motors and all appurtenant work, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 20 10 – Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 WARRANTY

A. Pumps shall be provided with manufacturer standard warranty for minimum of one year from date of project substantial completion to cover parts, labor, shipping, and travel.

PART 2 - PRODUCTS

2.1 SAMPLE PUMPS

A. Identification

1.	Equipment Number	-	P-120, P-121
2.	Quantity	-	2
3.	Location	-	3 MG Reservoir Valve Vault

B. Operating Conditions: The Work of this Section shall be suitable for long-term operation under the following conditions:

1.	Duty	-	Continuous
2.	Drive	-	Constant speed
3.	Ambient environment	-	Indoors
4.	Ambient temperature, (degrees F)	-	40 to 80
5.	Ambient relative humidity (percent)	-	20 to 90
6.	Fluid service	-	Treated Water
7.	Fluid temperature, (degrees F)	-	50 to 80
8.	Fluid pH range	-	7 to 8.3
9.	Fluid specific gravity	-	1.0
10.	Project site elevation (ft. a.s.l)	-	5,000
11.	Minimum available NPSH (ft)	-	10

C. Performance Requirements

1.	Maximum shutoff head (ft)	-	150
2.	Design flow capacity (gpm)	-	4.0
3.	Design flow pump head (TDH ft)	-	30

4.	Design flow minimum pump efficiency (percent)	-	40
5.	Maximum pump speed (rpm)	-	1,800
6.	Maximum motor speed (rpm)	-	1,800
7.	Minimum motor size (hp)	-	1/3

D. Pump Dimensions

1.	Minimum impeller diameter (in)	-	NA
2.	Minimum size of suction (in)	-	1
3.	Minimum size of discharge (in)	-	1
4.	Flange rating, ANSI (psi)	-	150

2.2 PUMP REQUIREMENTS

A. Construction: Construction of regenerative turbine pumps shall conform to the following requirements:

1.	Casing	-	Cast iron
2.	Impeller	-	Bronze
3.	Shaft	-	Stainless steel
4.	Configuration	-	Frame-mounted
5.	Bearings	-	2 sets of ball bearings with min L-10 life of 50,000 hours
6.	Coupling	-	Flexible heavy-duty shaft coupling with guard
7.	Seal	-	Mechanical seal
8.	Pump base	-	Cast iron or fabricated steel with drain
9.	Mounting method	-	Base-mounted
10.	Lubrication	-	Grease-lubricated
11.	Accessories	-	Bypass with relief valve discharging to pump suction

B. Drive: Direct drive with horizontal, ODP electric motor suitable for 120-volt, single-phase, 60-Hz ac power supply.

2.3 PROTECTIVE COATING

A. Pumps shall be coated in accordance with Section 09 90 00 - Coatings and Painting.

2.4 SPARE PARTS

A. The Contractor shall furnish a complete set of manufacturer's recommended spare parts for EACH pump. Parts subject to wear, such as seals, packing, gaskets, and bearings and any special tools shall be included.

2.5 MANUFACTURERS, OR EQUAL

A. Aurora Pumps.

B. Burk Pumps.

C. Colt Industries (Fairbanks Morse).

D. Roth Pump Company.

E. Paco Pumps.

PART 3 - PART 3 - EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with procedures submitted with the shop drawings.

B. General installation requirements shall be as indicated in Section 43 20 10 - Pumps, General.

END OF SECTION

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