Project Specifications and Contract Documents

For

Zone 41 Mingus Pump Station, Tank and Pipeline

CIP No. 17-009

MAYOR AND COUNCIL:

Phil Goode, Mayor
Connie Cantelme, Council Member
Lois Fruhwirth, Council Member
Ted Gambogi, Council Member
Brandon Montoya, Council Member
Eric Moore, Council Member
Cathey Rusing, Council Member

CITY CLERK:

Sarah M. Siep

PUBLIC WORKS DIRECTOR:

Gwen Rowitsch

Notice Inviting Bids

Zone 41 Mingus Pump Station, Tank and Pipeline

DESCRIPTION: The project generally consists of removing two existing 200,000-gallon water storage tanks and replacing with a single 750,000-gallon water storage tank. The project includes replacing the existing Mingus Pump Station at 810 Douglas Avenue to meet demands and upsize the pipeline between the pump station and the new tank and upsize the water main in Douglas Avenue to Northside Drive.

MANDATORY PRE-BID CONFERENCE: March 20, 2024, at 9:00 am, City of Prescott Public Works Department.

BID OPENING: Thursday, April 4, 2024, at 2:00pm **City Council Chambers 201 N. Montezuma Street, 3rd Floor, Prescott, Arizona 86301**

In accordance with local and State law, sealed bids with the project name on outside of envelope will be received by the Office of the **City Clerk at 201 N. Montezuma Street, Suite 302, Prescott, Arizona 86301**, until 2:00pm on the date specified above, for the services specified herein. Bids will be opened and read aloud at the above noted date, time, and location. Any bid received at or after 2:00pm on the referenced date will be returned unopened.

The City of Prescott reserves the right to accept or reject any or all bids, and/or some or all of the alternates bid, and waive any informality deemed in the best interest of the City and to reject the bids of any persons who have been delinquent or unfaithful in any contract with the City.

Copies of the Plans, Project Specifications and Contract Documents are available for inspection at the Public Works Department, or may be obtained free of charge on the City's website at https://prescott-az.gov/budget-and-finance/purchasing/.

PUBLISH: March 10th and 17th, 2024

Zone 41 Mingus Pump Station, Tank and Pipeline

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Attachments:

- City of Prescott Supplement to the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction (Technical Specifications)
- Project Technical Specifications
- Project Special Provisions
- Project Soils Report

Special Instructions

Bids will be returned unopened if not submitted properly sealed and prior to the time set forth in the Notice Inviting Bids.

Bids shall be enclosed in a sealed envelope, addressed to the Office of the City Clerk, and marked on the outside, lower right-hand corner indicating:

1. Bidder's Name
2. Project Title
3. Bid Opening Date and Time
4. Acknowledgement of Addenda Received, if applicable

Mandatory Pre-Bid Conference

The pre-bid conference is mandatory for potential bidders. Bids will only be accepted from contractors in attendance as established on the sign-in sheet. Anything discussed, or not discussed, in the meeting shall not change the requirements of the bid documents. Any changes to the bid documents shall be in writing. The minutes of this pre-bid conference will be distributed to all attendees. The minutes shall not be considered part of any addendum and shall not be considered part of the contract documents for the project.

The mandatory pre-bid conference will be held on March 20, 2024, at 9:00 am at this location:

City of Prescott
Public Works Division
433 N Virginia Street
Prescott, AZ 86301

Bid Submittal

All bids must contain the following completed forms, provided herein:

1. Bidding Schedule (pages 7-11)
2. Proposal (pages 10-14)
3. Subcontractors List (page 15)
4. Proposed Staging Locations (page 16)
5. Bidder's Affidavit (page 17)
6. Proposal Guarantee (certified check, cashier's check, or surety bond)
7. Addendum Acknowledgement (all pages), if applicable

Failure to complete and sign (where required) and return the above documents with your bid may render it irregular. It is not necessary to return a complete copy of the Notice Inviting Bids, Project Specifications and Contract Documents, other than the documents noted above.

DELIVERY OF SUBMITTALS

Sealed bids will be received **before 2:00 PM on Thursday, April 4, 2024**, at the **City Clerk's Office, 201 N. Montezuma Street, Suite 302, Prescott, Arizona 86301**, at which time all submittals will be publicly opened. **The City will not accept delivery of the bid at any other City location.**

Any submittals received at or after 2:00 PM on the above-stated date will be returned unopened. Firms are solely responsible for the delivery of their submittals to the above location by the time and date specified. The City is not responsible for lateness of mail, carrier, etc. The City will not accept delivery of the bid at any other city locations. The time and date stamp in the City Clerk's Office shall be the official time of receipt. Electronic or facsimile submittals will not be considered. Modifications to submittals will not be considered after the 2:00 PM deadline.

The outside of the submittal envelope shall indicate the name and address of the Respondent; shall be addressed to the City Clerk, City of Prescott, at the above address; and shall be clearly marked:

Notice of Inviting Bids:
Zone 41 Mingus Pump Station, Tank and Pipeline
Due before 2:00 PM on April 4, 2024

Requests for Information

Questions pertaining to this project prior to opening and award of the contract shall be directed to:

Melissa Busby
Purchasing Manager
contracts@prescott-az.gov

Requests for information must be received **by 5:00 PM on Tuesday, March 26, 2024.** Responses or addenda will be issued **no later than 12:00 PM on Monday, April 1, 2024.** It is the prospective proposer's full responsibility to check the City's website at https://prescott-az.gov/budget-and-finance/purchasing/ for Addenda related to this procurement. A signed copy with all pages of the addenda must be submitted with the proposal package.

Scope of Work

The intent of the Plans and Specifications is to prescribe a complete work for the described project which the Contractor shall perform in a manner acceptable to the City Public Works Director and in full compliance with the terms of the Contract.

Unless otherwise specified in the Special Provisions, the Contractor shall furnish all materials, labor, tools, equipment, water, light, power, transportation, superintendence, temporary construction of every nature, and incidentals, but not limited to, dust and traffic control measures, and to perform all work involved in executing the Contract in a satisfactory and workmanlike manner within the specified time.

All standard specifications and details referenced, unless otherwise noted, shall conform to all the City of Prescott Standard Specifications and Detail Drawings, most current revisions, and to the most current editions of the Uniform Standard Specifications and Details for Public Works Construction by the Maricopa Association of Governments (MAG Specifications and Details), including revisions thereto.

Project Schedule

The Contractor shall fully complete all work under this Contract within four hundred twenty (420) calendar days beginning with the calendar day as noted in the Notice to Proceed. The Contractor shall at all times during the continuance of the Contract prosecute the work with such work force and equipment as is sufficient to complete the project within the time specified.

The following milestones are estimates of the earliest dates possible for planning purposes only and shall not represent any contractual commitment whatsoever on the part of the City. The City reserves the right to amend the project schedule as necessary.

Award of Contract	May 14, 2024
Pre-Construction Meeting	Week of May 27, 2024
Notice to Proceed	Week of June 10, 2024
Expected Completion Date	Week of August 4, 2025

City Protest Policy

Any protest against the solicitation or award must be filed with the City Clerk's Office by 4:00 PM up to ten (10) days after award. All such protests shall be in writing and contain the following: 1) Name, address, email address and telephone number of the interested party; 2) Signature of the interested party or its representative; 3) Identification of the purchasing department and Project name; 4) Detailed statement of the legal and factual grounds for protest including copies of relevant documents; and 5) Form of relief requested. Protesting parties must demonstrate as part of their protest that they made every reasonable effort within the schedule and procedures of this solicitation to resolve the basis or bases of their protest during the solicitation process, including asking questions, seeking clarifications, requesting addenda, and otherwise alerting the City to perceived problems so that corrective action could be taken prior to the selection of the successful vendors. The City will not consider any protest based on items which could have been or should have been raised prior to the deadline for submitting questions or requesting addenda. The filing of a protest shall not prevent the City from executing an agreement with any other proposer.

Bid Schedule

Zone 41 (Mingus) Pump Station, Tank and Pipeline Project

CIP #17-009

Line #	Item #	Description	Qty	Unit	Unit Cost	Amount
General Construction Items						
1	105.8	Construction Stakes, Lines and Grades	1	LS		
2	107.15 (SP)	Public Relations	1	ALL	$ 40,000.00	$ 40,000.00
3	107.16	Stormwater Pollution Prevention Plan (SWPPP)	1	LS		
4	109.10	Mobilization/Demobilization	1	LS		
5	109.11	Contract Allowance	1	ALL	$ 600,000.00	$ 600,000.00
6	401 (SP)	Traffic Control Plan	1	LS		
7	401.2(a) (SP)	Barricades and Storage	1	LS		
8	401.2(b) (SP)	Incidental Traffic Related Items	1	LS		
9	401.3(a) (SP)	Flaggers	240	HR		
10	401.3(b) (SP)	Uniformed Off-Duty Law Enforcement Officers	1	ALL	$ 5,000.00	$ 5,000.00
		General Construction Items Subtotal				
Roadway Improvements						
11	205.1.1	Roadway Excavation	654	CY		
12	205.2 (SP)	Unsuitable Material - Provisionary Item - May Not Be Used	131	CY		
13	211	Fill Construction	65	CY		
14	301 (SP)	Subgrade Preparation	1,783	SY		
15	310	Placement and Construction of Aggregate Base Course (6" thickness Tank Site Road)	155	CY		
16	310	Placement and Construction of Aggregate Base Course (8" thickness Douglas Ave)	189	CY		
17	321 (SP)	Asphalt Concrete (AC) Pavement, 4" Thick - Two Lifts	1,783	SY		
18	329	AC Bituminous Tack Coat, Type SS-1h	3.70	TON		
19	336.5	Pavement Replacement per QCSD 200Q-1	25	SY		
20	340.6(a) (SP)	Curb and Gutter per QCSD 220Q-1 (Type 'C')	312	LF		
21	340.6(b) (SP)	Curb and Gutter per QCSD 220Q-1 (Type 'D')	304	LF		
22	340.6(c) (SP)	Curb and Gutter Transition per QCSD 221Q	2	EA		
23	340.6(d) (SP)	Residential Driveway - 6" PCC on 4" ABC	412	SF		

Bid Schedule						
Zone 41 (Mingus) Pump Station, Tank and Pipeline Project						
CIP #17-009						
Line #	**Item #**	**Description**	**Qty**	**Unit**	**Unit Cost**	**Amount**
24	340.6(e) (SP)	Concrete Stair with Handrail	1	LS		
25	345.3 (SP)	Adjust Sewer Cleanout Frame and Cover to Grade per Quad City Std. Detail 270Q	1	EA		
26	345.4 (SP)	Adjust Water Valve Box and Cover to Grade per Quad City Std. Detail 391Q	2	EA		
27	350.11 (SP)	Existing mailbox removal and reinstallation per QCSD 134Q-1	3	EA		
29	430.3.2	Hydroseeding	0.20	ACRE		
		Roadway Improvements Items Subtotal				
Water Improvements						
30	601.2.11a (SP)	Rock Excavation for Utility Construction (Water - Provisionary Item - May Not Be Used)	328	CY		
31	601.2.12a (SP)	Trench Stabilization (Water - Provisionary Item - May Not Be Used)	328	CY		
32	610.3(a) (SP)	24" Restrained Joint DIP Water Main	14	LF		
33	610.3(b) (SP)	18" Restrained Joint DIP Water Main	88	LF		
34	610.3(c) (SP)	16" Restrained Joint DIP Water Main	520	LF		
35	610.3(d) (SP)	12" Restrained Joint DIP Water Main	1,018	LF		
36	610.3(e) (SP)	8" Restrained Joint DIP Water Main	65	LF		
37	610.3(f) (SP)	4" Restrained Joint DIP Water Main	221	LF		
38	630.4(a) (SP)	6" Tapping Sleeves and Valves	1	EA		
39	630.4(b) (SP)	8" Tapping Sleeves and Valves	1	EA		
44	610.13 (SP)	Water Service Connection per QCSD 316P (1")	14	EA		
45	612 (SP)	Temporary Water Main (Fly Lines) Sta 85+00 to 86+00	80	LF		
46	612 (SP)	Temporary Water Mains (Fly Lines) to existing water service meters	240	LF		
47	615.2 (SP)	Extra Protection at Water/Sewer Intersection at Douglas/Northside Intersection	2	EA		
48	615.2	Replace existing sewer main per QCSD 405Q	2	EA		
49	630.5 (SP)	18" Butterfly Valve, Box and Cover per QCSD 301Q & 391Q	1	EA		
50	630.5(a) (SP)	12" Gate Valve, Box and Cover per QCSD 301Q & 391Q	5	EA		
51	630.5(b) (SP)	8" Gate Valve, Box and Cover per QCSD 301Q & 391Q	1	EA		
52	630.5(c) (SP)	6" Gate Valve, Box and Cover per QCSD 301Q & 391Q	1	EA		

Bid Schedule

Zone 41 (Mingus) Pump Station, Tank and Pipeline Project

CIP #17-009

Line #	Item #	Description	Qty	Unit	Unit Cost	Amount
53	630.5(d) (SP)	4" Gate Valve, Box and Cover per QCSD 301Q & 391Q	1	EA		
54	630.6 (SP)	Combination Valve Assembly (ARV) per QCSD 317Q	2	EA		
55	630.6.1 (SP)	Blow Off Assembly per QCSD 318P	1	EA		
56	650.1 (SP)	Water Main Abandoned in Place	1	EA		
57	650.2 (SP)	Existing Water Main Removal	2,575	LF		
		Water Improvements Items Subtotal				
Drainage Improvements						
58	215.3.2a (SP)	Earthwork for Sedimentation Pond	310	CY		
59	215.3.2b (SP)	Earthwork for Berm/Sedimentation Basin	1	LS		
60	215.3.2c (SP)	Earthwork for Slope Restoration	1	LS		
61	220.1 (SP)	Rip Rap Placement - D50 = 6", 12" Thick Over Filter Fabric	616	CY		
62	340.6(f) (SP)	Concrete Valley Gutter per QCSD 240Q-2	335	SF		
63	350.4.1 (SP)	Remove Existing Tank Drain 18" CMP piping/catch basin	1	LS		
64	505.1.1(a) (SP)	Catch Basin - Type 'G' per MAG SD 537	1	EA		
65	505.1.1(b) (SP)	Headwall Drop Inlet per Per MAG SD 501-5	1	EA		
66	505.1.1(c) (SP)	Outlet Headwall per Per MAG SD 501-1	1	EA		
67	618(a) (SP)	Storm Drain per QCSD 200Q-1 (18" Ø HDPE)	140	LF		
68	618(b) (SP)	Storm Drain per QCSD 200Q-1 (24" Ø RCP)	100	LF		
69	601.2.11b (SP)	Rock Excavation for Utility Construction (Storm Drain - Provisionary Item - May Not Be Used)	60	CY		
70	601.2.12b (SP)	Trench Stabilization (Storm Drain - Provisionary Item - May Not Be Used)	60	CY		
		Drainage Improvements Subtotal				
Pump Station Improvements						
71	420	Chain Link Fence	170	LF		
72	201 (SP)	Clearing and Grubbing	1	LS		
73	201 (SP)	Site Grading per Grading Plan	1	LS		
74	301 (SP)	Subgrade Preparation	1,111	SY		

Bid Schedule

Zone 41 (Mingus) Pump Station, Tank and Pipeline Project

CIP #17-009

Line #	Item #	Description	Qty	Unit	Unit Cost	Amount
75	310 (SP)	Placement and Construction of Aggregate Base Course (8" thickness)	136	CY		
76	321 (SP)	Asphalt Concrete (AC) Pavement, 4" Thick - Two Lifts	610	SY		
77	329 (SP)	AC Bituminous Tack Coat, Type SS-1h	0.93	TON		
78	505.1.1(e)	Concrete Retaining Wall	2,205	SF		
79	520 (SP)	Safety Rail per QCSD 145Q	225	LF		
80	02 41 13	Pump Station Demolition	1	LS		
81	Div. 03 thru 10	Pump Station Building and Slabs	1	LS		
82	Div. 23	HVAC Systems	1	LS		
83	Div. 40	Mechanical and Yard Piping, Valves, Vaults	1	LS		
84	41 22 00	Hoists and Cranes	1	LS		
85	Div. 43	Vertical Inline Pumps	1	LS		
86	43 42 21	Bladder-Type Hydropneumatic Tanks	1	LS		
		Pump Station Improvements Items Subtotal				
Steel Storage Tank						
87	420	Chain Link Fence	305	LF		
88	420	Chain Link Gate	1	EA		
89	701.2 (SP)	Fine Gravel (Fractured Rock with No Fines)	1	LS		
90	505.1.1(e) (SP)	Concrete Retaining Wall	320	SF		
91	02 41 13	Tank Site Demolition	1	LS		
92	Div. 40	Mechanical and Yard Piping, Valves, Vaults	1	LS		
93	33 16 13.13	Steel, Above Ground Storage Tank and Appurtenances, Complete in Place	1	LS		
		Steel Storage Tank Items Subtotal				
Electrical and Instrumentation						
94	Div. 26 and 43	Electrical and Instrumentation	1	LS		
95	Div. 26	Electrical Service Fee	1	ALL	$ 3,300.00	$ 3,300.00
		Electrical and Instrumentation Items Subtotal				
		Total Bid Amount				

Bid Schedule

Zone 41 (Mingus) Pump Station, Tank and Pipeline Project

CIP #17-009

Line #	Item #	Description	Qty	Unit	Unit Cost	Amount

TOTAL BID AMOUNT:

Dollars and Cents

(In Written Words)

Company Name

Company Address

Signature of Company Official

Date Signed

Title

Email

Proposal

Date: _____

Proposal of _____
(Name)

Corporation organized and existing under the laws of the State of Arizona; a partnership consisting of _____ or an individual trading as _____.

TO THE HONORABLE MAYOR AND COUNCIL
CITY OF PRESCOTT
PRESCOTT, ARIZONA

Ladies and Gentlemen:

The Undersigned hereby proposes and agrees to furnish any and all required labor, material, construction equipment, transportation, and services for completion of the Zone 41 Mingus Pump Station, Tank and Pipeline Project, in strict conformity with the plans and specifications, at the total base bid price of:

_____ Dollars

($_____).

The Undersigned hereby declares that he has visited the site and has carefully examined the Contract Documents relating to the work covered by the above bid or bids.

The Proposal Guarantee (Certified Check, Cashier's Check, or Bid Bond) attached, payable to the City of Prescott in the sum of not less than ten percent (10%) of the total bid price submitted for the complete project, to ensure that the Undersigned, if his bid is accepted, shall enter into contract and give the bonds and certificates of insurance required. In the event that the contract and bonds and certificates of insurance required are not furnished to the City within the time required, then and in that event the City may retain from the proposal guarantee an amount, not to exceed the amount of the proposal guarantee, representing the difference between the amount specified in the proposal or bid, and such larger amount that the City in good faith contracts with another party to perform the work covered by the proposal or bid.

The project shall be completed within four hundred twenty (420) calendar days after the starting date set forth in the NOTICE TO PROCEED.

The Undersigned hereby declares, as bidder, that the only persons or parties interested in this PROPOSAL as principals are those named herein; that no elected official or employee of the City is in any manner interested directly or indirectly in this PROPOSAL or in the profits to be derived

from the contract proposed to be taken, other than as permitted by law; that this bid is made without any connection with any other person or persons making a separate bid for the same purpose; that the bid is in all respects fair and without collusion or fraud; that he has read the NOTICE INVITING BIDS, CONTRACT DOCUMENTS AND PROJECT SPECIFICATIONS, and agrees to furnish the items and perform the work called for in accordance with the provisions of said form of Contract and the Specifications and to deliver the same within the time stipulated herein, and that he will accept in full payment therefore the total bid price named in this Proposal.

The bidder shall be an A-General Engineering contractor properly licensed in the State of Arizona at the time of bidding to perform construction in connection with fixed works, including streets, roads, power and utilities plants, dams, hydroelectric plants, sewage and waste disposal plants, bridges, tunnels, and overpasses and shall also be licensed to perform work within residential and commercial property lines, or shall be properly licensed to sub-contract residential or commercial work, as may be required in the Scope of Work.

Any bid submitted without the proper contracting license to perform the required work shall be considered non-responsive and rejected.

The bidder further agrees that, upon receipt of written notice of the acceptance of this PROPOSAL, he will execute the Contract in accordance with the PROPOSAL as accepted and furnish the required bonds TEN (10) days from the date of mailing of said Notice of Award to him at his address as given below, or within such additional time as may be allowed by the City; and that upon his failure or refusal to do so within said time, then the certified or cashier's check or bid bond accompanying this bid shall be cashed or enforced and the money payable pursuant thereto shall be forfeited to and become the property of the City as liquidated damages for such failure or refusal; provided that if said bidder shall execute the Contract and furnish the required bonds within the aforesaid time, his certified or cashier's check, if furnished, shall be returned to him within three (3) days thereafter, and the bid bond, if furnished, shall become void.

Bidder understands and agrees that the City reserves the right to reject any or all bids and to waive any informality in the bidding.

The bidder agrees that this bid shall be good and may not be withdrawn for a period of sixty (60) calendar days after the scheduled closing time for receiving bids.

Bidder acknowledges receipt of the following Addenda: _____

The undersigned is the holder of Arizona State Contractor's License No(s). and Classification(s):

_____

Respectfully submitted,

_____

Bidder (Authorized Signature)

Corporate Seal

By: _____

Title: _____

Bidder's Contact Information:

Physical Address: _____

Mailing Address: _____

Telephone No: _____

Email Address: _____

Names and addresses of all members of the firm or names and titles of all officers of the corporation:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Subcontractors List

Zone 41 Mingus Pump Station, Tank and Pipeline

Subcontractor Information	Bid Item(s)	Subcontract Amount	% of Total Bid
Name: Address: Phone #: License #:			
Name: Address: Phone #: License #:			
Name: Address: Phone #: License #:			
Name: Address: Phone #: License #:			
Name: Address: Phone #: License #:			
Total Subcontract Amount and Percentage of Bid	**$**		**%**

**Use additional forms if needed*

Proposed Staging Locations

Project Name: Zone 41 Mingus Pump Station, Tank and Pipeline

Bid Date: April 4, 2024

Contractor Name: _____

Proposed Location No. 1	
General Description:	Parcel No:
	Physical Address:
Legal Owner:	Zoning District:

Proposed Location No. 2	
General Description:	Parcel No:
	Physical Address:
Legal Owner:	Zoning District:

**A map of each location may be attached to this form*

If <u>no</u> staging areas are proposed, please check here and sign below: ☐ No Areas Proposed

By signing below, I ("Contractor") certify that no staging areas are required for the above-named project. If necessary, staging area(s) are later determined, I understand that any associated costs shall be furnished by the Contractor and will be considered incidental without additional compensation from the City.

_____ _____

Signature of Company Official Date Signed

Bidder's Affidavit

Zone 41 Mingus Pump Station, Tank and Pipeline Project

State of _____)
) ss.
County of _____)

_____, being first duly sworn, deposes and says:

That he/she is _____ of _____
(Title) (Bidder)

who submits herewith to the City of Prescott, Arizona, a Proposal:

That all statements of fact in such Proposal are true.

That said Proposal was not made in the interest of or on behalf of any undisclosed person, partnership, company, association, organization, or corporation.

That said bidder has not, directly, or indirectly by agreement, communication, or conference with anyone attempted to induce action prejudicial to the interest of the City of Prescott, Arizona, or of any bidder or anyone else interested in the proposed contract; and further,

That prior to the public opening and reading of proposal, said bidder:

1. Did not directly or indirectly, induce or solicit anyone else to submit a false or sham proposal;
2. Did not directly or indirectly collude, conspire, connive or agree with anyone else that said bidder or anyone else would submit a false or sham proposal, or that anyone should refrain from bidding or withdraw his proposals;
3. Did not in any manner, directly or indirectly, seek by agreement, communication or conference with anyone to raise or fix the proposal price of said bidder or of anyone else, or to raise or fix any overhead, profit or cost element of his proposal price, or of that of anyone else;
4. Did not, directly or indirectly, submit his proposed price or any breakdown thereof, or the contents thereof, or divulge information or data relative thereto, to any corporation, partnership, company, association organization, bid depository or to any member or agent thereof, or to any individual or group of individuals, except the City of Prescott, Arizona, or to any person or persons who have a partnership or other financial interests with said bidder in his business.

By: _____

SUBSCRIBED AND SWORN to before me by _____

this _____ day of _____, 20___.

_____ _____
Notary Public Commission Expires

Construction Contract

Zone 41 Mingus Pump Station, Tank and Pipeline

Contract No. 2024-***

THIS AGREEMENT made and entered into this 14th day of May, 2024, by and between ** of the city of **, county of **, state of **, hereinafter designated "Contractor", and the City of Prescott, a municipal corporation, organized and existing under and by virtue of the laws of the State of Arizona, hereinafter designated "City".

WITNESSETH: That the said Contractor, for and in consideration of the sum to be paid by the said City, and of the other covenants and agreements herein contained, and under the penalties expressed in the bonds provided, hereby agrees, for him/herself, his heir, executors, administrators, successors and assigns as follows:

ARTICLE I - SCOPE OF WORK: The Contractor shall furnish any and all labor, materials, equipment, transportation, utilities, services and facilities, required to perform all work for the construction of the project described as City of Prescott: Zone 41 Mingus Pump Station, Tank and Pipeline Project and install the material therein for the City, in a good and workmanlike and substantial manner and to the satisfaction of the City through its Engineers and under the direction and supervision of the Public Works Director, or his properly authorized agents and strictly pursuant to and in conformity with the Plans and Specifications prepared by the engineers for the City, and with such written modifications of the same and other documents that may be made by the City through the Public Works Director or his properly authorized agents, as provided herein.

ARTICLE II - CONTRACT DOCUMENTS: The Notice Inviting Bids, Project Plans and Specifications, MAG Specifications and Details, City Supplement to MAG, Special Provisions, Addenda, Contractor's Affidavit Regarding Settlement of Claims and Certification of Completion of Warranties, Contractor Bid Proposal as accepted by the Mayor and Council per Council Minutes of May 14, 2024, Proposal Guarantee, Performance Bond, Payment Bond, Certificates of Insurance and required Endorsements, Contract Allowance Authorizations and Contract Amendments, are by this reference made a part of this Contract to the same extent as if set forth herein in full.

ARTICLE III - TIME OF COMPLETION: The Contractor hereby agrees to commence work on or before the tenth (10th) day after written notice to do so, unless such commencement of work is mutually agreed to be extended by the parties due to material unavailability and delayed lead times. The Contractor will complete the work within four hundred twenty (420) calendar days after the date of the written notice to commence work, subject to such extensions of time as are provided by the City Supplement to MAG. The contract will close 60 days after the substantial completion date, to finalize the payment process.

ARTICLE IV - COMPENSATION: Contractor shall be paid, pursuant to the provisions as set forth in the Contract Documents, a not to exceed amount of ** dollars and ** cents ($**), plus any approved contract amendments, for the full and satisfactory completion of all work as set forth in the Project Plans, Specifications and Contract Documents. Retention shall

SAMPLE

be in accordance with A.R.S. § 34-221. If the Contractor claims that any instructions involve additional/extra cost, it shall give the Director written notice thereof within forty-eight (48) hours after the receipt of such instructions, and in any event before proceeding to execute the services / work. No such claim shall be valid unless so made. The Contractor shall do such additional/extra services/work upon receipt of an accepted Contract Amendment or other written order of the Director. In the absence of such Contract Amendment or other written order of the Director, the Professional shall not be entitled to payment for such additional/extra services/work. In no case shall services/work be undertaken without written notice from the Director to proceed with the services/work. All Contract Amendments shall be approved by the Director, but Contract Amendments over $50,000 must also be approved by City Council.

ARTICLE V – CONFLICT OF INTEREST: Pursuant to A.R.S. § 38-511, the City may cancel this contract, without penalty or further obligation, if any person significantly involved in initiating, negotiation, securing, drafting or creating the contract on behalf of the City is, at any time while the contract or any extension of the contract is in effect, an employee or agent of any other party to the contract in any capacity or a consultant to any other party of the contract with respect to the subject matter of the contract. In the event of the foregoing, the City further elects to recoup any fee or commission paid or due to any person significantly involved in initiating, negotiation, securing, drafting or creating this contract on behalf of the City from any other party to the contract, arising as a result of this contract.

ARTICLE VI - AMBIGUITY: This Agreement is the result of negotiations by and between the parties. Although it has been drafted by the Prescott City Attorney, it is the result of the negotiations between the parties. Therefore, any ambiguity in this Agreement is not to be construed against either party.

ARTICLE VII - NONDISCRIMINATION: The Contractor, with regard to the work performed by it after award and during its performance of this contract, will not discriminate on the grounds of race, color, national origin, religion, sex, disability or familial status in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The Contractor will not participate either directly or indirectly in the discrimination prohibited by or pursuant to Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Section 109 of the Housing and Community Development Act of 1974, the Age Discrimination Act of 1975, the Americans With Disability Act (Public Law 101-336, 42 U.S.C. 12101-12213) and all applicable federal regulations under the Act, and Arizona Governor Executive Orders 99-4, 2000-4 and 2009-09 as amended.

ARTICLE VIII - INDEPENDENT CONTRACTOR STATUS: It is expressly agreed and understood by and between the parties that the Contractor is being retained by the City as an independent contractor, and as such the Contractor shall not become a City employee and is not entitled to payment or compensation from the City or to any fringe benefits to which other City employees are entitled other than that compensation as set forth in Article IV - Compensation above. As an independent contractor, the Contractor further acknowledges that he is solely responsible for payment of any and all income taxes, FICA, withholding, unemployment insurance, or other taxes due and owing any governmental entity whatsoever as a result of this Agreement. As an independent contractor, the Contractor further agrees that he will conduct himself in a manner consistent with such status, and that he will neither hold himself out nor claim to be an officer or employee of the City by reason thereof, and that he will not make any claim, demand or application to or for any right or privilege applicable to any officer or employee of the City, including but not limited to workmen's compensation coverage, unemployment insurance benefits, social security coverage, or retirement membership or credit.

SAMPLE

ARTICLE IX - CITY FEES: Prior to final payment to the Contractor, the City shall deduct therefrom any and all unpaid privilege, license and other taxes, fees and any and all other unpaid moneys due the City from the Contractor and shall apply to those moneys to the appropriate account. Contractor shall provide to the City any information necessary to determine the total amount(s) due.

ARTICLE X - LIQUIDATED DAMAGES: All time limits stated in the Contract Documents are of the essence and should the Contractor fail to complete the work required to be done on or before the time of completion as set forth in these Contract Documents, including any authorized extension of time, it is mutually agreed and understood by and between the parties that the public will suffer great damages; that such damages, from the nature of the project, will be extremely difficult and impractical to fix; that the parties hereto wish to fix the amount of said damages in advance; and that the sum of $**.00 per day for each and every day's delay in completion and acceptance of the work required to be done by the Contractor subsequent to the time of completion, including any authorized extensions of time, is the nearest and most exact measure of damages for such breach that can be fixed now or could be fixed at or after such breach and that, therefore, the Owner and Contractor agree to fix said sum of $**.00 per day for each and every said day's delay as liquidated damages, and not as a penalty or forfeiture for the breach of the agreement to complete the work required to be done by the Contractor on or before the time of completion and acceptance and, in the case of such breach, the Owner shall deduct said amount from the amount due the Contractor under the contract. In the event the remaining balance due the Contractor is insufficient to cover the full amount of assessed liquidated damages, then the Contractor or the surety on the bonds shall pay the difference due the Owner.

ARTICLE XI - OTHER WORK IN PROJECT AREA: The City, any other contractors, whether under contract with the City, a third party, and/or utilities, may be working within the project area while this Contract is in progress. The Contractor herein acknowledges that delays and disruptions may, and in all likelihood, will occur due to other work. The Contractor's bid shall be deemed to have recognized and included costs arising from and associated with other work in the project area disclosed by the Contract Documents or which would be apparent to an experienced contractor exercising due diligence during inspection of the project documents, the question-and-answer session in the pre-bid process or during site inspection. No payment will be made for any delays or disruptions in the work schedule that are wholly the fault of the Contractor, its agents, employees, or any of the Contractor's subcontractors. In the event the Contractor encounters delay or disruption in the project schedule due to factors not wholly the fault of the Contractor or within the Contractor's control then the Contract may be adjusted pursuant to the Delay's and Extension of Time provisions of this Contract and a timely request submitted for Contract Amendment. Failure to submit a timely request for Contract Amendment shall be deemed a waiver of any entitlement to additional compensation.

ARTICLE XII - BONDS:

A. On or before the execution of the contract, the Contractor shall obtain in an amount equal to the full contract price a performance bond pursuant to A.R.S. § 34-222, conditioned upon the faithful performance of this contract in accordance with the plans, specifications, and conditions herein. The bonds shall be solely for the protection of the City. A copy of this bond shall be filed with the Prescott City Clerk.

B. Contractor shall also obtain a payment bond, pursuant to the provisions of A.R.S. § 34-222, in an amount equal to this full contract price herein, said bond to be solely for the protection of claimants supplying labor or materials to the Contractor or his subcontractors in the prosecution of the work provided for in this contract. A copy of this bond shall be filed with the Prescott City Clerk.

SAMPLE

C. All bonds must be written by an insurance company authorized to do business in the State of Arizona, to be evidenced by a Certificate of Authority as defined in A.R.S. § 20-217, a copy of which certificate is to be attached to the applicable bid bond, payment bond and performance bond. In addition, depending upon the nature of the contract and amount thereof, the City Manager may also require insurance companies and/or bonding companies to have an "A" rating or better with Moody's or A.M. Best Company, and/or to be included on the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended) by the audit staff, Bureau of Accounts, US Treasury Department.

ARTICLE XIII – SUBCONTRACTORS:

A. During performance of this Agreement, the Contractor may engage such additional subcontractors as may be required for the timely completion of the construction. The addition of any Subcontractors shall be subject to prior written approval by the City. In the event of sub-contracting, the sole responsibility for fulfillment of all terms and conditions of this Agreement rests with the Contractor.
B. The Contract Amount includes payment for any and all Services to be rendered by the Contractor or Subcontractors which the Contractor may employ for this Agreement. It is expressly agreed by and between the parties that the Contractor is solely responsible for all payment to such any other Contractors or Subcontractors retained by the Contractor. The Contractor agrees to indemnify and save harmless the City of Prescott against any and all liens, claims of liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure to pay for all labor performance and materials furnished for the performance of said project when completed.

ARTICLE XIV – INDEMNITY:

The Contractor shall defend, indemnify and hold harmless the City, its departments, officers, officials, agents, and employees (hereinafter referred to as "Indemnitee") from and against any and all claims, actions, liabilities, damages, losses, or expenses (including court costs, attorneys fees and costs of claim processing, investigation and litigation) (hereinafter referred to as "Claims") for bodily injury or personal injury (including death), or loss or damage to tangible or intangible property caused, or alleged to be caused, in whole or in part, by the negligent or willful acts or omissions of the Contractor or any of the Contractor's owners, officers, directors, agents, employees or subcontractors. This indemnity includes any claim or amount arising out of or recovered under Worker's Compensation Law or arising out of failure of such Contractor to conform to any Federal, State, or local law, statute, ordinance, rule, regulation, or court decree. It is the specific intentions of the parties that the Indemnitee shall, in all instances, except for Claims arising solely from the negligent or willful acts of Indemnitee, be indemnified by the Contractor from and against any and all claims. In consideration of the award of this contract, the Contractor agrees to waive all rights of subrogation against the City, its departments, officers, officials, agents, and employees for losses arising from the work performed by the Contractor for the City.

ARTICLE XV – RIGHT TO ASSURANCE:

If the City in good faith has reason to believe that the Contractor does not intend to or is unable to perform or continue performing under this Contract, the Public Works Director may demand in writing that the Contractor give a written assurance of intent to perform. Failure by the Contractor to provide written assurance within the number of Days specified in the demand may, at the City's option, be the basis for terminating the Contract.

SAMPLE

ARTICLE XVI – TERMINATION FOR CONVENIENCE:
The City reserves the right to terminate the Contract, in whole or in part at any time, when in the best interests of the City without penalty or recourse. Upon receipt of the written notice, the Contractor shall stop all work, as directed in the notice, notify all subcontractors of the effective date of the termination, and minimize all further costs to the City. In the event of termination under this paragraph, all documents, data, and reports prepared by the Contractor under the Contract shall become the property of and be delivered to the City upon demand. The Contractor shall be entitled to receive just and equitable compensation for work completed, and materials accepted before the effective date of the termination.

ARTICLE XVII - MISCELLANEOUS:

A. All pay applications need to have these items contract number, pay application number, dates of service and date submitted. They need to be submitted to the project manager for review. Once they review and sign off, they will submit to our accounts payable department for payment processing.

B. The parties hereto expressly covenant and agree that in the event of a dispute arising from this Agreement, each of the parties hereto waives any right to a trial by jury. In the event of litigation, the parties hereby agree to submit to a trial before the Court. The Contractor further agrees that this provision shall be contained in all subcontracts related to the project, which is the subject of this Agreement.

C. Final Payment Acknowledgement to be signed by the contractor and sent in with the final pay application. This is to further certify that the project is completed to acceptable standards as defined in the plans and specifications per the Project Contract Agreement. Any changes to the plans have been noted on the Construction As-built Mylar Drawings certified by the Engineer of Record. The revised As-built Drawings have been delivered and approved by the Public Works department. All materials used and workmanship performed are expressly warranted to be free of defects for a period of twenty-four (24) months from the date of final acceptance by the City of Prescott.

D. Contractor's Affidavit Regarding Settlement of Claims and Certification of Completion of Warranties is to be signed and returned at the end of the two-year warranty period that is determined per the warranty letter sent out when the project has been completed.

E. The parties hereto expressly covenant and agree that in the event of litigation arising from this Agreement, neither party shall be entitled to an award of attorney fees, either pursuant to the Contract, pursuant to A.R.S. § 12-341.01 (A) and (B), A.R.S. §34-301, §34-302 & §34-321 or pursuant to any other state or federal statute, court rule, case law or common law. The Contractor further agrees that this provision shall be contained in all subcontracts related to the project that is the subject of this Agreement.

F. In the event of default, neither party shall be liable for incidental, special, or consequential damages.

SAMPLE

G. Any notices to be given by either party to the other must be in writing, and personally delivered or mailed by prepaid postage, at the following addresses:

City of Prescott	**
201 N. Montezuma Street	**
Prescott, Arizona 86301	**
contracts@prescott-az.gov	Email

H. This Agreement shall be construed under the laws of the State of Arizona.

I. This Agreement represents the entire and integrated Agreement between the City and the Contractor and supersedes all prior negotiations, representations, or agreements, either written or oral. This Agreement may be amended only by written instrument signed by both the City and the Contractor. Written and signed amendments shall automatically become part of the Agreement, and shall supersede any inconsistent provision therein; provided, however, that any apparent inconsistency shall be resolved, if possible, by construing the provisions as mutually complementary and supplementary.

J. In the event any provision of this Agreement shall be held to be invalid and unenforceable, the remaining provisions shall be valid and binding upon the parties. One or more waivers by either party of any provision, term, condition, or covenant shall not be construed by the other party as a waiver of a subsequent breach of the same by the other party.

K. No oral order, objection, claim or notice by any party to the other shall affect or modify any of the terms or obligations contained in this Agreement, and none of the provisions of this Agreement shall be held to be waived or modified by reason of any act whatsoever, other than by a definitely agreed waiver or modification thereof in writing. No evidence of modification or waiver other than evidence of any such written notice, waiver or modification shall be introduced in any proceeding.

L. Contractor agrees that notwithstanding the existence of any dispute, the Contractor shall continue to perform the obligations required of Contractor during the negotiation and resolution of any such dispute unless specifically enjoined or prohibited by an Arizona Court of competent jurisdiction.

M. In the event of a discrepancy between this Agreement and other documents incorporated into this Agreement, this Agreement shall control over Exhibit “A”.

N. Non-Availability of Funds: Fulfillment of the obligation of the City under this Agreement is conditioned upon the availability of funds appropriated or allocated for the performance of such obligations. If funds are not allocated and available for the continuance of this Agreement, this Agreement may be terminated by the City at the end of the period for which the funds are available. No liability shall accrue to the City in the event this provision is exercised, and the City shall not be obligated or liable for any future payments as a result of termination under this paragraph.

O. Compliance with Federal and State Laws: All Services performed by the Contractor shall be performed in compliance with all applicable federal, state, county, or city laws, rules, regulations, and ordinances, including, without limitations, those set forth on the attached Exhibit C, if applicable. The Contractor, at the Contractor’s expense, shall be responsible for

SAMPLE

obtaining all necessary licenses, permits and governmental authorizations required to perform the Services. The Contractor understands and acknowledges the applicability to it of the Immigration Reform and Control Act of 1986 and the Drug Free Workplace Act of 1989.

P. Nondiscrimination and Equal Employment Opportunity: The Contractor and any Subcontractors are required to comply with all applicable provisions of Title VII of the Civil Rights Act, Sections 501 and 505 of the Rehabilitation Act, Section 109 of the Housing and Community Development Act, the Age Discrimination Act, the Americans With Disabilities Act, the Equal Pay Act, the Genetic Information Non-Discrimination Act, the Vietnam Era Veterans Readjustment Act, and all applicable federal regulations or executive orders related to these laws. Additionally, the Contractor and any Subcontractors are required to comply with Arizona law on nondiscrimination and equal employment opportunity, including the Arizona Civil Rights Act and Arizona Governor Executive Orders 99-4, 2000-4 and 2009-09, as amended. The Contractor agrees not to discriminate on the grounds of age, race, color, national origin, religion, sex, disability, pregnancy, veteran, familial status, or any other protected status in the selection and retention of employees and subcontractors, including procurement of materials and leases of equipment.

Q. Employees on Public Works Construction Projects: E-Verify Requirements:
   1. The Contractor shall comply with A.R.S. § 34-301, "Employment of Aliens on Public Works Prohibited", and A.R.S. § 34-302, "Residence Requirements for Employees", as amended.

   2. Under the provisions of A.R.S. § 41-4401, the Contractor hereby warrants to the City that the Contractor and each of its Subcontractors will comply with, and are contractually obligated to comply with, all Federal Immigration laws and regulations that relate to their employees and A.R.S. § 23-214(A) (hereinafter referred to as "Contractor Immigration Warranty"). The Contractor further understands and acknowledges that:
      a. A breach of the Contractor Immigration Warranty shall constitute a material breach of this Agreement and shall subject the Contractor to penalties up to and including termination of this Agreement at the sole discretion of the City.
      b. The City retains the legal right to inspect the papers of any Contractor or Subcontractors' employee to ensure that the Contractor or Subcontractor is complying with the Contractor Immigration Warranty. The Contractor agrees to assist the City in regard to any such inspections.
      c. The City may, at its sole discretion, conduct random verification of the employment records of the Contractor and any of the Subcontractors to ensure compliance with the Contractor Immigration Warranty. The Contractor agrees to assist the City in regard to any random verification performed.
      d. Neither the Contractor nor any Subcontractor shall be deemed to have materially breached the Contractor Immigration Warranty if the Contractor or Subcontractor establishes that it has complied with employment verification provisions prescribed by Sections 274A and 274B of the Federal Immigration and Nationality Act and the E-Verify requirements prescribed by A.R.S. § 23-214(A).
      e. The provisions of this Article shall be included in any contract the Contractor enters with any and all of its Subcontractors who provide Services under this Agreement. "Services" are defined as furnishing labor, time, or effort in the State of Arizona by a Contractor or subcontractor. Services include construction or maintenance of any structure, building or transportation facility or improvement of real property.

SAMPLE

R. Israel: Contractor certifies that it is not currently engaged in and agrees for the duration of this Agreement that it will not engage in a “boycott”, as that term is defined in A.R.S. § 35-393, of Israel.

S. Force Labor of Ethnic Uyghurs Certification: Pursuant to A.R.S. § 35- 394, Contractor certifies that the firm does not currently, and agrees for the duration of the contract that it will not, use:

1. The forced labor of ethnic Uyghurs in the People' s Republic of China
2. Any goods or services produced by the forced labor of ethnic Uyghurs in the People' s Republic of China; and
3. Any Contractor / subcontractors or suppliers that use the forced labor or any goods or services produced by the forced labor of ethnic Uyghurs in the People' s Republic of China.

If the Contractor becomes aware during the term of the Contract that the company is not in compliance with the written certification, the Firm shall notify the City of Prescott within five business days after becoming aware of the noncompliance. If the Contractor does not provide City of Prescott with a written certification that the Company has remedied the noncompliance within 180 days after notifying the City of Prescott of the noncompliance, this Contract terminates, except that if the Contract termination date occurs before the end of the remedy period, the Contract terminates on the Contract termination date.

T. Contracting with small and minority firms, women's business enterprise and labor surplus area firms:

1. The Company will take all necessary affirmative steps to assure that minority firms, women’s business enterprises, and labor surplus area firms are used when possible.
2. Affirmative steps shall include:
   a. Placing qualified small and minority businesses and women's business enterprises on solicitation lists
   b. Assuring that small and minority businesses, and women's business enterprises are solicited whenever they are potential sources.
   c. Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority business, and women's business enterprises.
   d. Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority business, and women's business enterprises.
   e. Using the services and assistance of the Small Business Administration, and the Minority Business Development Agency of the Department of Commerce.

SAMPLE

DATED: _____ day of _____, 2024

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the date and year first set forth above.

** (Company Name)

_____
(Authorized Signature)

By: _____
(Printed Name)

Title: _____

Email: _____

City of Prescott, a municipal corporation:

_____
Philip R. Goode, Mayor

ATTEST:

_____
Sarah M. Siep, City Clerk

APPROVED AS TO FORM:

_____
Joseph D. Young, City Attorney

SAMPLE

INSURANCE REQUIREMENTS

Contractor and subcontractors shall procure and maintain until all of their obligations have been discharged, including any warranty periods under this Contract are satisfied, insurance against claims for injury to persons or damage to property which may arise from or in connection with the performance of the work hereunder by the Contractor, his agents, representatives, employees or subcontractors.

The insurance requirements herein are minimum requirements for this Contract and in no way limit the indemnity covenants contained in this Contract.

The City in no way warrants that the minimum limits contained herein are sufficient to protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, his agents, representatives, employees, or subcontractors. The Contractor is free to purchase such additional insurance as may be determined necessary.

ADDITIONAL INSURANCE REQUIREMENTS:

The policies shall include, or be endorsed to include the following provisions:

1. On insurance policies where the City of Prescott is named as an additional insured, the City of Prescott shall be an additional insured to the full limits of liability purchased by the Contractor even if those limits of liability are in excess of those required by this Contract.

   Additional Insured:
   City of Prescott
   201 N. Montezuma Street
   Prescott AZ 86301

2. The Contractor's insurance coverage shall be primary insurance and non-contributory with respect to all other available sources.

All certificates required by this Contract shall be emailed directly to coi@prescott-az.gov **AND** fandboperations@prescott-az.gov. The City contract number and project name/description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this Contract at any time. Any Renewal of insurance certificates with endorsements will need to be emailed to the above emails at least two weeks prior to expiration.

NOTICE OF CANCELLATION:

With the exception of a ten (10) day notice of cancellation for non-payment of premium, and changes material to compliance with this contract in the insurance policies above shall require a thirty (30) day written notice.

ACCEPTABILITY OF INSURERS:

Insurance is to be placed with insurers with a current A.M. Best's rating of no less than A-VII, unless otherwise approved by the City of Prescott. General liability, automobile liability, and worker's compensation insurance is to be placed with an insurer admitted in the state in which operations are taking place.

VERIFICATION OF COVERAGE:

Contractor shall furnish the City with certificates of insurance (ACORD form or equivalent approved by the City) as required by this Contract. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf.

All certificates and any required endorsements are to be received and approved by the City before work commences. Each insurance policy required by this Contract must be in effect at or prior to commencement of work under this Contract and remain in effect for the duration of the project and warranty period as set forth in warranty letter. Failure to maintain the insurance policies as required by this Contract or to provide evidence of renewal is a material breach of contract.

MAG Specifications, Sections 103.1 through 103.8, including: Unless otherwise specifically required by the Special Conditions, the minimum limits of public liability and property damage liability shall be as follows:

1. Contractor shall provide coverage with limits of liability not less than those stated below. An excess liability policy or umbrella liability policy may be used to meet the minimum liability requirements provided that the coverage is written on a following form basis.

   Commercial General Liability – Occurrence Form –

   Policy shall include bodily injury, property damage, broad form, contractual liability and XCU coverage.

   - General Aggregate $ 3,000,000
   - Products – Completed Operations Aggregate $ 3,000,000
   - Personal and Advertising Injury $ 1,000,000
   - Each Occurrence $ 1,000,000
   - Fire Legal Liability (Damage to Rented Premises) (if applicable) $ 100,000

The policy shall be endorsed to include the following additional insured language:

"The Contractor agrees to endorse the City of Prescott as an Additional Insured on the Commercial General Liability with the following Additional Insured endorsement, or similar endorsement providing equal or broader Additional Insured coverage, the CG 2010 10 01 Additional Insured - Owners, Lessees, or Contractors, or CG2010 07 04 Additional Insured – Owners, Lessees, or Contractors – Scheduled Person or Organization endorsement in combination with the additional endorsement of GC2037 10 01 Additional Insured – Owners, Lessees, or Contractors – Completed Operations shall be required to provide back coverage for the contractor's "your work" as defined in the policy and liability arising out of the products-completed operations hazard."

Business Automobile Liability: Bodily Injury and Property Damage for any owned, hired, and/or non-owned vehicles used in the performance of this Contract.

Combined Single Limit (CSL) $ 1,000,000

The policy shall be endorsed to include the following additional insured language:

"The City of Prescott shall be named as additional insured with respect to liability arising out of the activities performed by or on behalf of the Contractor, involving automobiles, owned, leased, hired, or borrowed by the Contractor."

Worker's Compensation and Employer's Liability

Workers' Compensation Statutory

Employer's Liability

Each Accident - $1,000,000

Disease – each employee -	$1,000,000
Disease – policy limit -	$1,000,000

Policy shall contain a waiver of subrogation against the City of Prescott for losses arising from work performed by or on behalf of the Contractor.

Professional Liability (Errors and Omissions Liability) – *if applicable*

Each Claim	$ 1,000,000
Annual Aggregate	$ 2,000,000

1. In the event that the professional liability insurance required by this Contract is written on a claims-made basis, Contractor warrants that any retroactive date under the policy shall precede the effective date of this Contract and that either continuous coverage will be maintained, or an extended discovery period will be exercised for a period of two (2) years at the time work under this contract is completed.

2. The policy shall cover professional misconduct or lack of ordinary skill for those positions defined in the Scope of Work of this contract.

Notice of Cancellation: With the exception of a ten (10) day notice of cancellation for non-payment of premium, any changes to material to compliance with this contract in the insurance policies above shall require thirty (30) day written notice.

Such policy shall not exclude coverage for the following:

1. Injury to or destruction of any property arising out of the collapse of/or structural injury to any building or structure due to grading of land, excavation, borrowing, filling, backfilling, tunneling, pile driving, cofferdam work or caisson work.

2. Injury to or destruction of wires, conduits, pipes, mains, sewers, or other similar property or any apparatus in connection therewith, below the surface of the ground, if such injury or destruction is caused by and occurs during the use of mechanical equipment for the purpose of grading of land, paving, excavating, drilling; or injury to or destruction of any property at any time resulting there from.

3. Injury to or destruction of any property arising out of blasting or explosion.

4. Motor vehicle public liability and property damage insurance to cover each automobile, truck, and other vehicle used in the performance of the Contract in an amount of not less than $1,000,000.00 for one person, and $1,000,000.00 for more than one person, and property damage in the sum of $1,000,000.00 resulting from any one accident which may arise from the operations of the Contractor in performing the work provided for herein.

The Contractor shall carry and maintain fire and extended coverage with an endorsement for vandalism and malicious mischief in Contractor’s name and also in the name of the City in an amount of at least ONE HUNDRED PERCENT (100%) of the Contract amount (if applicable).

The Contractor shall secure "all risk"-type builder's risk insurance for work to be performed. Unless specifically authorized by the City, the amount of such insurance shall not be less than ONE HUNDRED PERCENT (100%) of the contract price. Such policy shall include coverage for

earthquake, landslide, flood, collapse, or loss due to the results of faulty workmanship, during the contract time and until final acceptance of work by the City (if applicable).

FINAL PAYMENT ACKNOWLEDGEMENT

To the City of Prescott, Arizona:

Contractor company name
Address
city, state,zip
Email

Contractor Name, has submitted the final pay application for the Zone 41 Mingus Pump Station, Tank and Pipeline project Contract Number 2024-*** in the consideration of:

$ _____
(Total Final Project Amount)

as full and complete payment under the terms of the Contract. All materials used and workmanship performed are expressly warranted to be free of defects for a period of twenty-four (24) months from the date of final acceptance by the City of Prescott, as stated in the warranty letter to be provided.

The Undersigned further agrees to indemnify and save harmless the City of Prescott against any and all liens, claims of liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performance and materials furnished for the performance of said project within the next 90 days.

Signed and dated this _____ day of _____, 20____.

_____
(Authorized Signature)

By: _____

Title: _____

State of _____)
) ss.
County of _____)

SUBSCRIBED AND SWORN to before me by _____

this _____ day of _____, 20_____.

_____ _____
Notary Public Commission Expires

CONTRACTOR'S AFFIDAVIT REGARDING SETTLEMENT OF CLAIMS AND CERTIFICATION OF COMPLETION OF WARRANTIES

(Send in after 2-year Warranty)

Project: Zone 41 Mingus Pump Station, Tank and Pipeline
Contract Number: 2024-***

To the City of Prescott, Arizona:

1. This affidavit is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.
2. The Undersigned, for the consideration of $ _____
   (Total project price)
   as set out in the final pay application, as full and complete payment under the terms of the Contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above-described project. The Undersigned further agrees to indemnify and save harmless the City of Prescott against any and all liens, claims of liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performance and materials furnished for the performance of said project.

Signed and dated this _____ day of _____, 20___.

_____
(Authorized Signature)

By: _____

Title: _____

State of _____)
) ss.
County of _____)

SUBSCRIBED AND SWORN to before me by _____

this _____ day of _____, 20___.

_____ _____
Notary Public Commission Expires

SUPPLEMENT TO THE MARICOPA ASSOCIATION OF GOVERNMENTS (MAG) UNIFORM STANDARD SPECIFICATIONS AND DETAILS FOR PUBLIC WORKS CONSTRUCTION

Technical Specifications

February 14, 2019

City of Prescott Public Works
433 N. Virginia Street, Prescott, Arizona 86301
Ph: 928.777.1130 | TDD: 928.777.1100 | Fax: 928.771.5929

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NEW 2/14/19 REVISIONS

New Specifications:

- Section 102 Bidding Requirements and Conditions
- Section 103 Award and Execution of Contract
- Section 110 Notification of Changed Conditions and Dispute Resolution
- Section 703 Riprap

Specifications Rewritten, or With Major Updates:

- Section 100 General Conditions
- Section 101 Abbreviations and Definitions
- Section 104 Scope of Work
- Section 105 Control of Work
- Section 106 Control of Materials
- Section 107 Legal Regulations and Responsibility to Public
- Section 108 Commencement, Prosecution and Progress
- Section 109 Measurements and Payments
- Section 205 Roadway Excavation
- Section 321 Placement and Construction of Asphalt Concrete Pavement
- Section 340 Concrete Curb, Gutter, Sidewalk, Curb Ramps, Driveway and Alley Entrance
- Section 405 Survey Monuments
- Section 611 Water, Sewer and Storm Drain Testing
- Section 630 Tapping Sleeves, Valves and Valve Boxes on Water Lines

Specifications With Minor Updates:

- Section 206 Structure Excavation and Backfill
- Section 211 Fill Construction
- Section 301 Subgrade Preparation
- Section 306 Mechanically Stabilized Subgrade – Geogrid Reinforcement
- Section 310 Placement and Construction of Aggregate Base Course
- Section 317 Asphalt Milling
- Section 329 Tack Coat
- Section 336 Pavement Matching and Surfacing Replacement
- Section 345 Adjusting Frames, Covers and Valve Boxes
- Section 350 Removal of Existing Improvements
- Section 401 Traffic Control
- Section 402 Pavement Markings and Striping
- Section 403 Permanent Signing, Sign Posts and Delineators
- Section 404 Loop Detectors
- Section 430 Landscaping and Planting
- Section 431 Landscape Rock

- Section 505 Concrete Structures
- Section 601 Trench Excavation, Backfilling and Compaction
- Section 610 Water Line Construction
- Section 612 Temporary Water Mains (Fly Lines)
- Section 615 Sanitary Sewer Line Construction
- Section 618 Storm Drain Construction
- Section 625 Manhole Construction and Drop Sewer Connections
- Section 626 Manhole Coatings
- Section 650 Abandonment and Removal of Water Main
- Section 651 Abandonment and Removal of Sanitary Sewer
- Section 701 Aggregate
- Section 710 Asphalt Concrete
- Section 725 Portland Cement Concrete

Details That Have Been Updated:

- All references to COP Standard Details to correspond with updated City of Prescott General Engineering Standards

PART 100 – GENERAL CONDITIONS

ADD the following section to Part 100- General Conditions:

SECTION 100: GENERAL CONDITIONS

100.2 STANDARD SPECIFICATIONS AND DRAWINGS

(A) Standard details and specifications for the project shall be the most recent versions of the Maricopa Association of Governments Uniform Standard Specifications and Details for Public Works Construction (MAG Details/MAG Specifications), City of Prescott Supplement to MAG Standards (COP Supplement), City of Prescott General Engineering Standards (COP GES), Prescott City Code (City Code) and Arizona Revised Statutes (A.R.S.), except as modified in the project plans and specifications.

(B) Other standard specifications and details will be incorporated within the plans, project documents and specifications by reference, as necessary. These may include references to the Arizona Department of Transportation Standard Specifications for Roadway and Bridge Construction (ADOT Specifications), Arizona Department of Environmental Quality (ADEQ), Manual on Uniform Traffic Control Devices (MUTCD) (with Arizona Supplement), American Association of State Highway and Transportation Officials (AASHTO), American Society for Testing and Materials (ASTM), and others.

100.3 GENERAL NOTES

(A) All construction shall conform to the most recent versions of the MAG Standards, COP Supplement to MAG, and the COP GES, unless specifically modified on the plans.

(B) It shall be the Contractor's responsibility to obtain copies of all standards, details and specifications necessary to completely and accurately interpret the plans.

(C) All plans are null and void 1 year from date of signature if construction has not started.

(D) All quantities shown on plans are approximate, are not verified by the Engineer, and are furnished solely for the Contractor's convenience. They do not necessarily correspond to bid schedule items. Payment shall be based on bid schedule items for actual quantities provided and installed. The Contractor shall not be relieved of their responsibility for independently estimating work quantities prior to bidding. If any discrepancy in quantities is found, Contractor shall notify the Engineer of such no later than 24 hours prior to bid opening.

(E) A City right-of-way permit will be required for all off-site construction and construction within the public right-of-way.

(F) It is the sole responsibility of the Contractor to obtain, at the Contractor's own expense, such permits as are required from the appropriate agencies.

(G) The Public Works Department shall be notified a minimum of 24 hours prior to beginning any construction in the public right-of-way at (928) 777-1176.

(H) Inspection is to be done by the City Public Works Department.

(I) Any work performed without the knowledge of the City Inspector or the Inspector's authorized representative is subject to removal and replacement of same, to be done at the Contractor's expense.

(J) All work and materials, which do not conform to the specifications, are subject to removal and replacement at the Contractor's expense.

(K) Approval of a portion of the work in progress does not guarantee its final acceptance. Testing and evaluation may continue until the written final acceptance of a complete and workable unit.

(L) The City may suspend the work by written notice when, in its judgment, progress is unsatisfactory, work being done is unauthorized or defective, weather conditions are unsuitable, or there is a danger to the public health and safety.

(M) The Contractor shall provide sufficient men and equipment on the job at all times during construction to comply with specifications and to complete work.

(N) The Contractor shall be responsible for construction surveying and layout.

(O) The Contractor shall notify Arizona 811 (formerly Arizona Blue Stake) at 1-800-STAKE-IT (1-800-782-5348) between 6 a.m. and 5 p.m. Arizona time, Monday-Friday (excluding State holidays), at least 48 hours prior to construction.

(P) It is the Contractor's responsibility to locate all underground pipelines, telephone, communication and electric conduits and structures in advance of any construction and will observe all possible precautions to avoid any damage to such. The Engineer and/or City will not guarantee any locations as shown on these plans, or those omitted from it.

(Q) The Contractor is to uncover all existing lines being tied into and verify grades, pipe material, and pipe diameter before material submittals and planned construction activities.

(R) The Contractor shall comply with all ADEQ requirements.

(S) All water lines shall be provided with 12 AWG HS-CCS wire. Trace wire shall be subject to traceability test. Testing is to be by the Contractor and witnessed by the City Representative and at no extra cost to the City.

(T) Water and sewer separation shall be pursuant to Arizona Administrative Code (AAC) R18-5-502.C. and City specifications.

(U) Water mains shall be subject to a pressure and leakage test in accordance with the American Water Works Association (AWWA) C600 Standard.

(V) Water mains shall be disinfected in accordance with ADEQ Engineering Bulletin No. 8 “Disinfection of Water Systems”.

(W) Operation of valves to be done by City personnel only.

(X) All pipeline materials shall be installed per manufacturer's requirements unless superseded by City specifications.

(Y) All materials for water line construction shall meet AAC R18-4-119.

(Z) ADEQ requirements will apply when more stringent than MAG Specifications; more specifically where they pertain to maximum allowable sewer line/pressure sewer line exfiltration-infiltration rates.

(AA) Sewer line low-pressure air tests shall be done on 100 percent of all sanitary sewer lines.

(BB) Sewer manholes exfiltration tests shall be done on 100 percent of all manholes. Vacuum testing in accordance with City standards may be used in lieu of exfiltration test.

(CC) Sewer line deflection tests shall be done on 100 percent of all pipes.

(DD) Prior to project acceptance, the Contractor shall be responsible for providing the City with a video (DVD format) of the entire sewer main installed including service laterals. A City Representative shall attend the video data collection. If the City is not present during the video data collection, the City may require that the video data be redone, at the Contractor’s expense, with the City Representative present. The video will be reviewed and deemed acceptable by the City prior to project acceptance.

(EE) Acceptance of the completed work will not be given until 3 ml Mylar as-built reproducible plans and all required digital files have been submitted by the Engineer of Record and approved by the Engineer.

(FF) The Contractor shall warrant all work for a minimum of 2 years after formal acceptance of the work.

SECTION 101: ABBREVIATIONS AND DEFINITIONS

101.2 DEFINITIONS AND TERMS

REVISE and ADD the following:

Agency/City/Contracting Agency/Owner: Interchangeable to mean, the City of Prescott, a municipal corporation, organized and existing under and by virtue of the laws of the State of Arizona, unless otherwise noted; and meant as the governmental agency/legal entity for which the work is being done, either by permit or contract.

City's Representative: The authorized representative of the City, which may be an individual or a firm, or their assistants assigned to the project work, the project site, or any part thereof during the performance of the work by the Contractor and until final acceptance.

County: Yavapai County, organized and existing under and by virtue of the laws of the State of Arizona.

Director: The City of Prescott Public Works Director, or their designee, representative or assistants, unless otherwise noted.

Engineer: The duly authorized person, or their designees, employed by or contracted with the City of Prescott who is responsible for all aspects of the project and with the authority to make revisions to and approve the changes to the plans or specifications.

Engineer of Record: The Engineer of Record is a Civil Engineer registered in the State of Arizona by the Board of Technical Registration and is responsible for design, calculations and preparation of contract documents. The Engineer of Record shall provide field observation, compile, review and comment on project documentation, material testing reports and prepare as-built drawings.

Materially Unbalanced Bid: A bid that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the City.

Mathematically Unbalanced Bid: A bid containing lump sum or unit bid prices that do not reflect reasonably anticipated actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

Notice Inviting Bids: Refers to the standard forms inviting proposals or bids.

SECTION 102: BIDDING REQUIREMENTS AND CONDITIONS

102.2 CONTENTS OF PROPOSAL PAMPHLET

ADD the following:

All standard specifications and details referenced, unless otherwise noted, shall conform to the most current editions, including revisions thereto.

102.4 EXAMINATION OF PLANS, SPECIAL PROVISIONS AND SITE OF WORK

ADD the following:

If any person contemplating submitting a bid for the proposed contract is in doubt as to the true meaning of any part of the plans, specifications, or other proposed contract documents, or finds discrepancies in or omissions from the plans or specifications, they shall submit to the Director a written request for an interpretation or correction thereof no later than 5 working days before bid or proposal opening. The person submitting the request will be responsible for its prompt delivery. Interested bidders may call, email or visit the office of the Director with any questions up to 5:00 PM on the fifth working day prior to the bid opening date. The City will no longer address or interpret any general questions or comments after that time. Should any issue be determined significant to the project by the Director, appropriate action will be taken. Any interpretation or correction of the proposed documents will be made available to prospective bidders a minimum of 3 working days prior to the bid opening date. Any correction of the contract documents will be made only by an addendum duly issued by the City and a copy of such addendum will be available on the City's website. The City will not be responsible for any other explanations or interpretations of the documents.

102.5 PREPARATION OF PROPOSAL

ADD the following:

(D) If the proposal is made by an individual, it shall be signed and the individual's full name and address shall be given. If it is made by a partnership, it shall be signed with the partnership name and by a general partner of the firm who shall also sign their own name, and the name and address of each partner shall be given; and, if it is made by a corporation, the name of the corporation shall be signed by its duly authorized officer or officers.

All submittal forms are contained in the Notice Inviting Bid and must be submitted as part of the bid.

ADD the following subsection to 102.5 Preparation of Proposal:

102.5.1 Instructions for Preparing Proposal

Payment for all work performed under this contract shall be based on the units as shown in the bidding schedule. Payment of the bid items as stated in the Contractor's proposal for the completed work, shall be compensation in full for the furnishing of all overhead, labor, materials, devices, equipment and appurtenances included in the work as are necessary to complete the total work under this contract in a good, neat, and satisfactory manner as indicated on the plans, as described in the specifications, and as otherwise implied or required to fulfill the objective of the work.

All construction elements, as identified in the bid schedule, shown on the plans or details or described in the special provisions, are required for the construction and are to include all costs associated with earthwork, trenching, subgrade construction, valves, fittings, tapping sleeves, appurtenances, utility boxes, bedding, pavement replacements, hauling, placing, disposing of, start up, testing, certifying, or any other associated work and materials required for a complete in place and operable item of construction. All work items and materials not specifically itemized in the bid schedule and that are required for construction are to be considered incidental to the total project bid amount.

It is the intent of the contract that maximum payment shall not exceed the agreed unit price without duly authorized contract amendments. Each item, fixture, piece of equipment, work, etc., as indicated on the plans, or specified anywhere in these documents shall be completed with all necessary connections and appurtenances for the satisfactory use and operation of said item, and the total system or systems.

Any and all patents, license fees, insurance premiums, etc., for the right to use equipment or processes included in this contract shall be included in the total bid price.

Cost of testing, and other incidental operations, profit and overhead cost, including the cost of supervision, temporary field offices, move-in, move-out, insurance, taxes, equipment not a permanent part of the job, and other incidental items, shall be included in the total bid price.

The "Total Amount of Bid" must be filled out by the bidder. In case of any discrepancy between the price in figures and price in written words, as written or corrected, the price in written words shall be presumed to be correct unless obviously in error, and shall be considered as the Contractor's correct and intended bid.

Bids shall not contain any recapitulations of the work to be done. Alternative proposals will not be considered unless called for.

102.6 SUBCONTRACTORS LIST

REMOVE the first paragraph in its entirety and REPLACE with the following:

The Subcontractors List must be completed, attached and submitted along with the bidding schedule. Only 1 name shall be listed for each category.

102.7 IRREGULAR PROPOSALS

ADD the following:

(F) If the bid is mathematically unbalanced.

(G) If the bid is materially unbalanced.

102.9 SUBMISSION OF PROPOSAL

ADD the following:

Bids shall be delivered to the office of the City Clerk, City of Prescott, Arizona, before the day and hour set for the submittal of bids in the Notice Inviting Bids as published. Bids shall be enclosed in a sealed envelope bearing the title of the work and the name of the bidder. It is the sole responsibility of the bidder to ensure the bid is received in proper time.

102.13 SUCCESSFUL BIDDERS

REMOVE in its entirety and REPLACE with the following:

The successful bidder may obtain 1 set of plans and specifications for the project at no extra cost.

ADD the following subsection to Section 102- Bidding Requirements and Conditions:

102.14 ADDENDA

Any addenda issued during the time of bidding, forming a part of the documents issued to the bidder for the preparation of a bid, shall be covered in the bid and shall be made a part of the contract. Addenda may be issued until noon on the third working day prior to the bid opening date. It is the prospective bidder's responsibility to check for addenda related to this procurement. Addenda will be posted on the City's website.

SECTION 103: AWARD AND EXECUTION OF CONTRACT

ADD the following subsection to 103.1 Consideration of Proposals:

103.1.1 Confirmation of Bid

At any time after the opening of the bids, the Director may require any bidder on the project to confirm such bid in writing prior to contract award. An acknowledgement will be sent to the bidder to certify the prices bid have been reviewed and to confirm work can be completed in accordance with the requirements of the contract documents, plans and specifications in the total bid amount stated in the bidding schedule.

ADD the following subsection to 103.1 Consideration of Proposals:

103.1.2 Experience and Qualifications

When requested by the City, the bidder shall supply a list of all public projects begun within the previous 3 years prior to contract award. The project list shall contain all public projects entered into by the bidder and shall include the project name and location, original and final contract amounts, project status and a contact name and information for each project. The bidder shall provide a description and explanation for any projects that were not completed successfully. Failure to provide complete and factual information may be grounds for rejection of the bid in accordance with City Procurement Code 1-27-18(K).

ADD the following subsection to 103.1 Consideration of Proposals:

103.1.3 Pre-Award Conference

The City may require the apparent low bidder to attend a pre-award conference in order to establish that the bidder fully understands the scope, complexity and expectations of the project as described in the contract documents; to discuss issues, concerns, risk areas and how to minimize them within the bounds of the contract; and to determine that the apparent low bidder is the most responsible and/or most qualified bidder in accordance with City Procurement Code 1-27-18(K).

The purpose of the pre-award conference is to ensure that all participants are apprised of their responsibilities and obligations regarding all applicable laws, rules, regulations and ordinances contained in the contract documents prior to entering into a contract.

103.3 AWARD OF CONTRACT

REMOVE the first paragraph in its entirety and REPLACE with the following:

The contract will be awarded to the lowest qualified bidder complying with these instructions and with the Notice Inviting Bid. The City, however, reserves the right to accept or reject any or all bids if it deems it best for the public good, and to waive any informality in the bids received. The award, if made, will be within 60 calendar days after the opening of bids.

ADD the following subsection to 103.3 Award of Contract:

103.3.1 Assignment of Contract

No partial or full assignment by the Contractor of any contract to be entered into hereunder, or any part thereof, or of funds to be received there under by the Contractor, will be recognized by the City unless such assignment has had prior written approval of the City and the surety has been given due notice of such assignment in writing and has consented thereto in writing.

103.6 CONTRACTOR'S INSURANCE

ADD the following:

The Contractor and subcontractors shall procure and maintain until all of their obligations have been discharged, including any warranty periods under the contract are satisfied, insurance against claims for injury to persons or damage to property which may arise from or in connection with the performance of the work hereunder by the Contractor, the Contractor's agents, representatives, employees or subcontractors.

The insurance requirements herein are minimum requirements for a contract and in no way limit the indemnity covenants contained in the contract.

The City in no way warrants that the minimum limits contained herein are sufficient to protect the Contractor from liabilities that might arise out of the performance of the work under a contract by the Contractor, the Contractor's agents, representatives, employees, or subcontractors. The Contractor is free to purchase such additional insurance as may be determined necessary.

(A) Additional Insurance Requirements: The policies shall include, or be endorsed to include, the following provisions:

(1) On insurance policies where the City is named as an additional insured, the City shall be an additional insured to the full limits of liability purchased by the Contractor even if those limits of liability are in excess of those required by this contract.

(2) The Contractor's insurance coverage shall be primary insurance and non-contributory with respect to all other available sources.

(B) Notice of Cancellation: With the exception of a 10 day notice of cancellation for non-payment of premium, any changes material to compliance with this contract in the insurance policies above shall require a 30 day written notice.

(C) Acceptability of Insurers: Insurance is to be placed with insurers with a current A.M. Best's rating of no less than A-VII, unless otherwise approved by the City. General liability, automobile liability, and worker's compensation insurance is to be placed with an insurer admitted in the state in which operations are taking place.

(D) Verification of Coverage: The Contractor shall furnish the City with certificates of insurance (ACORD form or equivalent approved by the City) as required by this contract. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf.

All certificates and any required endorsements are to be received and approved by the City before work commences. Each insurance policy required by this contract must be in effect at or prior to commencement of

work under this contract and remain in effect for the duration of the project and warranty period as set forth in Paragraph 3 of the "Contractor's Affidavit Regarding Settlement of Claims and Certification of Completion of Warranties". Failure to maintain the insurance policies as required by this contract or to provide evidence of renewal is a material breach of contract.

All certificates required by this contract shall be sent directly to the Public Works Department, 433 N. Virginia Street, Prescott, AZ 86301. The City project/contract number and project description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this contract at any time.

(E) Such policy shall not exclude coverage for the following:

(1) Injury to or destruction of any property arising out of the collapse of/or structural injury to any building or structure due to grading of land, excavation, borrowing, filling, backfilling, tunneling, pile driving, cofferdam work or caisson work.

(2) Injury to or destruction of wires, conduits, pipes, mains, sewers, or other similar property or any apparatus in connection therewith, below the surface of the ground, if such injury or destruction is caused by and occurs during the use of mechanical equipment for the purpose of grading of land, paving, excavating, drilling; or injury to or destruction of any property at any time resulting there from.

(3) Injury to or destruction of any property arising out of blasting or explosion.

(4) Motor vehicle public liability and property damage insurance to cover each automobile, truck, and other vehicle used in the performance of the contract in an amount of not less than $1,000,000.00 for one person, and $1,000,000.00 for more than one person, and property damage in the sum of $1,000,000.00 resulting from any one accident which may arise from the operations of the Contractor in performing the work provided for herein.

(F) The Contractor shall carry and maintain fire and extended coverage with an endorsement for vandalism and malicious mischief in the Contractor's name and also in the name of the City in an amount of at least 100 percent of the contract amount (if applicable).

(G) The Contractor shall secure "all risk"-type builder's risk insurance for work to be performed. Unless specifically authorized by the City, the amount of such insurance shall not be less than 100 percent of the contract price. Such policy shall include coverage for earthquake, landslide, flood, collapse, or loss due to the results of faulty workmanship, during the contract time and until final acceptance of work by the City (if applicable).

103.6.1 General

REMOVE item (A) in its entirety and REPLACE with the following:

(A) The Contractor shall provide and maintain, during the life of the contract, General Liability, Automobile Liability, and Worker's Compensation Insurance as provided herein.

Unless otherwise specifically required by the special provisions, the minimum limits of public liability and property damage liability shall be as provided herein.

The Contractor shall provide coverage with limits of liability not less than those stated below. An excess liability policy or umbrella liability policy may be used to meet the minimum liability requirements provided that the coverage is written on a following form basis.

(1) Commercial General Liability: Occurrence Form

Policy shall include bodily injury, property damage, broad form contractual liability and XCU coverage.

- General Aggregate $3,000,000
- Products – Completed Operations Aggregate $3,000,000
- Personal and Advertising Injury $1,000,000
- Each Occurrence $1,000,000
- Fire Legal Liability (Damage to Rented Premises) (if applicable) $100,000

The policy shall be endorsed to include the following additional insured language:

"The Contractor agrees to endorse the City of Prescott as an Additional Insured on the Commercial General Liability with the following Additional Insured endorsement, or similar endorsement providing equal or broader Additional Insured coverage, the CG 2010 10 01 Additional Insured - Owners, Lessees, or Contractors, or CG2010 07 04 Additional Insured – Owners, Lessees, or Contractors – Scheduled Person or Organization endorsement in combination with the additional endorsement of GC2037 10 01 Additional Insured – Owners, Lessees, or Contractors – Completed Operations shall be required to provide back coverage for the Contractor's "your work" as defined in the policy and liability arising out of the products-completed operations hazard."

(2) Business Automobile Liability: Bodily Injury and Property Damage for any owned, hired, and/or non-owned vehicles used in the performance of this Contract

- Combined Single Limit (CSL) $1,000,000

The policy shall be endorsed to include the following additional insured language:

"The City of Prescott shall be named as additional insured with respect to liability arising out of the activities performed by or on behalf of the Contractor, involving automobiles, owned, leased, hired, or borrowed by the Contractor."

(3) Worker's Compensation and Employer's Liability:

Worker's Compensation Statutory

Employer's Liability

- Each Accident $1,000,000
- Disease- each employee $1,000,000
- Disease- policy limit $1,000,000

The policy shall contain a waiver of subrogation against the City for losses arising from work performed by or on behalf of the Contractor.

(4) Professional Liability (Errors and Omissions Liability) (if applicable)

- Each Claim $1,000,000
- Annual Aggregate $2,000,000

(a) In the event that the professional liability insurance required by this contract is written on a claims-made basis, the Contractor warrants that any retroactive date under the policy shall precede the effective date of this contract and that either continuous coverage will be maintained or an extended discovery period will be exercised for a period of two (2) years at the time work under this contract is completed.

(b) The policy shall cover professional misconduct or lack of ordinary skill for those positions defined in the Scope of Work of this contract.

(c) Notice of Cancellation: With the exception of a 10 day notice of cancellation for non-payment of premium, any changes material to compliance with this contract in the insurance policies above shall require a 30 day written notice.

103.6.2 Indemnification of the Contracting Agency Against Liability

REMOVE in its entirety and REPLACE with the following:

The Contractor shall defend, indemnify and hold harmless the City, its departments, officers, officials, agents, and employees (hereinafter referred to as "Indemnitee") from and against any and all claims, actions, liabilities, damages, losses, or expenses (including court costs, attorneys fees and costs of claim processing, investigation and litigation) (hereinafter referred to as "Claims") for bodily injury or personal injury (including death), or loss or damage to tangible or intangible property caused, or alleged to be caused, in whole or in part, by the negligent or willful acts or omissions of the Contractor or any of the Contractor's owners, officers, directors, agents, employees or subcontractors. This indemnity includes any claim or amount arising out of or recovered under Worker's Compensation Law or arising out of failure of such Contractor to conform to any Federal, State or local law, statute, ordinance, rule, regulation or court decree. It is the specific intentions of the parties that the Indemnitee shall, in all instances, except for Claims arising solely from the negligent or willful acts of Indemnitee, be indemnified by the Contractor from and against any and all claims. In consideration of the award of this contract, the Contractor agrees to waive all rights of subrogation against the City, its departments, officers, officials, agents, and employees for losses arising from the work performed by the Contractor for the City.

ADD the following subsection to Section 103- Award and Execution of Contract:

103.9 PRECONSTRUCTION CONFERENCE

Within 15 days of the date of the Notice of Award, the Contractor is required to attend a preconstruction conference. The City will contact the Contractor to schedule a specific date, time and location for the preconstruction conference. The purpose of the meeting is to outline specific construction items and procedures and to address items, which require special attention on the part of the Contractor. The Contractor may also present proposed variations in procedures, which the Contractor believes may be of benefit to the project, reduce cost, or will reduce inconvenience to the public. Communication and coordination issues will be also addressed during the preconstruction conference. The Contractor will be required to provide 5 sets of the following information at the preconstruction conference:

- Key personnel names and emergency phone numbers involved in the project.
- Public information plan
- Project signage plan
- Stormwater Pollution Prevention Plan (SWPPP) (NOI if applicable)
- Contractor quality control plan
- Subcontractor contracts and purchase orders for each and every item of work under subcontract on the project
- Payment schedule showing the estimated dollar volume of work for each calendar month during the life of the project
- Overall construction schedule and two-week look ahead schedule (provided weekly)

- Dust abatement/street sweeping plan and construction water meter application
- Traffic control plan and access management plan providing for continuous access to residents and businesses affected by the project
- Contractor's company safety plan
- An itemized list of shop drawings, materials, mix designs, equipment submittals and a schedule indicating the dates each of these items will be transmitted to the Director for review

Each of the above items is subject to review and approval by the Director.

ADD the following subsection to Section 103- Award and Execution of Contract:

103.10 COMMENCEMENT

The Contractor shall commence work on or before the tenth calendar day after receiving the Notice to Proceed, and shall complete all work under the contract within the period of time specified in the special provisions. The City reserves the right to issue Notice to Proceed at any time between 0 and 60 days after contract award. Notice to Proceed will be issued not later than 60 calendar days after the contract has been awarded unless otherwise agreed upon in writing, or as may be specified in the special provisions. In addition, the Contractor shall not commence work until all required documents, bonds, plans and schedules have been received and approved by the City. These submittals will not affect the issuance of Notice to Proceed by the City.

ADD the following subsection to Section 103- Award and Execution of Contract:

103.11 CONTRACTOR AND SUBCONTRACTOR RECORDS

(A) The Notice Inviting Bids, Information for Bidders, special provisions, specifications, plans, and all supplementary documents are intended to be complete and complementary and to prescribe a complete work. If any omissions are made of information necessary to carry out the full intent and meaning of the contract documents, the Contractor shall immediately call the matter to the attention of the Director for furnishing of detailed instructions. In case of discrepancies, the specifications shall govern over the plans. Figured dimensions shall govern over scaled dimensions.

(B) Any drawings or plans listed anywhere in the specifications or addenda thereto shall be regarded as a part thereof and of the contract. Anything mentioned in these specifications and not indicated on the plans, or anything indicated on the plans and not mentioned in these specifications, shall be in the same force and effect as if indicated or mentioned in both.

(C) The Contractor, subcontractors and all suppliers shall keep and maintain all books, papers, records, files, accounts, reports, bid documents with back-up data, including electronic data, and all other material relating to the contract and project for 3 years following completion and acceptance of the work. All records shall be accurately maintained in accordance with generally accepted accounting principles and practices uniformly and consistently applied in a format that will permit audit. The Director or the Director's authorized representative(s) shall have access at all reasonable times to all applicable records of the Contractor and the records of the Contractor's subcontractors.

The Contractor and subcontractors shall preserve all such materials for a period of 3 years after all payments to the Contractor or subcontractors, or until the final resolution of all claims made by the Contractor or subcontractor on this contract, whichever is later. The Contractor and subcontractors shall make all of the above materials available to the Director for auditing, inspection and copying and shall produce such materials upon written request at the office of the Public Works Director located at 433 N. Virginia Street, Prescott, Arizona 86303.

The Contractor shall insert the above requirement in each subcontract, purchase order, lease agreement, or other document under which goods or services are provided for the performance of this contract and shall also include in all subcontracts a clause requiring subcontractors to include the above requirement in any lower-tier subcontract, purchase order, lease agreement or document under which goods or services are provided for the performance of this contract.

ADD the following subsection to Section 103- Award and Execution of Contract:

103.12 ERROR AND OMISSIONS

The written dimensions, calculations and quantities on the plans are presumed to be correct, but the Contractor shall be required to check carefully all dimensions, calculations and quantities before beginning work. If any errors or omissions are discovered, the Director shall be so advised in writing and will make the proper corrections. If the Contractor claims that any such errors or omissions should change the cost of any pay item or the construction as identified in the plans, the Contractor shall also submit to the Director a written proposed contract amendment. Any such adjustments made by the Contractor that are claimed to change the cost of any pay item or the construction as identified in the plans, without prior review and acceptance of a proposed contract amendment, shall be at the Contractor's own risk. The settlement of any complications or disputed expenses arising from the Contractor's adjustment shall be borne by the Contractor at the Contractor's own expense.

ADD the following subsection to Section 103- Award and Execution of Contract:

103.13 CONTINGENCIES

All loss or damage arising from obstruction or difficulties which may be encountered in the prosecution of the work, from the action of the elements, or from any act or omission on the part of the Contractor or any person or agent employed by him shall be borne by the Contractor.

ADD the following subsection to Section 103- Award and Execution of Contract:

103.14 NOTICE AND SERVICE THEREOF

Any notice to the Contractor from the City relative to any part of this contract shall be in writing and considered delivered and the service thereof completed when said Notice is posted, by first class mail to the Contractor at the Contractor's last given address, electronically delivered, or delivered in person to the Contractor or the Contractor's authorized representative on the work.

ADD the following subsection to Section 103- Award and Execution of Contract:

103.15 PROJECT CLOSEOUT

It is the intent of these specifications and contract documents that the Contractor shall deliver a complete and operable facility capable of performing its intended functions and ready for use. The City shall withhold Final Payment and release of retention until ALL of the following items have been completed:

(A) Completion of all work, including punch-list items and final acceptance of the work by the City.

(B) Submittal by the Contractor of final pay estimate, which shall show the amount of work performed according to the contract and approved by the City.

(C) Submittal by the Contractor of all project record documents, including as-built drawings, operation and maintenance manuals, and other records as referenced herein.

(D) Submittal by the Contractor of the Contractor's Affidavit Regarding Settlement of Claims and Certification of Completion and Warranties.

(E) Closeout of any and all permits issued to the Contractor by the City or any other agency for the work included in the project.

(F) Submittal by the Contractor of an Environmental Protection Agency (EPA) Stormwater Pollution Prevention Plan (SWPPP) Notice of Termination (if applicable).

SECTION 104: SCOPE OF WORK

104.1.1 General

REMOVE the last paragraph in its entirety and REPLACE with the following:

Unless otherwise specified in the special provisions, the Contractor shall furnish all materials, labor, tools, equipment, water, light, power, transportation, superintendence, temporary construction of every nature, and incidentals, including, but not limited to, dust and traffic control measures, and to perform all work involved in executing the contract in a satisfactory and workmanlike manner within the specified time.

The Contractor shall at all times during the continuance of the contract prosecute the work with such work force and equipment as is sufficient to complete the project within the time specified.

ADD the following:

The work shall conform to such other drawings relating thereto as may be furnished by the City prior to the opening of proposals, and to such drawings in the explanation of details or minor modifications as may be furnished from time to time during construction, including such minor modifications as the Director may consider necessary during the prosecution of the work.

Scaled dimensions shall not be used in the construction of the work.

All work, as identified in the contract documents, not specifically itemized in the bid schedule that are required for the construction, are to be considered incidental to the project bid amount.

104.1.3 Water Supply

ADD the following:

(A) The Contractor shall supply adequate, pure, cool drinking water with individual drinking cups for the use of employees on the project. The quality of drinking water shall meet the requirements specified by the Arizona State Department of Health.

(B) It shall be the responsibility of the Contractor to provide and maintain, at the Contractor's own expense, a supply of water sufficient for the needs of the project and to install and maintain necessary supply connections and piping for the same. Before final acceptance of the completed project, all temporary connections and piping installed by the Contractor shall be removed.

(C) The Contractor shall apply for a fire hydrant meter for all construction water used if the Contractor desires to obtain water from the City distribution system at any point. All contractors requesting construction water from the City must submit an application for a construction water meter to the Water Distribution

Department. A $1,000 deposit will be required for hydrant meters. If construction water use occurs during the months of May through September the Contractor shall also include a dust abatement program. Potable water may not be allowed for dust abatement during these months. Potable water can be used to process embankment fill and base materials year round. However, contractors are encouraged to use treated effluent for construction activities. The City has two outlets for effluent, the Sundog Wastewater Treatment Plant and the Airport Wastewater Treatment Plant. The City will provide metered standpipes for effluent at both plants. The Contractor will be required to estimate daily and total potable/effluent water usage for the project as identified on the application for a construction water meter. The Contractor will be responsible for all costs associated with obtaining and delivering construction water.

104.1.4 Cleanup and Dust Control

ADD the following:

(A) Street Sweeping: The Contractor shall be responsible for sweeping the project no less than 4 times a week, or more as deemed necessary by the Engineer, to suppress dust, pick up dirt, soil, and construction debris so it does not travel to a water body or the City's storm drain system. A street sweeping plan documenting the frequency of sweeping, time and dates, route and type of sweeper that will be utilized shall be submitted to the City at the first preconstruction conference. The street sweeper shall be a mechanical sweeper with water applying equipment. No brooms, mechanical brooms mounted on drivable construction equipment or regenerative air sweepers will be accepted without prior approval from the City.

No measurement or payment will be made for street sweeping, unless otherwise provided for in the special provisions or proposal. The cost of street sweeping will be deemed incidental and the cost included in the proposal price for the construction operation to which dust control is incidental or appurtenant.

(B) Waste Disposal, Grading and Material Storage

(1) The Contractor shall provide for the disposal of all surplus materials, waste products, debris, etc., and shall make necessary arrangements for such disposal. The Contractor shall obtain written permission from property owners(s) prior to disposing of any surplus materials, waste products, debris, etc., on private property, and shall also obtain the approval of the Director prior to such disposal.

(2) The Director will not approve the filling of ditches, washes, drainage ways, etc., which may in the Director's opinion create water control problems.

(3) The Director will not approve disposal operations, which will, in the Director's opinion, create unsightly and/or unsanitary nuisances.

(4) The Contractor shall maintain the disposal site(s) in a reasonable condition of appearance and safety during the construction period as required by the Director. Prior to final acceptance of the project, the Contractor shall have completed the leveling and cleanup of the disposal site(s) to the satisfaction of the Director.

(5) The Contractor shall obtain a grading permit or any other permit required by the City, Yavapai County or any other county, or State or Federal rules, regulations, laws, ordinances, or any other regulatory authority for all construction operations of the project, including but not limited to the following:

(a) Areas disturbed by the Contractor, including staging areas, borrow areas, waste areas, or material storage areas, located within the City limits that are subject to any requirements of the City Code, COP Land Development Code or COP General Engineering Standards, including but not limited to Section 6.7 – Site Disturbance, Grading and Restoration Standards; and Section 9.6 – Site Disturbance and Grading Permit, of the COP Land Development Code; Chapter 16-2: Drainage Regulations of the City Code; and Articles 2 and 3 of the COP General Engineering Standards;

(b) Areas outside of the City limits that are subject to the requirements of Yavapai County, Arizona Department of Transportation (ADOT), and/or Yavapai-Prescott Indian Tribe (YPIT) for any activities described herein;

(c) The disposal of waste material on private property dependent upon site specific conditions at the waste area(s) and characteristics of the fill in accordance with this section. The fees for a permit for this activity shall not be waived; said fees are incidental to the appropriate bid item(s);

(d) The staging or material storage area(s) that:

(i) Are not City owned property on the project, or

(ii) Require clearing or grubbing in excess of 10,000 square feet

Fees for a permit(s) for this activity shall not be waived; said costs are incidental to the appropriate bid item(s).

(e) Site disturbances for infrastructure improvements on City owned property not within the right-of-way for which the disturbance is greater than 50 cubic yards of material or in excess of 10,000 square feet. The associated fees for grading permits for this activity on City owned property shall be waived.

104.1.5 Final Cleaning Up

ADD the following:

Upon completion of construction and before final acceptance can be made by the Engineer, the Contractor shall clean up each individual construction area to the satisfaction of the Engineer. Small trees, weeds, and brush, which were removed as part of construction work, shall be removed from the project site and properly disposed of. All debris including but not limited to broken pipe, concrete and other construction debris shall be removed from the project site and properly disposed.

Existing landscape improvements, drainage ditches, etc., shall be restored in "like kind" so that the improvement is put back in as close to its prior state as possible. Restoration of incidental items impacted by construction activity shall be in any and all areas utilized by the Contractor in relation to the project. The Contractor shall restore each individual work site to grades existing before construction work. No separate payment will be made for restoration of items impacted by the Contractor's construction operation and the cost of these items shall be included in the unit prices in the bid schedule.

104.2 ALTERATION OF WORK

ADD the following:

(A) Changes in the Work: The City, without invalidating the Contract, may order extra work, make changes by altering, or delete any portion of the work as specified herein, or as deemed necessary or desirable by the Director. All such work shall be executed under the conditions of the original contract except that any claim for extension of time and additional cost caused thereby shall be adjusted at the time of ordering such change or extra work.

Extra work shall be that work not indicated or detailed on the plans and not specified. Such work shall be governed by all applicable provisions on the contract document.

In giving instructions, the Director shall have authority to make minor changes in the work, not involving extra cost, and not inconsistent with the purposes of the work, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Director, and no claim for an addition to the total amount of the contract shall be valid unless so ordered.

It is mutually understood that it is inherent in the nature of municipal construction that some changes in the plans and specifications may be necessary during the course of construction to adjust them to field conditions, and that it is of the essence of the contract to recognize a normal and expected margin of change. The Director shall have the right to make such changes, from time to time, in the plans, in the character of the work, and in the termination of the completion of the work in the most satisfactory manner without invalidating the contract.

Any change ordered by the Director which involves installation of work essential to complete the Contract, but for which no basis of payment is provided for herein, said payment therefore shall be subject to agreement prior to said work being performed.

The prices agreed upon and any agreed upon adjustment in contract time shall be incorporated in the written order issued by the Director, which shall be written so as to indicate acceptance on the part of the Contractor as evidenced by the Contractor's signature. In the event prices cannot be agreed upon, the City reserves the right to terminate the contract as it applies to the items in questions and make such arrangements as it may deem necessary to complete the work, or it may direct the Contractor to proceed with the items in question to be reimbursed pursuant to the unit prices in the Contractor's bid or on a force account basis as provided hereinafter, at the City's option.

(B) Claims for Extra Work: If the Contractor claims that any instructions involve extra cost under this contract, he shall give the Director written notice thereof within 48 hours after the receipt of such instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property, and the procedure shall then be as provided for herein. No such claim shall be valid unless so made.

SECTION 105: CONTROL OF WORK

105.1 AUTHORITY OF THE ENGINEER

ADD the following:

All references to "the Engineer" shall mean the City Public Works Director.

105.2 PLANS AND SHOP DRAWINGS

ADD the following:

Drawings of minor or incidental fabricated materials and/or equipment may not be required by the Director. The Contractor shall furnish the Director tabulated lists of such fabrications, showing the names of the manufacturers and catalog numbers, together with samples of general data as may be required to permit determination by the Director as to their acceptability for incorporation in the work.

ADD the following subsection to 105.2 Plans and Shop Drawings:

105.2.1 Submittals

In ample time for each to serve its proper purpose and function, the Contractor shall submit to the Director such schedules, reports, drawings, lists, literature samples, instructions, directions, and guarantees as are specified or reasonably required for construction, operation, and maintenance of the facilities to be built and/or furnished under this contract.

Shop drawings and data shall be submitted to the Director in such number of copies as will allow him to retain 4 copies of each submittal. The submittal shall clearly indicate the specific area of the specifications or plans for which the submittal is made. The additional copies received by him will be returned to the Contractor's representative at the job site. The Director's notations of the action, which he has taken, will be noted on 1 of these returned copies.

The above drawings, lists, prints, samples, and other data shall become a part of the contract and a copy of the same shall be kept with the job site plans and the fabrications furnished shall be in conformance with the same.

ADD the following subsection to 105.3 Conformity with Plans and Specifications:

105.3.1 Order of Work

When required by the contract documents, the Contractor shall follow the sequence of operations as set forth therein. Full compensation for conforming to such requirements will be considered as included in the prices paid for contract items of work and no additional compensation will be allowed therefore.

105.4 COORDINATION OF PLANS AND SPECIFICATIONS

ADD the following:

In the event of any doubt or question arising regarding the true meaning of these specifications, special provisions, or the plans, reference shall be made to the Engineer, whose decision thereon shall be final. In the event of any discrepancy between any drawing and the figures written thereon, the figures shall be taken as correct.

The contract plans consist of general drawings. These indicate such details as are necessary to give a comprehensive idea of the construction contemplated. All authorized alterations affecting the requirements and information given on the contract plans shall be in writing. The contract plans shall be supplemented by such working or shop drawings prepared by the Contractor as are necessary to adequately control the work. No change shall be made by the Contractor in any working or shop drawing after it has been accepted by the Engineer.

The Contractor shall keep a copy of the contract documents, plans and specifications at the job site, and shall at all times give the Engineer access thereto. Any drawings or plans listed in the detailed specifications shall be regarded as a part thereof and the Engineer will furnish from time to time such additional drawings, plans, profiles and information as he may consider necessary for the Contractor's guidance.

All authorized alterations affecting the requirements and information given on the accepted plans shall be in writing. No changes shall be made of any plan or drawing after the same has been accepted by the Engineer except by consent of the Engineer in writing.

105.5 COOPERATION OF CONTRACTOR

REMOVE the first paragraph in its entirety and REPLACE with the following:

1 set of approved plans and specifications shall be kept available on the work site at all times by the Contractor.

105.6 COOPERATION WITH UTILITIES

ADD the following:

Location of Underground Utilities

(A) The Contractor shall contact Arizona 811 (formerly Arizona Blue Stake) within the time frame specified under Arizona law and request field location of underground utilities on public and private property. The Contractor shall employ private locating companies for private utilities not found by Arizona 811. At the time these locations have been marked and prior to the commencement of excavation within the affected area, the Contractor shall at the Contractor's expense manually determine the exact location of all buried facilities.

(B) The Contractor shall notify all affected utilities prior to the start of construction and shall ascertain the location of the various underground utilities either shown on the plans and/or as may be brought to the Contractor's attention.

(C) The Contractor shall perform all operations in accordance with Arizona 811.

(D) Utility locations shown on the plans are approximate and based on drawings furnished by the respective utility. It shall be the Contractor's responsibility to protect all existing utilities. Should a utility conflict occur, the Contractor shall cooperate with the said utility to resolve the conflict. No claim for extra costs shall be made against the City for delays due to any utility conflict.

(E) If performance of the Contractor's work is delayed because the utility owners fail to relocate or adjust their facilities in a timely manner, the Contractor may file for an extension of time. To receive consideration, this request shall contain specific information as to the nature of the delay and the actual loss of time involved.

(F) The Contractor shall assume full responsibility for damage to all marked utilities due to the Contractor's operations and shall repair the damaged utilities in accordance with regulatory authority requirements at the Contractor's own expense.

(G) Measurement and Payment: No separate measurement and payment shall be made for the location of underground utilities. This work shall be considered incidental and included in the unit price bid for construction or installation of the appropriate contract pay items.

105.8 CONSTRUCTION STAKES, LINES AND GRADES

ADD the following:

(A) Construction staking shall be the responsibility of the Contractor. The control for the project is provided in the contract documents. The Contractor shall be held responsible for preservation of control monumentation. If any of the control monumentation have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them will be charged against him and will be deducted from the payment of work.

(B) The Contractor shall not retain the Engineer of Record for construction staking due to conflict of interest.

(C) Staking shall be performed and certified by a Registered Land Surveyor in good standing with the Arizona State Board of Technical Registration.

(D) The staking shall be performed in such a manner and frequency that the Contractor is able to construct the project in accordance with the plans and specifications. At a minimum, staking shall include:

(1) Slope or limit stakes

(2) Limits of Temporary Construction Easements (TCE)

(3) Horizontal and vertical alignment of pipeline

(4) Valves, tees, horizontal and vertical bends, blow offs, air release valves, tracer wire stations, water meters and hydrant locations

(5) Tank and appurtenances

(6) Electrical, instrumentation and control facilities, including, but not limited to, antennae pole

(7) Site improvements including, but not limited to, retaining walls, curbs, fencing, drainage, chain link fence enclosures, protection posts, gates, etc. The original grade of all retaining walls shall be surveyed and established prior to beginning any earthwork.

(8) Cross-sections will be required, at no additional expense to the City, should quantity disputes arise pertaining to the following: earthwork, subgrade, ABC or asphaltic concrete.

(9) Curb stakes at all PC's, PT's, vertical PI's (grade breaks), transitions to and from super elevated sections and at 50 foot intervals

(10) Blue tops for subgrade and ABC at intervals specified for curb. Quarter crown blue tops shall be required when the typical section is 4 lanes or more without median curb.

(11) Other staking as needed to complete the work in conformance with the plans and specifications.

(E) The Engineer and the Contractor’s superintendent shall meet monthly or as necessary to jointly measure all work items under the contract to determine pay quantities for each pay period. Quantities of work items shall be documented on the respective plan sheets and separately in tabular fashion with Station to Station measurements noted to assure there is no duplication of payment for work performed. Measurements will be for work actually completed. No projections for expected completion of work will be allowed.

(F) All survey data will be referenced to the City Coordinate System in accordance with the City Survey Datum Requirements as noted below.

CITY OF PRESCOTT SURVEY DATUM REQUIREMENTS		
Coordinate Units	International Feet	
Distance Units	International Feet	
Height Units	International Feet	
Datum		
Geodetic (Horizontal) Datum	North American Datum of 1983 (1992), (NAD83 (1992)	
Coordinate System	Arizona Coordinate System (State Plane)	
Zone	Central (0202)	
Vertical Datum	North American Vertical Datum of 1988, (NAVD88)	
Geoid Model	GEOID99 (Conus)	
City of Prescott Coordinate System (COPCS) – Conversion from State Plane		
COPCS Northing	(State Plane Northing x 1.000329975) – 701,456.0090	
COPCS Easting	(State Plane Easting x 1.000329975) + 69,457.2499	
Note: Distances computed between COPCS coordinates approximate "ground" distances		
State Plane – Conversion from City of Prescott Coordinate System		
State Plane Northing	(COPCS Northing + 701,456.0090) x 0.999670134	
State Plane Easting	(COPCS Easting – 69,457.2499) x 0.999670134	
Example – City of Prescott Mingo Base		
Latitude	34°34'29.27969" N	
Longitude	112°28'48.72638" W	
Height	5587.018'	
	State Plane Coordinates	**City of Prescott Coordinates**
Northing	1,301,026.703	600,000.0000
Easting	530,367.742	600,000.0000
Elevation	5,673.561'	5,673.955'

(G) Measurement and Payment: The quantity of construction staking measured for payment shall be the lump sum bid by the Contractor. The contract unit price per lump sum paid for construction staking shall be full compensation for all labor, materials, and equipment to perform the construction staking as described in this section.

105.9 DUTIES OF INSPECTOR

ADD the following:

An inspector is to be assigned to the project by the City to monitor the project and to keep the Engineer informed as to the progress of the work and the manner in which it is being done. Additionally, the Inspector will call the Contractor's attention to any nonconformance with the plans and specifications. Inspection will be done on an as needed or on-call basis. The Inspector will not be authorized to approve or accept any portion of the work. The Inspector will exercise such additional authority only as may from time to time be delegated to him by the Engineer.

105.10 INSPECTION OF WORK

ADD the following:

Inspection is to be done by the City Public Works Department. The Contractor shall furnish the Engineer with every reasonable facility for ascertaining whether or not the work as performed is in accordance with the requirements and intent of the specifications and contract. If the Engineer requests it, the Contractor at any time before acceptance of the work shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standards required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering or removing and the replacing of the covering or making good of the part removed will be paid for as provided in Sections 104 and 105 of these specifications, but should the work so exposed or examined prove unacceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed shall be at the Contractor's expense.

105.15 ACCEPTANCE

REMOVE item (A) in its entirety and REPLACE with the following:

(A) Partial Acceptance: Partial acceptance may be given upon substantial completion of the work at the sole discretion of the Engineer as provided herein. After completion of certain units of work under this contract, such as a structure, utility service, or a section of road or pavement, including all testing and other preparation necessary for operation of the unit by the City as herein specified, but prior to final project completion, the Contractor may request the Engineer to make final inspection of that work for partial acceptance. If the Engineer finds, upon inspection, that the work has been satisfactorily completed in compliance with the contract, the Engineer may accept the work, in writing, as being completed and the Contractor may be relieved of further responsibility for that work. Such partial acceptance shall in no way void or alter any terms of the contract.

(1) For the purpose of this section, substantial completion shall mean that stage in the progress of the work where the work or designated portion is sufficiently complete in accordance with the contract documents so that the City can occupy or utilize the work for its intended use with only minor work items or cleanup items remaining to be accomplished. Partial acceptance shall not be given for incomplete major work items nor minor work items affecting public health and safety.

(2) The units to be included for partial acceptance prior to final project completion will be noted at the time of the preconstruction conference in accordance with Contractor's schedule, or by written notice to the Contractor at the earliest possible time.

(3) The guarantee period for these units shall commence with the date of final acceptance of the entire project by the City. Full payment for these units will not be made until final acceptance of the total work is made.

(4) Acceptance of any portion of the project prior to acceptance of the whole shall not be construed as absolving the Contractor of responsibility for any item of construction or incidental work included in the original contract.

(5) Contract time accounting and/or assessment of liquidated damages shall be suspended on the date of partial acceptance and the Contractor shall complete all remaining work items necessary for final acceptance within 30 calendar days of the date of partial acceptance. The City shall withhold release of retention until all items under the contract have been completed and final acceptance has been issued.

ADD the following subsection to Section 105- Control of Work:

105.16 RECORD DRAWING PREPARATION AND COORDINATION

(A) As-built field data collection and preparation of record drawings will be performed by the Engineer. The Contractor shall notify the Engineer as required in this section, provide access to the work, and cooperate with the Engineer to gather information to accurately depict the as-built conditions. During the construction phase and prior to any backfilling or covering and subsurface improvements, the Contractor shall notify the Engineer of Record and the Engineer of Record will survey the work for the purpose of record drawing preparation. As-built measurements and surveying shall be performed and certified by a Registered Land Surveyor in good standing with the Arizona State Board of Technical Registration. The Engineer shall supply all horizontal and vertical as-built data in ASCII format, including a northing, easting, elevation and description of all work completed under this contract. The Contractor shall aid the Engineer in determining and providing this information. As-built data shall include, but not be limited to all items noted below.

(1) Grading and Drainage Plans

(a) Finished pad grades: An Average pad grade may be used if the pad is not flat. Pad elevations shall not exceed plus 0.5 feet tolerance (plus 0.2 feet if located adjacent to an existing development). Pad elevations shall not exceed minus 0.2 feet tolerance (0.1 feet if located in a floodplain or adjacent to a wash or channel).

(b) Flow line elevations of channels

(c) Hinge point elevations on all slopes and grade breaks

(d) Percentage of all slopes, flow lines and channels

(e) Catch basin grates elevation at top of grate

(f) Inverts of storm drain lines and headwalls

(g) As-built elevations shall be provided at all drainage control point (i.e. detention overflow point, tops and bottoms of detention basins, drain rims, valley gutters, curbs, curb openings, flow line elevations in swales, etc). As-built enough spot elevations to verify the design intentions are met (i.e. grade breaks, high/low points, scuppers, extreme outfall, etc). Show the direction of drainage flow to illustrate that design intent has been met.

(h) Provide calculations to verify that actual as-built volume of all detention facilities included on the as-builts, as well as a table which compares the as-built volumes with the approved, required volumes indicated on the design drawings or in the approved drainage report

(i) Detention calculations shall be revised to as-built condition by the Engineer of Record

(j) Flow line elevations and/or pipe inverts, grate elevations for catch basins, underground detention storage tanks, and all other drainage structures

(k) Top of flood walls, retaining walls, and cutoff walls

(l) Stations, offsets, and invert elevations for spillways and box culverts

(m) When storm drain lines and appurtenances are included in the grading and drainage drawings, the Contractor shall refer to the storm drain plan record drawing requirements for additional required items

(2) Water/Fire/Reclaimed Water Plans

(a) All fittings and appurtenances shall be surveyed, including but not limited to the following: valves, bends, tees, reducers blow offs, air release valves, tracer wire stations, water meters, and hydrant locations.

(i) Valves shall be measured on the nut and center of the cover. If extensions are used, the length of the extension shall be noted.

(ii) All fittings shall be measured at the middle of the fitting.

(iii) Air release valves shall be measured at the main connection, the air release box, and any major alignment changes between the two.

(b) Pipe sizes, lengths and materials

(c) Horizontal and vertical separation from existing and new utilities and drainage culverts/storm drain

(d) Street centerline station and offset dimension to:

(i) All fire hydrants and fittings (e.g. valves)

(ii) Main at all changes in alignment

(iii) All horizontal control points (e.g. centerline intersects, PC, PT)

(e) Centerline station and offset to each service tap; size of tap and meter

(f) Note centerline station, offset and elevations to all changes in vertical alignment (e.g. dips, bends, etc. required to avoid conflicts with other utilities). If the water main continues in a straight horizontal and vertical alignment for more than 100 feet, the water main will be surveyed every 100 feet. Sufficient survey measurements shall be taken on horizontal and vertical curves to establish an accurate alignment.

(g) The drawings must clearly indicate the specific points of reference. No dimensioning from points of curvature or tangency is acceptable for record drawing purposes. In all cases where the pipeline is constructed within, or parallel in close proximity with the right-of-way, all stationing and dimensioning must be from the nearest appropriate monument line and monument line intersection.

(h) When water services are not installed perpendicular to the water main, both the location of the tap at the main and the distance of the meter set from the nearest side property line of the lot must be shown.

(i) On phased projects, the phase lines must be clearly shown on the key map and on the plan and profile sheets, and their locations clearly identifiable. Actual pipe end locations relative to phasing lines must be shown by dimensioning or stationing.

(j) A complete list of all materials installed and abandoned must be shown. The specific size and material type of each pipeline installed must be shown at every construction reference to that pipe. Any changes to the record drawing must be reflected on the materials list.

(k) Water tank and appurtenances

(i) Required information for water tanks include, but are not limited to finished floor elevations, footing elevations, inlets, outlets, drains and overflow locations.

(ii) Required information for site piping and appurtenances shall follow the requirements of this section.

(iii) Manufacturer detail drawings for tanks shall be supplied and sealed by a Registered Engineer.

(3) Sewer Plans

(a) The alignments of the main(s) including all horizontal and vertical curves. If the sewer main continues in a straight horizontal and vertical alignment for more than 100 feet, the sewer main shall be surveyed every 100 feet. Sufficient survey measurements shall be taken on horizontal and vertical curves to establish an accurate alignment.

(b) All manholes, cleanouts, backwater valves, individual services, lift stations, and force main valves shall be surveyed. Structures shall have rim and invert elevations included.

(c) Pipe sizes and lengths

(d) Recalculated pipe slopes

(e) All valves at lift stations and line or isolation valves on force mains shall be measured on the nut and the center of the cover or vault lid.

(f) Separation from existing/newly installed water main and culverts

(g) Street centerline station and offset dimension from street centerline to main at manholes

(h) Sewer line stationing at centerline of each service tap at 90 degrees to main; if not installed at 90 degrees to main, station and offset to end of each service tap.

(i) New manholes built on existing lines require showing its station from the nearest existing downstream manhole and its distance to the nearest existing upstream manhole.

(j) Where construction begins with removal of an existing pipe plug or cleanout, 0+00 stationing always begins at the nearest existing downstream manhole. Pipe length measurement and stationing is always from the centerline of the downstream manhole to the centerline of the upstream manhole or cleanout. Do not give partial pipe lengths in plan or profile at match lines. Always indicate the distance between manholes or to cleanouts or pipe ends.

(k) All as-built adjustments to manhole, cleanout and pipe information shall be shown on both plan and profile, and repeated on every sheet that refers to the same information.

(l) A complete list of all materials installed and abandoned must be shown. The specific size and material type of each pipeline installed must be shown at every construction reference to that pipe. Any changes to the record drawing must be reflected on the materials list.

(m) On phased projects, the phase lines must be clearly shown on the key map and on the plan and profile sheets- and their locations clearly identifiable. Actual pipe end locations relative to phasing lines must be shown by dimensioning or stationing.

(4) Paving/Roadway Construction Plans

(a) Top of curb, flow line, and pavement centerline elevations at all grade breaks, Points of Tangency (PT), Points of Curvature (PC), Beginning Curb Return (BCR), and Ending Curb Return (ECR), valley gutters, spandrels at intersections, plus any other location necessary to adequately show drainage

(b) Percentage of slope

(c) ADA ramps including ramp slopes

(d) Edge of pavement on rural road sections

(e) Location of traffic signage, signals, poles and cabinets

(f) Station for all grade breaks

(g) Back of curb offset dimension at all changes in alignment

(h) Survey monuments - as-built installation and provide the City Northing/Easting to the hundredth of 1 foot. For street monuments, provide top of monument as-built elevation in addition.

(i) Distances from monument line to back/face of curb, edge of pavement, and sidewalk; show on plan view or typical detail for street section

(j) Beginning and ending stations and elevations for all traffic calming devices

(k) Stations, offsets, and invert elevations for spillways and box culverts

(l) Flow line elevations and/or pipe inverts, grate elevations for catch basins, underground detention storage tanks, and all other drainage structures

(5) Traffic Signal Plans

(a) Street centerline station and offset dimension to all fixture poles, cabinets, boxes, or other signal related furniture

(b) Horizontal location of conduit along with elevations to top of conduit

(6) Signing and Striping Plans

(a) Street centerline station and offset dimension to all signage, painted arrows, wording, and symbols

(b) Face of curb dimensions to all striping

(7) Storm Drain Plans

(a) Street centerline station and offset dimension to the main at all changes in alignment and/or changes in grade

(b) Street centerline station and offset dimension to all structures and changes in alignment

(c) Top and invert elevations for all structures

(d) Drainage pipe inverts

(e) Finish elevation for catch basins

(f) Invert elevations of box culverts

(g) Headwall data shall include top of wall/wingwall, footing elevations, inverts, and apron boundaries whether concrete or rip-rap

(h) Length of catch basin wings

(i) Drainage ditches, swales, and channels; the flow line and sufficient cross sections (minimum of 50 foot intervals) including grade changes, shall be provided

(8) Landscaping

(a) Revise as needed to reflect the addition, removal, relocation or change of irrigation main lines, plant materials or hardscape

(9) Street Light Plans

(a) Record drawings for street lights are required to have the Arizona Public Service (APS) ID number of each street light noted on the plan

(b) Street centerline stationing and offsets for street lights

(B) Prior to backfilling or covering any work, the Contractor shall notify the Engineer 48 hours in advance in writing for the item of work. The minimum 48 hours notice time shall not include weekends or holidays. The notification shall be via e-mail to both the City and the Engineer.

(C) The Contractor must provide access for the Engineer to verify all as-built information prior to backfilling or covering. The Contractor shall not backfill or cover an item of work until verification has been completed by the Engineer. If the Contractor backfills or covers an item of work prior to being measured or recorded by the Engineer, the Contractor at the direction of the Engineer shall uncover the item of work at no additional cost to the City.

(D) The Contractor shall maintain on site, available to the City and Engineer at all times, 1 redlined copy of all project plans and documents including drawings, specifications, addenda, approved shop drawings, and change orders which reflect all changes and modifications made during construction of the project. The redline copy shall be updated on a weekly basis in preparation for the weekly as-built field meeting. The Contractor shall maintain the plans and documents in good order and shall provide the Engineer with a redlined copy of all plans and documents upon completion of the project or upon termination of the contract.

(E) Weekly field meetings with the Contractor, Engineer and City shall occur to review as-built information for conformance with the specifications. The Contractor shall provide the Engineer with a schedule of work items to be constructed in the upcoming 30 day period, including approximate dates of installation prior to backfilling or covering. The Contractor field redlines will be reviewed for notation of changes in the work. Missing, erroneous or deficient data must be corrected by the Contractor at no additional cost to the City.

(F) Measurement and Payment: No separate measurement and payment shall be made for record drawing preparation and coordination. This work shall be considered incidental and included in the unit price bid for construction or installation of the appropriate contract pay items.

SECTION 106: CONTROL OF MATERIALS

106.1 SOURCE OF MATERIALS AND QUALITY

ADD the following:

The Contractor shall submit in writing all materials to be used in the project in accordance with ADOT Specifications 106 and 730-4.

Where equipment, materials, or articles are referred to in the specifications as “or equal”, or “equal to” any particular standard, the Director shall decide the question of equality.

Wherever any standard published specification is referred to, the latest edition or revision, including all contract amendments, shall be used unless otherwise specified. Materials of a general description shall be the best of their several kinds, free from defects, and adapted to the use for which provided. The physical characteristics of all materials not particularly specified shall conform to the latest standards published by the American Society for Testing and Materials (ASTM), where applicable. 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 specifications or from the plans; and it shall be the duty of the Contractor to call the Director's attention to apparent errors or omissions and request instructions before proceeding with the work. The

Director may, by appropriate instructions, correct errors and supply omissions, which instructions shall be binding upon the Contractor as though contained in the original specifications or plans.

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

Nothing in the contract shall be construed as vesting in the Contractor any right of property in materials used after they have been attached or affixed to the work or the soil and accepted. All such materials shall become the property of the City upon being so attached or affixed and accepted.

106.2 SAMPLES AND TESTS OF MATERIALS

REMOVE the second paragraph in its entirety and REPLACE with the following:

The City will pay for the initial or normal test required by the Engineer as provided by Section 106.9 of these specifications. All Quality Control initial or normal testing will be performed by the Contractor's Quality Control subcontractor, at no cost to the City. Additional tests, required due to failure of the initial or normal test(s), shall be paid for by the Contractor for both Quality Control and Quality Assurance testing. The Engineer will designate the laboratory which will accomplish the additional test(s).

106.4 TRADE NAMES AND SUBSTITUTIONS

ADD the following:

Requests relative to substitutions for materials or equipment specifically designated on the plans or in the specifications shall be accompanied by complete data on which the Director can make determination on the merits of the proposed substitution. The written request shall state how the product proposed for a substitution compares with or differs from the designated product in composition, size, arrangement, performance, etc., and in addition, the request shall be accompanied by documentary evidence of equality in price and delivery or evidence of difference in price and delivery. Data on price shall be in the form of certified quotations from suppliers of both the designated and proposed items. All items accepted for substitution shall be subject to all applicable provisions of the specifications.

Should substitution be allowed under the foregoing provisions, and should the item subsequently prove to be defective or otherwise unsatisfactory for the service for which it was intended, the Contractor, shall without cost to the City, and without obligation on the part of the Director, replace the item with the material originally specified.

106.5 STORAGE OF MATERIALS

ADD the following:

Protection of materials and equipment stored on the site shall be the responsibility of the Contractor. The City reserves the right to direct the Contractor to provide proper means of protection for materials if such is deemed advisable by the Director; however, the exercise of or failure to exercise this right shall not be deemed to relieve the Contractor of the Contractor's primary responsibility for protecting the material and equipment. The Contractor shall provide suitable warehouses or other adequate means of protection for such if the materials and equipment require storage and protection. The Contractor shall store and care for the materials and equipment in the most suitable manner to protect them from distortion, rain, dust, or other damage. The cost of replacing any material or equipment damaged in storage shall be borne by the Contractor, and the fact that material or equipment has been damaged after partial payment has been made shall not relieve the Contractor of the Contractor's primary responsibility.

No motor shall be left uncovered or unprotected.

ADD the following subsection to Section 106- Control of Materials:

106.9 QUALITY ACCEPTANCE TESTING

(A) The Engineer may provide quality acceptance sampling and testing. The number of tests and location of each shall be determined by the Engineer.

(B) The Contractor and the Engineer's representative shall coordinate on a daily basis the following day's work schedule and any testing that may be necessary.

(C) Construction quality acceptance testing performed by the City does not relieve the Contractor or the manufacturer of materials produced for the Contractor, of the obligation to perform and document quality control testing of materials and workmanship.

(D) Measurement and Payment: No separate payment shall be made for Contractor Quality Control. This work shall be considered incidental and included in the unit price bid for construction or installation of the appropriate contract pay items. An independent geotechnical firm shall perform all quality control testing. The Contractor shall furnish copies of all test results to the City on a weekly basis.

The expense of the initial quality acceptance sampling and testing shall be paid for by the City. Additional tests, required due to failure of the initial or normal test(s), shall be paid for by the Contractor for both Quality Control and Quality Assurance testing at no expense to the City. The Engineer will designate the laboratory which will accomplish the additional test(s).

SECTION 107: LEGAL REGULATIONS AND RESPONSIBILITY TO PUBLIC

ADD the following subsection to 107.1 Compliance with Laws:

107.1.1 Compliance with Federal and State Laws

The Contractor understands and acknowledges the applicability to it of the Americans with Disabilities Act, the Immigration Reform and Control Act of 1986 and the Drug Free Workplace Act of 1989. The following is only applicable to construction contracts: The Contractor must also comply with A.R.S. § 34-301, "Employment of Aliens on Public Works Prohibited", and A.R.S. § 34-302, as amended, "Residence Requirements for Employees".

Under the provisions of A.R.S. § 41-4401, the Contractor hereby warrants to the City that the Contractor and each of its subcontractors will comply with, and are contractually obligated to comply with, all Federal Immigration Laws and regulations that relate to their employees and A.R.S. § 23-214 (A) (hereinafter "Contractor Immigration Warranty").

A breach of the Contractor Immigration Warranty Shall constitute a material breach of this contract and shall subject the Contractor to penalties up to and including termination of this contract at the sole discretion of the City.

The City retains the legal right to inspect the papers of any Contractor or subcontractor's employee who works on this contract to ensure that the Contractor or subcontractor is complying with the Contractor Immigration Warranty. The Contractor agrees to assist the City in regard to any such inspections.

The City may, at its sole discretion, conduct random verification of the employment records of the Contractor and any of the subcontractors to ensure compliance with the Contractor Immigration Warranty. The Contractor agrees to assist the City in regard to any random verification performed.

Neither the Contractor nor any of the subcontractors shall be deemed to have materially breached the Contractor Immigration Warranty if the Contractor or subcontractor establishes that it has complied with the employment verification provisions prescribed by Sections 274A and 274B of the Federal Immigration and Nationality Act and the E-Verify requirements prescribed by A.R.S. § 23-214 (A).

The provisions of this Article must be included in any contract the Contractor enters into with any and all of its subcontractors who provide services under this contract or any subcontract. "Services" are defined as furnishing labor, time or effort in the State of Arizona by building or transportation facility or improvement to real property.

ADD the following subsection to 107.1 Compliance with Laws:

107.1.2 Employment Provisions

Subject to existing law, and regulations, illegal or undocumented aliens will not be employed by the Contractor for any work or services to be performed pursuant to this contract. The Contractor will ensure that this provision is expressly incorporated into any and all Subcontracts or subordinate agreements issued in support of this contract. The Contractor agrees to comply with the provisions of Sections 274A(a)(1)(A) and 274A(a)(2) of the Immigration and Nationality Act (8 U.S.C. 1324a(a)(1)(A) and 1324a(a)(2)) (the "INA employment provisions"), and any amendments thereto, prohibiting the unlawful employment of illegal or undocumented aliens. Under the terms of this agreement, the Contractor shall not knowingly hire or employ for any work performed pursuant to this contract any workers or employees not lawfully authorized to work under the provisions of the Immigration and Nationality Act or any other applicable Federal or State laws. Violation of the provisions of this section shall be deemed a material breach of this contract.

ADD the following subsection to 107.1 Compliance with Laws:

107.1.3 Independent Contractor Status

It is expressly agreed and understood by and between the parties that the Contractor is being retained by the City as an independent contractor, and as such the Contractor shall not become a City employee, and is not entitled to payment or compensation from the City or to any fringe benefits to which other City employees are entitled. As an independent contractor, the Contractor further acknowledges that he is solely responsible for payment of any and all income taxes, FICA, withholding, unemployment insurance, or other taxes due and owing any governmental entity whatsoever as a result of this Agreement. As an independent contractor, the Contractor further agrees that he will conduct himself in a manner consistent with such status, and that he will neither hold himself out nor claim to be an officer or employee of the City by reason thereof, and that he will not make any claim, demand or application to or for any right or privilege applicable to any officer or employee of the City, including but not limited to workmen's compensation coverage, unemployment insurance benefits, social security coverage, or retirement membership or credit.

ADD the following subsection to 107.1 Compliance with Laws:

107.1.4 Nondiscrimination

The Contractor, with regard to the work performed by it after award and during its performance of this contract, will not discriminate on the grounds of race, color, national origin, religion, sex, disability or familial status in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The Contractor will not participate either directly or indirectly in the discrimination prohibited

by or pursuant to Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Section 109 of the Housing and Community Development Act of 1974, the Age Discrimination Act of 1975, the Americans with Disabilities Act (Public Law 101-336, 42 U.S.C. 12101-12213) and all applicable Federal regulations under the Act, and Arizona Governor Executive Orders 99-4, 2000-4 and 2009-09 as amended.

ADD the following subsection to 107.1 Compliance with Laws:

107.1.5 Americans with Disabilities Act

The Contractor shall comply with all Federal, State and local nondiscrimination statutes in the operation, implementation and delivery of, including State and Federal civil rights and disabilities laws. In particular the Contractor shall ensure that the City 's obligations for program, facility and service accessibility in Title II of the Americans with Disabilities Act are complied with in all activities arising under this contract, and shall hold harmless the City for any and all loss, including but not limited to damages, costs or expenses, incurred or arising from any alleged violations of the Americans with Disabilities Act under the auspices of this contract unless resulting from an intentional or actual negligent act of the City and its employees. Failure to comply with the nondiscrimination or accessibility requirements herein shall be construed as nonperformance and may result in termination of funding, civil action or both.

ADD the following subsection to 107.2 Permits:

107.2.1 Permits, Taxes and Licenses

Except as otherwise provided in the specifications, it is the duty of the Contractor to procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work. All applicable permits, licenses and taxes are the responsibility of the Contractor.

City permit fees are waived for contractors performing work on City capital improvement projects.

107.5 SAFETY, HEALTH AND SANITATION PROVISIONS

REMOVE the first paragraph in its entirety and REPLACE with the following;

The Contractor shall provide and maintain, in a neat and sanitary condition, suitable and adequate sanitary conveniences for the use of all persons employed on the project. All sanitary conveniences shall conform to the regulations of the public authority having jurisdiction over such matters. At the completion of the project, all such sanitary conveniences shall be removed and the premises left in a sanitary condition.

On all projects, with respect to sanitation facilities, for which Federal funds are allocated, the Contractor shall cooperate with and follow directions of representatives of the Public Health Service and the Arizona State Department of Health. Federal, State and County public health service representatives shall have access to the work wherever it is in preparation or progress, and the Contractor shall provide proper facilities for such access and inspection.

ADD the following:

The Contractor shall make adequate provision, subject to the approval of the Director, to protect the project and Contractor's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.

At least 1 fire extinguisher, rated at least 2A, shall be provided on the job site.

All construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities shall be of ample size and capacity to adequately support and/or move the loads to which they will be subjected. All railings,

enclosures, safety devices, and controls required by law or for adequate protection of life and property shall be provided.

Machinery, equipment and other hazards shall be guarded or eliminated in accordance with the safety provisions of the Manual of Accident Prevention in Construction published by the Associated General Contractors of America, and the requirements of the Occupational Safety and Health Administration.

First aid facilities and information posters conforming at least to the minimum requirements of the Occupational Safety and Health Administration shall be provided in a readily accessible location or locations.

The Contractor shall provide all temporary facilities and utilities required for prosecution of the work; protection of employees and the public; protection of the work from damage by fire, weather or vandalism; and such other facilities as may be specified or required by any legally applicable law, ordinance, rule, or regulation.

The Contractor shall make all reports as are, or may be, required by the Engineer or any authority having jurisdiction, and permit all safety inspections of the work being performed under this contract. Before proceeding with any construction work, the Contractor shall take all the necessary action to comply with all provisions for safety and accident prevention. In the event the Contractor fails to comply with said safety provisions or directions of the Engineer, the Engineer without prejudice to any other rights of the City, may issue an order stopping all or any part of the work.

Thereafter, a start order for resumption of the work may be issued at the discretion of the Engineer when in the Engineer's opinion the defection from safety requirements has been corrected. The Contractor shall make no claim for an extension of time or for compensation or damages by reason of or in connection with such work stoppage.

107.6 PUBLIC CONVENIENCE AND SAFETY

ADD the following:

(A) Maintenance of Traffic

(1) Unless otherwise provided, streets and roads subjected to interference by the prosecution of work shall be kept open to all traffic and maintained by the Contractor until the work is complete. When so requested by the Contractor and approved by the Engineer, the Contractor may by-pass traffic over an approved detour route. Regardless of whether it is through or local traffic, the Contractor shall keep the portion of the project being used by traffic in such condition that traffic will be adequately accommodated. A City approved traffic control plan and right-of-way permit is required prior to the detour.

(2) The Contractor shall also provide and maintain in a safe condition temporary approaches or crossings, intersections with trails, roads, streets, businesses, parking lots, driveways residences, garages and farms. The Contractor shall also be required to remove snow as directed by the Engineer.

(3) Before any detour is opened to traffic, the Engineer shall have been satisfied that traffic is able to proceed in a safe manner.

(4) The Contractor shall bear all expense of maintaining traffic over the road being improved as well as constructing, maintaining and subsequently removing the Contractor requested detours, approaches, crossings, intersections and other features as may be necessary without any direct compensation.

(5) Except as otherwise shown or specified, off-site access roads shall be adequately maintained, graded-earth roads. Such roads shall be built only in the public right-of-way or easements obtained by the City. If the Contractor elects to build along some other alignment, he shall obtain, without additional cost to the City, the necessary right-of-ways or easements.

(6) The Contractor shall remove all unnecessary signage from the project area daily. If unnecessary signage is left, the City will contact the Contractor to remove it immediately. If the Contractor fails to remove the signage in a timely manner, the City will remove the signage at the Contractor's expense.

(7) Sidewalks shall be maintained to allow pedestrian foot traffic without obstruction. If a sidewalk must be closed, the Contractor shall maintain adequate prior warning for pedestrians to safely cross the street with as much advance notice as possible. Where sidewalk is not present, a City approved pedestrian detour shall be provided.

(B) Access to Businesses/Residences

(1) The Contractor shall provide to all residents and businesses affected by the project, access to 1 of their driveways at all times except as modified by the following: If the Contractor finds it unavoidable to temporarily close off access for any time, the residents/businesses affected shall be contacted a minimum of 48 hours in advance and an alternate procedure for access mutually agreed to. The Contractor shall provide the Engineer with signed evidence of a mutually accepted agreement between the property owner/business manager/residential manager and the Contractor prior to said closure.

(2) Direct access shall be provided at all times to fire engine houses, fire hydrants, hospitals, police stations and at all other agencies or services where emergencies may require immediate access to same.

(C) Safety

(1) The safety and convenience of the general public and the residents along the project and the protection of persons and property shall be provided for by the Contractor in accordance with the requirements of this contract.

(2) The Contractor shall submit a safety plan to the Engineer at the preconstruction conference. The plan shall detail the procedures the Contractor will implement to satisfy the Occupational Safety and Health Administration (OSHA) and the Arizona Division of Occupational Safety and Health (ADOSH) Guidelines related to the worker as well as public safety in construction of excavations, structures and confined air spaces as identified by the Engineer. The Contractor's safety plan shall include the requirement that all workers and visitors must wear hard hats while within the project limits.

(3) The safety plan submitted by the Contractor shall include proposed methods to prevent unauthorized persons from gaining access to the work areas.

(4) In conjunction with the safety plan, the Contractor shall furnish and install 72 inch temporary chain link fencing, or approved equal satisfactory to the Engineer, around any unattended excavation deeper than 4 feet with slopes steeper than 2:1. Temporary fencing shall completely enclose the referenced construction activity and shall be secured after normal working hours to prevent unauthorized access.

(5) Unless otherwise approved in writing by the Engineer, open utility trenches shall be limited to 50 feet in length except for cast-in-place pipe installations and during non-working hours shall be covered with steel plate in a manner satisfactory to the Engineer. Appropriate warning signs shall be installed when steel plates are left during non-work hours. Any traffic control signing shall be included in the traffic control line item(s) for the project.

107.6.1.1 Contractor's Marshaling Yard when the Agency is the Contracting Party:

ADD the following to item (F):

The Contractor will be fully and solely responsible for any and all adverse impacts and damages caused by the Contractor's operations on the property and the settlement of all claims pertaining thereto. The failure of the Contractor to comply with these provisions will result in the retention of some portion of the Contractor funds, payable under the contract, until such claims are resolved.

107.6.2

ADD the following:

In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation. Particular consideration shall be given to noise generated by construction, repair and/or service activities during the night hours in residential areas. No construction, repair or service activities shall be conducted between the hours of 6:00 PM and 7:00 AM, without prior approval of the City.

107.7 BARRICADES AND WARNING SIGNS

ADD the following:

Excavations on project sites from which the public is to be excluded shall be marked or guarded in a manner appropriate for the hazard.

The Contractor shall protect all existing structures, trees, shrubs, and other items on the project site that are to be preserved, by substantial barricades or other devices commensurate with the hazard, from injury or destruction by vehicles, equipment, workmen, or other agents.

107.9 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE

ADD the following to the first paragraph:

Any land monuments and property marks displaced by the Contractor shall be replaced at the Contractor's expense in accordance with Section 405 of these specifications and to the City Surveyor's satisfaction, including filing of new record of survey if monuments could not be reestablished to pre-project conditions.

ADD the following:

The Contractor shall replace or repair any damage done to driveways and walks to not less than the condition existing prior to the Contractor's work.

Streets and roads subjected to interference by the prosecution of this work shall be kept open and maintained by the Contractor until the work is completed.

All trees and shrubbery within the right-of-way or easements shall be protected by the Contractor insofar as practicable. In the event shrubbery or trees must be trimmed, or removed, the Contractor shall notify the property owner to do so within a reasonable time prior to construction. All shrubbery or trees not removed by the property owner shall be trimmed or removed by the Contractor and hauled from the job at the Contractor's expense. All trees, shrubs, hedges, brush, etc. designated on the plans, or by the Director for removal, shall be completely removed and disposed of as indicated on the plans or as specified by the Director.

The Contractor shall contact the owners of any drainage ditches, irrigation lines, and appurtenances, which interfere with the work and shall make arrangements for dry-up or scheduling of water deliveries as necessary. The Contractor shall be liable for any damage due to irrigation facilities damaged by the Contractor's operations and shall repair such damaged facilities to an "equal or better than" original condition.

In excavation, fill, and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or into streets or drainage ways inadequate for the increased flow.

Mailboxes and traffic signs removed during construction shall be installed in "like kind" and shall be considered incidental to the unit prices for work included in the bid schedule, provided they are not in the bid schedule.

The Contractor shall restore each individual work site to grades existing before construction work, including wheel ruts and other scarring.

Measurement and Payment: No separate payment will be made for restoration of items impacted by the Contractor's construction operation and the cost of these items shall be included in the unit bid prices in the bid schedule, unless specifically called out in the bid schedule as protection and restoration of property and landscape.

107.10 CONTRACTOR'S RESPONSIBILITY FOR WORK

ADD the following:

(A) The Director shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provisions of the contract. The Contractor shall immediately comply with the written order of the Director to suspend work wholly or in part. The suspended work shall be resumed when conditions are favorable and methods are corrected, as reviewed and accepted in writing by the Director.

(B) In case of suspension of work for any cause whatsoever, the Contractor shall be responsible for all materials and shall properly store them if necessary and shall provide suitable drainage and erect temporary structures where necessary.

(C) If the performance of all or any portion of the work is suspended or delayed by the Director in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the Contractor shall submit to the Director, in writing, a request for an adjustment within 7 calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

(D) Upon receipt, the Director will evaluate the Contractor's request. If the Director agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Director will make an adjustment (excluding profit) and modify the contract in writing accordingly. The Contractor will be notified of the Director's determination whether or not an adjustment of the contract is warranted. In the event an adjustment of the contract is warranted a contract amendment shall be executed by both parties evidencing mutual agreement to same.

(E) No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time limits prescribed.

(F) No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided or excluded under any other term or condition of this contract.

Add the following subsection to 107.13 Personal Liability of Public Officials:

107.13.1 Non-Responsibility of the City

Indebtedness incurred for any cause in connection with this work must be paid by the Contractor, and the City is hereby relieved at all times from any indebtedness or claim other than payments under terms of the contract.

ADD the following subsection to Section 107- Legal Regulations and Responsibility to Public:

107.15 PUBLIC RELATIONS

107.15.1 Public Notice

Unless otherwise directed, the Contractor shall issue written notification to those residents affected by the project. The notification shall contain, at a minimum: (1) Type of Work (2) Contractor Name, Phone Number and Point of Contact (3) Duration of Project (4) Date Project Commences (5) Description of the Project Site (6) Contractor's After-hours Point of Contact and Phone Number.

The Contractor is required to post public notification signs at all entrances to the project specifying the following information: (1) Project Name and Description (2) Construction Calendar (3) Contractor Name and Phone Number for both Day and Night (4) City Public Works (928) 777-1130.

The sign size and legend shall be appropriate for the intended purpose and be easily read. Sign background shall be blue with white letters. The sign size and legend content shall be approved by the Director prior to sign manufacture. All signs shall be posted prior to commencement of any work on the project. Signs will be removed by the Contractor upon final acceptance of the project. No direct payment shall be made for said signs. The cost of such signs shall be considered incidental to the project, unless otherwise noted.

107.15.2 Community Relations Organization

The Contractor shall be required to furnish a private telephone line to be used solely for receiving incoming calls from local citizens with questions or complaints concerning construction operations or procedures. The Contractor shall be required to publish this telephone number and maintain a 24 hour answering service. The answering service shall be manned by the Contractor's personnel during all hours during the course of construction that there is work being performed on the project. The Contractor shall maintain a log of incoming calls, responses, and action taken, which shall be submitted to the Engineer weekly and upon request.

The Contractor shall retain the services of a community relations organization for the project. The Contractor shall submit for approval, to the Engineer, the resume of the proposed community relations organization. Included in the resume shall be the names and credentials of the staff. The community relations organization shall be proactive and knowledgeable in the means and effectiveness of various notification techniques. The Engineer will rely on the organization's experience and suggestions in the presentation of information to the public. The Engineer will review the resume and possibly interview the organization. The Engineer will notify the Contractor within 10 calendar days of the acceptability of the community relations organization. Upon notification by the Engineer of an acceptable community relations organization, the Contractor shall hire the organization.

The community relations organization's activities shall include, but not necessarily be limited to:

- Printing and distribution of public notices
- Providing media news releases after review by the Engineer
- Planning and attending other public meetings as required by the Engineer
- Planning or otherwise participating in the dedication ceremonies as requested by the Engineer

- Possess the means for the development and fabrication of newsletters, notices, posters and demonstration boards
- Providing telephone "Hot Line" 24 hour service

The Contractor shall have a community relations organization on board prior to the preconstruction conference, a meeting in which the community relations organization will have an important participatory role.

The community relations organization shall develop a community relations program. The program shall include but not necessarily be limited to:

(A) Distributing a preconstruction information letter to all residents, businesses, schools and churches affected by the project or use of staging areas, and within an area determined by the Engineer, which shall contain, as a minimum, the following information:

- Name of contractor
- A 24 hour informational telephone number
- Brief description of project
- Names of project manager and superintendent (Contractor)
- Name of project engineer (Public Works Department)
- Construction schedule including anticipated work hours
- Traffic regulations including lane restrictions
- Time and place for the preconstruction conference. This notification shall be delivered a minimum of 5 working days prior to the meeting date.

(B) Holding a preconstruction community meeting with affected neighbors, businesses, schools, churches, etc., as directed by the Engineer.

(C) Scheduling and conducting progress meetings, as required, with the affected business tenants and property owners, as directed by the Engineer.

(D) Printing and mailing of public notices and/or newsletters, including a list of the names, addresses and receipt of postage or delivery for recipients of these newsletters and/or notifications.

(E) Holding other public meetings, as required by the Engineer.

(F) The community relations organization shall use the means (Items A through E) or others to inform the local citizens of operations which may create changes to the norm such as high noise levels, road closures, limited access, haul routes, changes to material delivery routes, unusual hours of construction, disruption of bus routes or changes to other passenger delivery/pick-up routes.

(G) Newsletters shall be distributed each month. A final draft shall be submitted to the Engineer for review and approval at least 2 days before the planned distribution. Each distribution area shall be approved by the Engineer. Each distribution shall include 1 electronic copy and 12 hard copies for the Engineer.

(H) The community relations organization shall keep daily personnel time logs which shall include the name of the employee, date of work, amount of time worked, description of work performed and project number.

Measurement and Payment: The bid schedule includes an allowance for public relations for the purpose of encumbering funds to cover the cost of public relation services. The amount of the allowance is determined

by the Engineer and is not subject to individual bid pricing. All bidders shall incorporate the amount pre-entered in the bid proposal and shall reflect the same in the total bid for the project.

It shall be understood that this allowance item is an estimate only. The allowance shall not be used without approval of the Engineer, and in no case shall exceed the allowance.

Reimbursement for public relations shall be based on the community relations organization invoice cost, plus an allowable markup to the prime Contractor of 15 percent, for those services approved by the Engineer.

107.15.3 Publicity Releases

The Contractor and the Contractor's subcontractors and suppliers, if any, shall not reveal to others through literature, brochures, or other types of publicity releases any information regarding the work or the Contractor's activities or participation on the project without prior written approval from the Director. Any and all jobsite photographs taken by the Contractor, subcontractor or others must be processed in duplicate form with copies provided to the Director. No project photographs shall be released to others without prior written approval of the Director.

ADD the following subsection to Section 107- Legal Regulations and Responsibility to Public:

107.16 STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

The project is subject to the Arizona Pollutant Discharge Elimination System (AZPDES) stormwater requirements for construction sites under the Environmental Protection Agency (EPA) delegation to ADEQ for the Construction General Permit for Arizona. The following specifications shall apply:

(A) General Requirements

The Contractor shall comply with AZPDES stormwater requirements for construction sites under the ADEQ Construction General Permit for Arizona. Under provisions of that permit, the Contractor shall be designated as permittee and shall be responsible for providing the necessary labor and materials, and for taking the appropriate measures to assure compliance with the AZPDES Construction General Permit for Arizona as well as other Federal, State and local requirements pertaining to stormwater discharges. As the permittee, the Contractor is responsible for completing, in a manner acceptable to ADEQ, all documents required by this regulation including the following:

(1) The SWPPP shall be sealed by a professional engineer licensed in the State of Arizona.

(2) The SWPPP for the project including certification form. The Contractor will be required to update and revise the SWPPP as necessary throughout the construction of the project in order to assure compliance with ADEQ permit requirements. The completed SWPPP shall be kept on the project site at all times during construction of the project.

(3) Notice of Intent (NOI) to be covered by AZPDES Construction General Permit for Arizona including certification of signature.

(4) Notice of Termination (NOT) of coverage under AZPDES Construction General Permit for Arizona (upon project completion).

ADEQ's website http://www.azdeq.gov/node/524 provides guidance for NOI submittal and SWPPP templates.

(B) Submittals

(1) Preliminary copies of the NOI and SWPPP shall be submitted to the Engineer at the time of the preconstruction conference. Any necessary revisions to the SWPPP shall be subject to review by the Engineer, before submitting to ADEQ.

(2) The Contractor shall submit completed, signed NOI forms to ADEQ at least 48 hours prior to the initial start of construction on the project. The completed, signed NOI form shall be submitted to ADEQ.

(3) Failure by the Contractor (or any of its appropriate subcontractors) to submit the NOI forms within the required time frame shall result in delay of the start of construction. Any delay resulting from the Contractor failing to fulfill these requirements shall not extend the completion date of the contract unless authorized by the City. The Contractor shall submit a completed copy of the NOI prior to Notice to Proceed. A copy of the completed NOI shall be posted on the construction site and a copy of the SWPPP shall be kept on the construction site.

(C) Contractor Responsibilities

(1) It is the Contractor's responsibility to perform inspection of all stormwater pollution control devices on the project as required under the AZPDES Construction General Permit for Arizona.

The Contractor shall prepare reports on these inspections and retain these reports for a period of 3 years following project completion as required under the AZPDES Construction General Permit for Arizona. Inspection reports shall be submitted monthly to the contracting agency along with payment requests. The Contractor shall maintain all stormwater pollution control devices on the project in proper working order, including cleaning and/or repair during the duration of the project.

(2) No condition of either the AZPDES Construction General Permit for Arizona or the SWPPP shall release the Contractor from any responsibilities or requirements under other environmental statutes and regulations.

(D) Upon total project completion, acceptance, and de-mobilization, the Contractor shall submit a completed, signed NOT form to ADEQ with copies to the same agencies who received copies of the NOI, thereby terminating all AZPDES permit coverage for the project.

Measurement and Payment: Payment shall be at the lump sum unit price bid in the contract documents for all material, labor, and other incidental costs relating to the provision, installation, and maintenance of items relating to this permit during project construction. Such incidental costs shall include the Contractor's costs in order to assure proper operation of the pollution-control devices installed including all maintenance, cleaning, and disposal costs associated with clean-up and repair following storm events or other runoff or releases on the project.

SECTION 108: COMMENCEMENT, PROSECUTION AND PROGRESS

108.1 NOTICE TO PROCEED

ADD the following to item (A):

(1) The Contractor shall not work on any part of the project or incur any expenses or obligations until a Notice to Proceed has been issued by the City.

(2) The Notice to Proceed will be delivered to the Contractor by first class mail, electronically and/or delivered in person.

108.2 SUBLETTING OF CONTRACT

REMOVE item (E) in its entirety and REPLACE with the following:

(E) The Contractor shall perform more than 40 percent of the dollar value of the work (by total contract amount) involved in the project with the Contractor's own forces. Total subcontracted amounts shall be limited to less than 60 percent of the dollar value of the work (by the total contract amount). For purposes of this requirement, materials purchased directly from suppliers and installed by the Contractor's own forces shall be included in the Contractor's total and materials installed by subcontractors, regardless of who originally purchased them, will be included in the subcontractor's totals.

ADD the following:

(F) All subcontractors and purchase orders for equipment shall state and establish guaranteed delivery dates, at such times as determined by the Contractor, which will allow the Contractor to complete the project within the contract time.

(G) The Contractor shall furnish the Subcontractors List form with the Contractor's bid including the estimated amount of each subcontract. Additionally, a duplicate copy of each subcontract, including lower tier subcontracts, shall be delivered to the Director upon award of the project and prior to the issuance of the Notice to Proceed.

108.4 CONTRACTOR'S CONSTRUCTION SCHEDULE

ADD the following:

At the preconstruction conference the Contractor shall submit for review by the Engineer a complete construction schedule. The Engineer reserves the right to reject construction schedule submittals when in the Engineer's opinion the schedule lacks the proper detail. It shall be the responsibility of the Contractor to maintain overall coordination of the project. Based on the general contract construction schedule prepared in accordance with these specifications, the Contractor shall obtain from each of the Contractor's subcontractors a similar schedule and shall be responsible for all parties maintaining these schedules or for coordinating changes necessitated by unforeseen difficulties.

(A) The construction schedule shall indicate the time of starting and completing each major phase of the project and such intermediate phases as will serve for well-defined control points. The schedule shall be of sufficient detail to define the critical path for project completion. It shall also indicate the scheduled receipt of major items of equipment and the items of equipment installation dates of which is critical to the scheduled progress of the project. Two week look-ahead schedules will be provided by the Contractor at each weekly construction meeting. The comprehensive project schedule shall be updated and submitted monthly. Such updates shall include and accurately reflect additional work, changes in the work, delays to individual items of work and reasons therefore along with the extent of delay and any other items affecting the progress of the project.

(B) Failure by the Contractor to provide the weekly and monthly updates will result in the City withholding an amount equal to 5 percent of the monthly pay estimate relative to the billing period in which the schedule updates are to be provided. Said 5 percent withholding will be retained by the City until the required schedule updates are submitted by the Contractor, reviewed by the City and found to be current. When the schedule updates are determined to be in conformance with the provisions herein the 5 percent retainer will be released with the next monthly payment.

(C) The construction schedule shall serve as an index of progress prosecution as contemplated by the Contractor. In the event the actual construction progress varies substantially from the scheduled progress, the

Engineer will require and the Contractor shall be required, within 10 calendar days written notice, to provide a revised construction schedule, giving in detail the particular changes in production as estimated by the Contractor to complete the work within the specified contract time. Time is of the essence in this regard.

ADD the following subsection to 108.4 Contractor's Construction Schedule:

108.4.1 Project Meetings

(A) It shall be the responsibility of the Contractor to conduct weekly meetings to be attended by representatives of subcontractors, utilities, the City and other interested parties for the purpose of keeping the project on schedule and to provide for necessary coordination of the work of the various parties. The Contractor shall take minutes at each meeting for distribution to all attendees the following week. The minutes shall be of sufficient detail to accurately recount the meeting discussion, including but not limited to progress, work schedule, submittals and certifications, utilities, construction issues, contract changes, safety and traffic control, action items, and resolved and unresolved issues.

(B) Additionally the Contractor shall furnish the Director with written weekly project status reports at the beginning of each weekly project meeting. The report shall cover the work of the preceding work week and shall include the following for each week:

(1) A comprehensive daily list of the Contractor's men and equipment performing the work on the jobsite.

(2) A comprehensive daily list of the Contractor's subcontractor's men and equipment, if any, performing the work on the jobsite.

(3) A brief description of the work performed by the Contractor and Contractor's subcontractors, if any.

(4) The estimated percentage of each portion of the work performed for the period together with the total percentage of each portion of the work performed to the date of the report.

(5) A detailed summary of each work stoppage, if any, occasioned by the City, other contractors, or other designated reasons, which were beyond the Contractor's control.

(6) Comments or exceptions to prior weekly meeting minutes shall be addressed at each subsequent construction meeting.

108.7 DETERMINATION AND EXTENSION OF CONTRACT TIME

ADD the following:

It is the Contractor's responsibility to establish construction methods and a construction schedule, which will facilitate the completion of work required by this contract within the contract period and with full consideration for the season during which the work is scheduled. Judgment as to hazardous conditions shall be made by the Director.

To receive consideration for an extension of time, a request must be made in writing to the Director stating the reason for said request, and such request must be received by the Director as soon as reasonably practicable when the Contractor has knowledge or should have known of the delay causing event, condition or circumstances, but in no event later than immediately following the end of the delay-causing condition. The extension of time allowed shall be as determined by the Director and approved by the City. In setting the contract time, it has been assumed that up to 5 working days may be lost as a result of weather conditions which will slow down the normal progress of work; therefore no extensions in contract time will be allowed for the first 5 working days lost due to bad weather conditions. An extension of time may be granted by the City after the expiration of the time originally fixed in the contract or as previously extended, and the extension so granted shall be deemed to commence and be effective from the date of such expiration.

Any extension of time shall not release the sureties upon any bond required under the contract. Extensions of time in and of themselves will not be a basis for a request of additional compensation by the Contractor.

Any delays in the project, or extensions of time which may be granted, shall not entitle the Contractor to any additional compensation or monies whatsoever, including but not limited to compensation for loss of anticipated profits, extended overhead, unabsorbed home office overhead, or any other payments, unless expressly agreed to by the City in a duly executed and approved contract amendment.

108.8 GUARANTEE AND WARRANTY PROVISIONS

REMOVE the first paragraph in its entirety and REPLACE with the following:

The Contractor shall guarantee the work against defective workmanship and materials for a period of 2 years from the date of its final acceptance under the contract, ordinary wear and tear and unusual abuse or neglect excepted.

During the 2 year guarantee period, should the Contractor fail to remedy defective material and/or workmanship, or to make replacements within 5 calendar days after written notice by the City, it is agreed that the City may make such repairs and replacements and the actual cost of the required labor and materials shall be chargeable to and payable by the Contractor.

108.10 FORFEITURE AND DEFAULT ON CONTRACT

ADD the following:

In accordance with Section 109 of these specifications, if the Contractor fails, neglects, or refuses to perform work tasks necessary for the completion of the total job; replace defective work; to repair or resurface, in a manner that is acceptable to the City and Engineer, public right-of-ways disturbed by the Contractor's work which are a nuisance, hazard, impedes or endangers vehicular traffic and the public; the City may serve written notice upon the Contractor of its intention to have the work performed by others. Unless, within 3 calendar days after the service of such notice, the Contractor has made such arrangement and scheduled the accomplishment of said work tasks to the satisfaction of the City and Engineer, the City will proceed to have the work accomplished by others or by itself and deduct the costs thereof from amounts due to the Contractor.

The foregoing provisions are in addition to and not in limitation of any other rights or remedies available to the City.

108.11 TERMINATION OF CONTRACT

ADD the following:

The foregoing provisions are in addition to and not in limitation of any other rights or remedies available to the City.

SECTION 109: MEASUREMENTS AND PAYMENTS

109.2 SCOPE OF PAYMENT

ADD the following:

The Contractor shall maintain any and all documentation to substantiate all costs on the project, including but not limited to those items included in force account computations, computations reflecting the actual cost of work on the project and computations substantiating any claimed increases or additional costs incurred in the project by the Contractor, and shall make those records available to the City (or provide copies thereof to the City) within 24 hours of request by the City. The failure of the Contractor to maintain and produce the foregoing documentation will preclude the Contractor from being entitled to any additional payments for any additional work in question.

109.4 COMPENSATION FOR ALTERATION OF WORK

ADD the following:

New or additional work will be classed as extra work when determined by the Director that such work is not covered by the contract.

The value of such work or change shall be determined and paid for with a contract amendment in one of the following ways according to the contract amendment procedure set down by the Public Works Department, and at the option of the City:

(A) As may be mutually agreed upon by the City and the Contractor.

(B) By unit prices in accordance with the Contractor's bid.

(C) By lump sum based upon the Contractor's estimate and the Director's review and acceptance of the estimate.

(D) By force account in accordance with the requirements of that section.

(E) The Contractor shall do such extra work and furnish material and equipment therefore upon receipt of an accepted contract amendment or other written order of the Director. In no case shall work be undertaken without written notice from the Director to proceed with the work. In absence of such contract amendment or other written order of the Director, the Contractor shall not be entitled to payment for any extra work. All contract amendments must be approved by the Director. Contract amendments over $25,000.00 must be approved by City Council.

(F) In the event that the Contractor and the City cannot agree on the compensation to be paid to the Contractor prior to the issuance of a contract amendment, then and in that event the City has the option of terminating the contract with the Contractor or directing the Contractor to proceed and to receive compensation pursuant to the force account provisions herein. In the event that this contract is terminated by the City pursuant to this subsection, the Contractor shall only be paid for those services performed to date of the City's Notice of Termination, said payment to be based upon the unit prices as set forth in the Contractor's bid. In no event shall the Contractor be entitled to additional compensation for lost profits, mobilization or de-mobilization costs, loss of anticipated profits, extended overhead, unabsorbed home office overhead, or any other payments other than for work actually performed as based upon unit prices. In the event that there are no unit prices pertaining to work in question, then and in that event the Contractor's compensation for early termination pursuant to this subsection shall be based upon force account as here-in-before described.

(G) It is expressly agreed that in the event of a contract amendment, any compensation due the Contractor shall be set forth in the contract amendment, and shall be considered full and complete payment (if any) for any and all work related costs, including but not limited to labor, materials, equipment, supervision, field office overhead, extended home office overhead, unabsorbed home office overhead, taxes, bonds, insurance and profits. Additionally, the Contractor shall not be entitled to any additional compensation based upon a contract amendment (or the accumulation of contract amendments) unless specifically set forth in that contract amendment.

(H) In the event that the Contractor submits a proposed contract amendment, the Director shall have 10 days after receipt of the Contractor's written proposed contract amendment to either accept or agree to the contract amendment under the above provisions or deny such proposed contract amendment. If necessary to assess the proper purpose and function of a Contractor's proposed contract amendment, because of the proposed contract amendment's complexity or scope, the Director may either accept and agree to the contract amendment of deny such proposed contract amendment under the above provisions beyond such 10 day period and for an additional reasonable period commensurate with the nature of the proposed contract amendment. The failure of any party to take any action within the time periods or in the manner specified in the subparagraph shall be deemed a waiver of that party's right to recover for such delay in acting.

109.5 ACTUAL COST WORK

ADD the following:

The basis of payment for construction of the project shall be unit prices for all work actually performed in accordance with the specifications and scope of work, and shall include all labor and materials incorporated in the completed work.

Upon final inspection and acceptance of the work, the City will pay the Contractor the amount earned under the Contract, as provided herein.

ADD the following subsection to 109.5 Actual Cost Work:

109.5.8 Force Account

The compensation for force account work performed by the Contractor shall be approved by the Director in the following manner:

(A) Labor: The Contractor shall provide monthly certified payroll reports for all labor and for foremen in direct charge of the specific operations. The Contractor will be compensated as follows:

(1) The actual cost of wages paid by him but at rates not to exceed those for comparable labor currently employed on the project as determined by the Director.

(2) The actual cost of social security taxes and unemployment compensation insurance. There will be no payment for fringe benefits unless mandated by Federal law on federally funded projects.

(3) An amount equal to 15 percent of the actual cost of wages and other costs listed above to cover the Contractor's profit and overhead.

(4) In case work is performed by a subcontractor, the said 15 percent will be added only once to the actual cost of the work, however, the Contractor may add 5 percent to the subcontractor's price to cover the Contractor's own overhead and supervision.

(B) Tools and Equipment: For any special or heavy equipment, the use of which has been authorized by the Director, except for small tools and manual equipment, the Contractor shall be reimbursed the actual cost of rental, not to exceed the latest Rental Rate Blue Book for Construction Equipment. In the event that any of the equipment to be used is not shown in said schedule, the rental rate for such equipment shall be as agreed upon in writing before the work is started. No percentage shall be added to equipment rental rates. In the event said special or heavy equipment is owned by the Contractor, he shall be compensated only for the actual hours said equipment is required for the work under force account on the job site, at a rate not to exceed the latest Rental Rate Blue Book for Construction Equipment.

(C) Materials: For all materials accepted by the Director and used in the work the Contractor shall be paid the actual cost of such material, including transportation charges, to which cost shall be added a sum equal to 15 percent thereof.

(D) Supervision Overhead and Home Office Overhead: No allowance shall be made for general superintendence. The cost of supervision and all overhead is presumed to be included in the 15 percent added in accordance with the above.

(E) Records: The Contractor's representative and the Director shall compare the records of the work performed as ordered on a force account basis at the end of each day on which such work is performed. Copies of these records shall be made on suitable forms provide for this purpose and signed by both the Director and the Contractor's representative. All claims for work done on a force account basis shall be certified and submitted to the Director by the Contractor, and such statements shall be filed with the Director not later than the fifth day of the month following that in which the work was actually performed.

(F) Bonds and Insurance: The Contractor shall be paid the actual cost for additional bonding and insurance pertaining to force account work when the Contractor can provide evidence of additional payment for premiums on required payment and performance bonds. No duplication of payment for Contractor's costs associated with labor costs above will be allowed.

(G) The Director authorized representative is in charge of force account work and has the authority to direct which labor and equipment will be used, to suspend operations, and to refuse to pay for any labor or equipment, which he feels is not doing productive work.

109.7 PAYMENT FOR BOND ISSUE AND BUDGET PROJECTS

ADD the following:

For and in consideration of the faithful performance of the work, the City will pay to the Contractor the amount earned less retention as computed from the actual quantities of work performed under the contract and to make such payment in the manner and at the time(s) specified herein.

ADD the following to the third paragraph of item (A):

The Contractor shall obtain approval from the City prior to reducing the percentage of funds retained and prior to requesting the release of one-half the previous retained amount.

ADD the following to item (A) (1):

(a) Once each month, the Inspector and the Contractor's Superintendent shall meet, or as necessary, to jointly measure all work items under the contract to determine pay quantities for each pay period. Quantities of work items shall be documented on the respective plan sheets and separately in tabular fashion with station to station measurements noted to assure there is no duplication of payment for work performed. Measurements will be for work actually completed. No projections for expected completion of work will be allowed.

(b) The Contractor shall submit partial payment requests in a format approved by Public Works together with the City's Pay Request Application and Certification for Payment (form provided by Public Works) or equal, subject to approval by the Director.

(c) The Contractor shall furnish a detailed breakdown showing unit prices and quantities for use in preparing the monthly estimate. No partial payment will be made until this breakdown is presented by the Contractor and has been reviewed and accepted by the Director. Green-lined plan sheets shall be submitted with each monthly pay request illustrating the line item quantities constructed for the period. The green-lined plan sheets and pay estimate spreadsheets must reconcile with one another**.**

(d) Partial payments for stored materials may be considered by the Director, if it is determined to be in the best interest of the City. The Contractor shall not rely on payment for stored materials being approved in the preparation of the project bid.

REMOVE the first paragraph of item (B) in its entirety and REPLACE with the following:

(B) Final Payment: When the project has been accepted as provided in Section 105 of these specifications, and within 30 calendar days after final inspection of the work completed under the contract, the Contractor shall render to the City a final estimate, which shall show the amount of work performed and accepted under the contract. All prior estimates and partial payments will be subject to correction in the final estimate for payment.

ADD the following to the second paragraph of item (B):

(See the Contractor's Affidavit Regarding Settlement of Claims and Certification of Completion of Warranties within the contract documents.) Additionally, the Contractor shall furnish lien waivers for all completed labor and materials consumed during the project.

Prior to the final payment to the Contractor, the City shall deduct therefrom any and all unpaid privilege, license and other taxes, fees and any and all other unpaid moneys due the City from the Contractor, and shall apply to those moneys to the appropriate account. The Contractor shall provide to the City any information necessary to determine the total amount(s) due. The quantities appearing in the bidding schedule are approximate only, and are prepared for the comparison of bids. Payment to the Contractor will be made only by actual quantities of work performed and accepted in accordance with the requirements of the contract. Only the items listed in the bidding schedule are pay items. The scheduled quantities of work to be done and materials to be furnished may each be increased, decreased or omitted.

Final project as-built plans shall verify line item quantities constructed for the project by individual plan sheet. The Contractor shall submit final payment request in a format approved by the City.

109.10 PAYMENT FOR MOBILIZATION/DEMOBILIZATION

REMOVE in its entirety and REPLACE with the following:

The Agency will compensate the Contractor for a single round trip mobilization/demobilization of the Contractor's personnel, equipment, supplies and incidentals, including establishment of offices, buildings and other facilities required for the performance of the work on the project, as well as preparatory work and operations prior to the commencement of the work on the project site.

Measurement and Payment: Mobilization will be measured for payment by the lump sum bid as a single complete unit of work. Payment for mobilization will be made as provided herein which shall be full compensation for supplying and furnishing all materials, facilities, and services and performing all the work involved as specified above. The total amount allowed for mobilization during the life of the contract shall not exceed 9 percent of the original contract amount. If the bid price exceeds this percentage the excess amount will be paid to the Contractor upon completion of the contract and 9 percent of the contract amount shall be used to determine partial payments. Partial payments under this item will be made in accordance with the following provisions:

(1) The first payment of 1/3 of the lump sum price for mobilization may be made provided that all submissions required under this section and as otherwise noted in the contract documents are submitted by the Contractor at the preconstruction conference to the satisfaction of the Engineer and when the Engineer has determined that a significant amount of equipment has been mobilized to the project site which will be used to perform portions of the project work.

(2) The second payment of 1/3 of the lump sum price for mobilization shall be made on the first estimate following completion of 13 percent of the contract.

(3) The third payment of 1/3 of the lump sum price for mobilization will be made on the first estimate following completion of 26 percent of the contract.

ADD the following subsection to Section 109- Measurements and Payments:

109.11 CONTRACT ALLOWANCE

(A) Contract allowance items are provided for the purpose of encumbering funds to cover the costs of possible contract amendment work. The amount of the allowance item is determined by the Engineer and is not subject to individual bid pricing. All bidders shall incorporate the amount pre-entered in the bid proposal and shall reflect the same in the total amount bid for the project.

(B) This allowance item provides an estimated funding to cover unforeseen changes that may be encountered and corresponding extra work needed to complete the contract per plan. Unforeseen extra work, if any, shall be in accordance with MAG Specification and COP Supplement 109.4.

(C) It shall be understood that this allowance item is an estimate only and is based on contract amendment history of similar projects. It shall not be utilized without an approved contract amendment. It is further understood that authorized extra work, if any, may be less than the allowance item. The Contractor, by submittal of a bid, acknowledges that the total bid and individual bid items were prepared without anticipation of use of the contract allowance.

SECTION 110: NOTIFICATION OF CHANGED CONDITIONS AND DISPUTE RESOLUTION

110.2.2 Dispute Resolution

REMOVE the first paragraph of item (A) and REPLACE with the following:

(A) The Contractor shall provide in writing the following information to the Engineer. In providing the information required by this section, the Contractor shall provide specific factual detail as to each item and show the methods of calculating each item.

110.3.1 General

ADD the following:

Level I shall mean the Public Works Project Manager as appointed by the Public Works Director

Level II shall mean the Public Works City Engineer as appointed by the Public Works Director

Level III shall mean the Public Works Director

In the event of litigation, the parties hereby agree to submit to a trial before the court. The Contractor further agrees that this provision shall be contained in all subcontracts related to the project, which is the subject of this agreement.

The parties hereto expressly covenant and agree that in the event of litigation arising from this agreement, neither party shall be entitled to an award of attorney fees, either pursuant to the contract, pursuant to A.R.S. §

12-341.01 (A) and (B), or pursuant to any other State or Federal statute. The Contractor further agrees that this provision shall be contained in all subcontracts related to the project that is the subject of this agreement.

110.4 ARBITRATION

REMOVE the last sentence of the first paragraph in its entirety and REPLACE with the following:

The arbitration of claims shall be conducted either in Prescott or Phoenix, Arizona as agreed to by the parties, or if the parties cannot agree, to be determined by the arbitrator, taking into consideration the convenience and costs to the parties and their witnesses.

REMOVE the last paragraph in its entirety and REPLACE with the following:

The decision or award of the arbitrator shall be supported by substantial evidence and, in writing, contain the basis for the decision or award and findings of fact. The decision or award of the arbitrator shall be nonbinding.

Any resolution of a dispute in accordance with MAG Specification and COP Supplement 110 and the contract which causes the contract amount to be exceeded by $25,000.00 or more shall not be final until approved by the City Council.

PART 200 – EARTHWORK

ADD the following section to Part 200- Earthwork:

SECTION 200: DEWATERING AND BYPASS PUMPING

200.1 DEWATERING

(A) All water encountered during the work shall be disposed of by the Contractor in a manner such that it will not damage public or private property or create a public nuisance or health problem. The Contractor shall submit drawings and complete design data showing methods and equipment he proposes to utilize in dewatering prior to completing any dewatering work. This work shall consist of obtaining permits, furnishing equipment, materials, and labor necessary for the control and removal of water, the construction or installation of all facilities necessary to accomplish the work, and the subsequent removal of such facilities except when designated on the project plans or in the special provisions to remain in place.

(B) The Contractor shall keep, where appropriate, the rehabilitated pipe section free from water during rehabilitation. If groundwater is present in any excavation, the static groundwater level shall be drawn down a minimum of 1 foot below the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance. The Contractor shall have on hand pumping equipment and machinery in good working condition for emergencies and shall have workmen available for its operation. Dewatering systems shall operate continuously until backfill has been completed to 1 foot above the normal static groundwater level.

Groundwater shall be controlled to prevent softening of the bottom of excavations, or formation of "quick" conditions. Dewatering systems shall not remove natural soils. The Contractor shall control surface runoff to prevent entry or collection of water in excavations.

Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

Measurement and Payment: No separate measurement or payment shall be made for dewatering. This work shall be considered incidental and included in the unit price bid for construction or installation of the appropriate contract pay items.

200.2 BYPASS PUMPING

(A) Description

(1) Scope: This section specifies the requirements for temporary bypass pumping of sewers

(2) Requirements

(a) The Contractor shall provide labor, materials, and supervision to temporarily bypass flow around the Contractor's work.

(b) The Contractor shall have the entire bypassing system in place and tested before bypassing any sewage.

(3) At the preconstruction conference, the Contractor shall submit drawings and complete design data showing methods and equipment he proposes to utilize in sewer bypassing for approval by the Engineer. The submittal shall include the following information:

(a) Drawings indicating the location of temporary sewer plugs and bypass discharge lines

(b) Capacities of pumps, prime movers, and standby equipment

(c) Design calculations providing adequacy of the system and selected equipment

(d) Standby power source

(e) Staffing plan

(f) Traffic control plan

(4) Flow Data: It is the responsibility of the Contractor for design, construction, and operation of an adequate and properly functioning bypass. It is also the responsibility of the Contractor to coordinate with the City to gather flow data.

(5) Protection: In areas where flows are bypassed, all bypass flow shall be discharged as approved by the Engineer. No bypassing to the ground surface, receiving waters, storm drains or bypassing which results in groundwater contamination or potential health hazards shall be permitted.

(6) Scheduling: The bypass system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer. Public advisory services will be required to notify all parties whose service laterals will be out of service and to advise against water usage until the main line is back in service.

(B) Materials

(1) The Contractor shall provide temporary pumps, conduits and other equipment to bypass the sewer flow. The Contractor shall furnish the necessary labor and supervision to set up and operate the pumping and bypass system. Engines shall be equipped with mufflers and/or enclosed to keep the noise level less than 50dB or 10dB above ambient noise levels when measured at the property line closest to the noise source. Pumps and bypass lines shall be of adequate capacity and size to handle the flows.

(2) The Contractor shall maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass systems. Standby pumps shall be fueled and operational at all times. The Contractor shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, sewer plugs, piping and other parts or system hardware to ensure immediate repair or modification to any part of the system as necessary.

(3) All piping, joints and accessories shall be designed to withstand at least twice the maximum system pressure, or 50 psi, whichever is greater. All hoses/pipes used for bypass pumping shall be ramped to allow for the ease of vehicular and pedestrian traffic. All hoses/pipes shall be color-coded for identification to prevent cross contamination of water and wastewater lines. Hose/pipes used for wastewater conveyance shall not be used for water conveyance.

(C) General

(1) During bypass pumping, sewage shall not be leaked, dumped or spilled outside the sewer system. When bypass pumping operations are complete, all piping shall be drained into the sanitary sewer prior to disassembly. In the event that sewage accidentally drains into the storm drainage system or the street, the Contractor shall immediately stop the overflow, notify the City and take the necessary action to clean up and disinfect the spillage to the satisfaction of the City. The Contractor shall submit an emergency spillage and cleanup action plan for all sewage spills to the Engineer for approval prior to beginning construction. It shall include but not be limited to a remediation plan that indicates what labor, equipment and resources will be used to restore the site to the condition prior to the spillage.

(2) The Contractor shall repair without cost to the City any damage that may result from this negligence, inadequate or improper installation, maintenance and operation of bypassing system including mechanical or electrical failures, regulatory infractions and penalties resulting from sewer spillage.

(D) Flow Control

(1) Complete stoppage or bypassing of flow is required during sewer line and manhole rehabilitation work.

(2) When the depth of flow at the upstream manhole of the sewer line section being worked is above the maximum allowable for television inspection, the flow shall be reduced to the level shown below by plugging or blocking of the flow, or by pumping and bypassing of the flow as specified.

(3) Plugging or Blocking: A sewer line plug shall be inserted into the line upstream of the section being worked. The plug shall be so designed that all or any portion of the sewage can be released. During TV inspection, flow shall be reduced to within the limits specified above. After the work has been completed, flow shall be restored to normal. Precautions shall be taken to prevent flooding damage. See flow precautions below.

(4) Pumping and Bypassing: When pumping and bypassing is required the Contractor shall supply the pumps, conduits and other equipment to divert the flow of sewage around the manhole section in which work is to be performed. The bypass system shall be of sufficient capacity to handle existing flow plus additional flow that may occur during peak flow periods or from precipitation and shall be constructed of such material that will prevent leakage during the pumping operation. The Contractor will be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing systems. All pump drivers shall have noise suppressor exhaust systems to reduce noise levels to less than 50dB, or 10dB above ambient noise levels, when measured at the closest property line.

(5) Flow Control Precautions: When flow in a sewer line is plugged, blocked or bypassed; sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations

do not cause flooding or damage to public or private property being served by the sewer involved. All piping(s), joints and accessories shall be designed to withstand at least twice the maximum system pressure or a minimum of 50 psi whichever is greater. During by-pass pumping sewage shall not be leaked, dumped or spilled onto any area outside the sewer system. When bypass pumping operations are complete all piping shall be drained into the sanitary sewer prior to disassembly. In the event sewage accidentally drains into the drainage system or street, the Contractor shall immediately stop the overflow, notify the Engineer and take the necessary action to clean up and disinfect the spillage to the satisfaction of the Engineer. If sewage is spilled onto public or private property, the Contractor shall wash down, clean up and disinfect the spillage to the satisfaction of the City. The Contractor shall report any and all overflows to the City.

(E) Measurement and Payment: Payment for bypass pumping shall be made at the lump sum bid by the Contractor.

SECTION 201: CLEARING AND GRUBBING

201.1 DESCRIPTION

REMOVE in its entirety and REPLACE with the following:

This work shall consist of removing objectionable material from the right-of-way, easements, all areas to be graded, and such other areas as may be specified in the special provisions. Clearing and grubbing shall be performed in advance of grading operations.

201.3 CONSTRUCTION METHODS

REMOVE the second paragraph in its entirety and REPLACE with the following:

All trees and shrubs found suitable for improvement and beautification, which will not interfere with excavation or embankment or cause disintegration of the improvements shall not be disturbed. In any event, the Contractor shall avoid injury to shrubbery, vines, plants, grasses and other vegetation growing outside of the clearing limits. The dragging and the piling of materials of various kinds and the performing of other work which may be injurious to vegetation shall be confined to areas which have no vegetation or which will be covered by embankment or disturbed by excavation during grading operations.

REMOVE the fourth paragraph in its entirety and REPLACE with the following:

From excavated areas, all stumps, roots and other obstructions 3 inches or over in diameter shall be grubbed to a depth of not less than 24 inches below finish grade.

REMOVE Table 201-1 in its entirety and REPLACE with the following:

TABLE 201-1	
EMBANKMENT CLEARING AND GRUBBING	
Height of Embankment Over Stump	**Height of Clearing and Grubbing**
0 Feet to 2 Feet	All stumps or roots 6 inches or over in diameter shall be grubbed to 24 inches below original grade. All others shall be cut flush with the ground.
2 Feet to 3 Feet	All stumps 1 foot and over in diameter shall be grubbed to 24 inches below original grade. All others shall be cut flush with the ground.
Over 3 Feet	All stumps shall be cut flush with the ground.

REMOVE the last paragraph in its entirety and REPLACE with the following:

All tree trunks, stumps, brush, limbs, roots, vegetation and other debris removed in clearing and grubbing shall be completely removed from the project and properly disposed of.

SECTION 205: ROADWAY EXCAVATION

ADD the following subsection to 205.1 Description:

205.1.1 General

The bidding schedule quantities for this item of work will be considered to be the final quantities for payment. Adjustments in the bidding schedule quantities for roadway excavation as contained in these specifications may be initiated by the Contractor or the Engineer if evidence indicates that the required quantity varies by an amount greater than 5 percent of the bidding schedule quantity. The Contractor shall advise the Engineer, in writing, submitting evidence in the form of a construction survey or photogrammetric survey with measurement for the proposed adjustment and requesting an adjustment in quantities. The Engineer will determine the amount of adjustment, if any. The quantity upon which payment will be based will be the bidding schedule quantity plus or minus only that portion of the adjustment that exceeds 5 percent of the bidding schedule quantity.

Variations caused by shrink/swell of materials shall not be considered for quantity adjustments.

Adjustments in roadway excavation quantities due to revisions ordered by the Engineer will be isolated by measurement or calculations. The bidding schedule quantities will be adjusted by the amount either measured or calculated, regardless of the 5 percent variation requirement above.

205.2 UNSUITABLE MATERIAL

REMOVE the third paragraph in its entirety and REPLACE with the following:

If material is encountered during excavation that the Engineer determines to be unsuitable, the following shall apply:

(1) Any unsuitable material which is located in a cut section at an elevation above finished subgrade shall not be utilized in construction but shall be removed and disposed of at a site secured by the Contractor. The cost of excavation, hauling and disposal are incidental to roadway excavation. No additional compensation will be allowed for any unsuitable materials found in a cut section at an elevation above finished subgrade.

(2) Material which is located below the finished subgrade elevation in excavation areas shall be removed to the limits as determined by the Engineer and the resultant cavity backfilled with aggregate base course (ABC) in accordance with Section 310 of these specifications. The costs of the removal, hauling, disposal, backfill material, placement and any related process, shall be included in the payment for this bid item.

205.6 SURPLUS MATERIAL

REMOVE the first paragraph in its entirety and REPLACE with the following:

Unless otherwise shown on the plans, addressed in the special provisions, or approved by the Engineer, no surplus excavated material shall be disposed of within the right-of-way. The Contractor shall make all arrangements for disposal of the material at off-site locations as may be approved by the Engineer. The Contractor shall provide to the Engineer copies of the written consent of the owner of the property upon which he intends to dispose of such material, and any permits that may be required by a governing agency for said disposal.

205.7 MEASUREMENT

REMOVE the first two paragraphs in their entirety and REPLACE with the following:

The following earthwork operations will be measured as roadway excavation for the quantities of material involved.

Excavating the roadway prism including public and private roadway approaches; excavating slides and slip-outs not resulting from overshooting; excavating excess material; excavating selected material and topsoil from within the limits of the project and removing such materials from stockpiles when stockpiling is ordered; and excavating ditches.

ADD the following:

Measurement for unsuitable material shall be to the nearest cubic yard as calculated in the field.

205.8 PAYMENT

ADD the following:

Payment for unsuitable material shall be at the contract unit price and shall include any and all processes associated with the removal and backfill of the unsuitable materials, all excavation, hauling and disposal at a site secured by the Contractor, and backfilling with aggregate base course (ABC).

SECTION 206: STRUCTURE EXCAVATION AND BACKFILL

206.4.2 Structure Backfill for Earth Retaining Structures

REMOVE item (A) in its entirety and REPLACE with the following:

(A) Shall conform to the material and the graduation requirements for Select Material, Type B in Table 702-1, unless otherwise approved by the Engineer.

206.4.4 Structure Backfill for Structures within Paved Areas

REMOVE in its entirety and REPLACE with the following:

Where a structure is located within an existing street, proposed street, or paved area:

All backfill material with the exception of controlled low strength material (CLSM) shall be compacted to 95 percent maximum dry density per ASTM D698. Controlled low strength material shall be 1 sack material as specified in MAG Specifications 604 and 728.

SECTION 211: FILL CONSTRUCTION

211.1 DESCRIPTION

REMOVE in its entirety and REPLACE with the following:

Fill construction shall consist of constructing embankments except as may otherwise be specified, including the preparation of the areas upon which they are to be placed; including the construction of dikes.

The bidding schedule quantities for this item of work will be considered to be the final quantities for payment. Adjustments in the bidding schedule quantities for Fill Construction as contained in these specifications may be initiated by the Contractor or the Engineer if evidence indicates that the required quantity varies by an amount greater than 5 percent of the bidding schedule quantity. The Contractor shall advise the Engineer, in writing, submitting evidence in the form of a construction survey or photogrammetric survey with measurement for the proposed adjustment and requesting an adjustment in quantities. The Engineer will determine the amount of adjustment, if any. The quantity upon which payment will be based will be the bidding schedule quantity plus or minus only that portion of the adjustment that exceeds 5 percent of the bidding schedule quantity.

Variations caused by shrink/swell of materials shall not be considered for quantity adjustments.

Adjustments in Fill Construction quantities due to revisions ordered by the Engineer will be isolated by measurement or calculations. The bidding schedule quantities will be adjusted by the amount either measured or calculated, regardless of the 5 percent variation requirement above.

211.2 PLACING

REMOVE the first paragraph in its entirety and REPLACE with the following:

Rocks or other solid material which are larger than 4 inches in greatest dimension shall not be placed in fill areas. Broken concrete or asphalt shall not be placed in the fill.

211.3 COMPACTING

REMOVE the seventh paragraph in its entirety and REPLACE with the following:

The interstices around the rock in each layer shall be filled with earth or other fine material and compacted. Broken Portland cement concrete and bituminous pavement shall not be permitted in the fill.

211.4 TESTS

ADD the following:

Quality Control testing frequency shall be 1 per soil type for proctor density testing and 1 per 500 feet per 8 inch lift for compaction testing.

211.5 MEASUREMENT

REMOVE the first paragraph in its entirety and REPLACE with the following:

The quantities of fill construction used to construct embankments or dikes will be those of the complete bid item within the limits of dimensions shown on the plans.

PART 300 – STREETS AND RELATED WORK

ADD the following section to Part 300- Streets and Related Work:

SECTION 300: SAW CUT

300.1 DESCRIPTION

(A) The work under this item shall consist of saw cutting the existing pavement where new asphalt concrete is to match existing bituminous surfaces with no provisions for overlaying the entire section. This item shall also include saw cutting of existing Portland cement concrete pavement, sidewalks, driveways and parking lots where new construction shall match the grade of existing surfaces that are to remain where called for on the project plans or where designated by the Engineer.

(B) Saw cuts shall be made to a full depth of the material to ensure a neat vertical joint. Portland cement concrete designated to remain that is damaged by the saw cutting shall be replaced in kind at the Contractor's expense.

(C) No separate measurement or payment will be made for saw cutting, being considered incidental to the cost for work for which saw cutting is required.

SECTION 301: SUBGRADE PREPARATION

301.1 DESCRIPTION

ADD the following:

The work under this item shall consist of furnishing all materials, equipment, and labor necessary for preparation of natural or excavated areas prior to the placement of any sub-base material, pavement, curbs and gutters, driveways, sidewalks or other structures. Unless provided for in another bid item, this work shall include the removal and disposal of all unsuitable material including existing pavement and other obstructions in accordance with Section 301 of these specifications. The Contractor shall be required to provide and pay for all Quality Control geotechnical testing in accordance with the MAG Specifications and the COP Supplement.

301.2.1

REMOVE in its entirety and REPLACE with the following:

The Contractor shall not use asphalt concrete or other bituminous roadway surfacing materials as embankment fill.

Project earthwork quantities, when included as separate contract pay items, will include removed asphalt/bituminous material volumes, unless there is a pay item for asphalt removal or asphalt milling in the bid schedule or otherwise specified in the special provisions.

All unsuitable material and all excess material shall be disposed of in accordance with the requirements of Sections 205.2 and 205.6 of these specifications, respectively. When additional material is required for fill, it shall conform to MAG Specification 210.

301.3 RELATIVE COMPACTION

REMOVE item (B) in its entirety and REPLACE with the following:

The subgrade shall be scarified and loosened to a depth of 8 inches.

(B) Below detached sidewalk not subject to vehicular traffic 95 percent

Subgrade Quality Control testing shall be 1 per 500 linear feet per lane for compaction testing.

301.7 MEASUREMENT

REMOVE in its entirety and REPLACE with the following:

Measurement for subgrade preparation will be by the square yard, measured by the total accepted area of new pavements, including paved shoulders, tapers, turnouts and driveways that are paved or surfaced with an aggregate base material. The areas under concrete curb and gutter, sidewalk and concrete driveway entrances will not be included. Unless provided for in other separate bid items or unless otherwise specified; Clearing and Grubbing, Roadway Excavation, Rock Excavation, Borrow Excavation, and Fill Construction shall not be measured, in which case payment for these earthwork items, if required, shall be included in the unit price for subgrade preparation.

SECTION 306: MECHANICALLY STABILIZED SUBGRADE – GEOGRID REINFORCEMENT

306.2 MATERIALS

ADD the following

Reinforcement Geogrid shall be Tensar BX1200 or approved equal.

306.8 PAYMENT

REMOVE in its entirety and REPLACE with the following:

Measurement of geogrid reinforcement shall be the surface area of accepted geogrid to the nearest square yard. No additional measurement or payment shall be made for geogrid overlap as required by the manufacturer.

Payment for geogrid reinforcement shall be per square yard installed complete and in place.

SECTION 310: PLACEMENT AND CONSTRUCTION OF AGGREGATE BASE COURSE

310.1 DESCRIPTION

REMOVE in its entirety and REPLACE with the following:

The work under this item shall consist of furnishing all materials, equipment, and labor necessary for the placement of an approved, imported aggregate base course material on top of a prepared subgrade per the required design thickness, grade, cross-section and compaction as specified on the project plan documents and in accordance with Sections 310 and 701 of these specifications, and MAG Specification 702. Aggregate base course shall not be placed on a prepared subgrade until the Engineer or the Engineer's authorized representative has inspected and accepted the underlying subgrade. The Contractor shall be required to provide and pay for all Quality Control geotechnical testing in accordance with MAG Specifications and COP Supplement. Use of Reclaimed Concrete Material (RCM) is not allowed per COP Supplement 701.4.

ADD the following subsection to 310.1 Description:

310.1.1 Reclaimed Asphalt Pavement (RAP)

Use of reclaimed asphalt pavement (RAP) aggregates or "millings" produced on-site, imported or stockpiled for the intended use in the underlying base or subgrade material must be approved by the Engineer or the Engineer's authorized representative; and shall be screened and meet MAG Sections 310, 701 and 702, and here within. RAP millings must be uniformly mixed with an imported virgin aggregate base course material.

310.2 PLACEMENT AND CONSTRUCTION

ADD the following:

Aggregate base course shall not be placed on excessively wet or frozen subgrade materials as determined by the Engineer.

ADD the following subsection to 310.2 Placement and Construction:

310.2.1 Quality Control Testing

Aggregate base course Quality Control testing frequency shall be as follows:

(A) Resistance to Degradation and Abrasion: 1 at the start of production and again if source changes.

(B) Fractured Faces, One Face, PI, and Gradation: 1 per shift.

310.3 COMPACTION

REMOVE the fifth paragraph in its entirety and REPLACE with the following:

For roadway construction, a minimum of 1 field density test shall be performed per 6 inch lift per 500 feet per lane. For other aggregate base course applications, a minimum of 1 field density test shall be performed for each 800 square yards.

REMOVE items (A), (B) and (C) in their entirety and REPLACE with the following:

Aggregate base course shall be compacted to 98 percent in all instances.

310.5 PAYMENT

REMOVE in its entirety and REPLACE with the following:

Measurement for aggregate base course material will be per cubic yard furnished and placed. Copies of material delivery tickets will be required for quantity verification purposes. Payment shall be made at the unit price bid and shall be considered full compensation for this work item.

SECTION 317: ASPHALT MILLING

317.2 CONSTRUCTION REQUIREMENTS

REMOVE in its entirety and REPLACE with the following:

When milling is specified, the existing asphaltic concrete shall be removed in accordance with the details shown on the project plans with equipment specifically designed to remove such material by means of grinding or chipping to a controlled line and grade. The equipment used shall be capable of removing the existing asphaltic concrete within 0.01 feet of the specified removal depth. The removal shall be accomplished in a manner which does not destroy the integrity of any asphaltic concrete pavement that remains and which does not result in a contamination of the milled asphaltic concrete with the underlying base material.

Pavement to be removed by milling, adjacent to manholes, valve boxes, small radius curbs and other fixed objects that produce confined areas shall be removed with milling equipment specifically designed to operate in restricted areas and capable of removing asphaltic concrete of the specified thickness without damage or displacement of the adjacent object. The removal of asphalt concrete pavement at the approaches to structures shall be accomplished in a manner approved by the City.

On projects with existing curb and gutter, any asphaltic concrete buildup in the gutter designated to be removed, shall be removed prior to the pavement removal operation by equipment and methods approved by the Engineer. The equipment and methods used shall be capable of removing the asphaltic concrete buildup without causing damage to the curb and gutter

Upon removal, all milled materials shall become the property of the Contractor. The City will not accept millings. The Contractor shall properly dispose of the millings away from the site. No additional compensation will be made for the disposal of millings.

Prior to milling and roadway excavation, all existing manholes, valve boxes, etc. shall be lowered and protected. All City facilities shall be protected from debris that may result from any adjustments and the Contractor shall be responsible for any maintenance activity resulting from debris related to the construction. No separate payment shall be made for lowering and protecting existing manholes, valve boxes, etc.

Under no circumstance shall the removal of existing asphaltic concrete begin until the mix design for replacement asphaltic concrete has been approved by the Engineer.

The extent of removal of existing asphaltic concrete must be in keeping with the Contractor's ability to produce, haul, place and compact replacement asphaltic concrete so that at all times the length of open "trench" is at a minimum. If the Contractor's production of replacement asphaltic concrete is stopped for any reason, the removal of asphaltic concrete shall either cease or shall be reduced. The Engineer will be the sole judge as to whether the removal shall cease or be reduced. The Engineer's decision will be based on the reason for the stoppage in asphaltic concrete production, the expected length of the stoppage, the type and depth of the material being removed, and the time of day.

ADD the following subsection to 317.2 Construction Requirements:

317.2.1 Quality Control

All milling shall be inspected and approved prior to paving. High spots in excess of the tolerances noted shall be milled until in conformance.

Low spots in excess of ½ inch shall have a leveling course placed prior to paving at no additional cost to the City.

ADD the following subsection to 317.2 Construction Requirements:

317.2.2 Paving

For mill and overlay areas, replacement asphaltic concrete shall be placed as soon as possible after milling has occurred and been approved. The surface on which the material is to be placed shall be uniform and free of loose material. Any exposed base material shall be compacted to the extent required by the Engineer.

The "trench" in which asphaltic concrete is being placed shall be filled before the end of each day's work and the lane shall be opened to traffic. The length of open "trench" at any one time shall not exceed 2 miles or ½ the length of the work, whichever is the lesser.

In the event of circumstances beyond the control of the Contractor, such as equipment breakdown, or if the production of the replacement asphaltic concrete has been stopped by the Engineer and the Contractor is unable to comply with the requirements in the preceding paragraph, the Contractor shall provide and maintain such traffic control devices that the Engineer deems necessary under the circumstances in order to provide safe and efficient passage through the work zone.

If the Engineer deems it to be warranted, the Contractor shall provide for the surface drainage of areas where the pavement surface has temporarily been removed.

ADD the following subsection to 317.2 Construction Requirements:

317.2.3 Macrotexture Milling

Macrotexture asphalt milling when included as a separate contract pay item shall be performed in accordance with the following:

Existing asphaltic concrete shall be removed by milling in accordance with the details shown on the project plans and as specified herein. The milling equipment shall be specifically designed to remove material to a controlled line and grade by means of grinding or chipping. The equipment used shall be capable of removing the existing asphaltic concrete uniformly throughout the milled area at the required cross-slope and within 1/8 inch of the specified removal depth. The specified removal depth of the existing bituminous pavement shall be as noted on the plans. The removal shall be accomplished in a manner which does not destroy the integrity of any pavement that remains. During production milling, the Contractor shall verify the actual depth of milling required to remove the desired underlying pavement surface. If it is determined by the Engineer that the required milling depth is greater than the specified milling depth, the additional material shall be completely removed to the desired underlying pavement surface, as approved, in accordance with COP Supplement 109.4. The milled material shall be removed and disposed of as specified by the City.

The milled surface shall have a maximum mean macrotexture depth of 4.50 millimeters, as determined in accordance with Arizona Test Method 742- Mean Macrotexture Depth of Milled Pavement.

At the start of the milling operation, the Contractor shall mill a 500 foot test section. The milled surface of the test section shall be evaluated by the Engineer for compliance with the maximum mean macrotexture depth requirement. If the milled surface is in compliance with the macrotexture requirement, the Contractor may begin production milling. If the milled surface is not in compliance with the macrotexture requirement, the Contractor shall make adjustments to the milling operation and then mill another test section.

During production milling, the mean macrotexture depth shall be determined at a minimum frequency of 1 test per ½ mile per lane. If, at any time, during the milling operation the Engineer determines that the macrotexture requirement is not being achieved, the Contractor shall stop milling. Milling shall not resume until the Engineer is satisfied that the macrotexture requirement can be met or until successful completion of another test section. The forward speed of the milling machine during production milling shall not exceed the speed used for the test section. The forward speed of the milling machine shall be checked throughout each production day, or at the discretion of the Engineer.

The profile of the milled surface, in both the longitudinal and transverse directions, shall not vary by more than 1/8 inch over a distance of 10 feet.

Under no circumstance shall the removal of existing asphaltic concrete begin until the mix design for replacement asphaltic concrete has been approved by the Engineer.

The extent of removal of existing asphaltic concrete must be in keeping with the Contractor's ability to produce, haul, place and compact replacement asphaltic concrete so that at all times the length of milled surface is at a minimum. If the Contractor's production of replacement asphaltic concrete is stopped for any reason, the removal of asphaltic concrete shall either cease of shall be reduced. The Engineer will be the sole judge as to whether the removal shall cease or be reduced. The Engineer's decision will be based on the reason for the stoppage in asphaltic concrete production, the expected length of the stoppage, the type and depth of the material being removed, and the time of day.

Asphaltic concrete shall be placed as soon as possible after the milling. The surface on which the material is to be placed shall be uniform and free of loose material.

The length of milled surface at any one time shall not exceed 2 miles, or ½ the length of the work, whichever is less. Asphaltic concrete shall be placed on the milled surface before the end of each day's work. The lane shall be opened to traffic at the end of each day's work.

In the event of circumstances beyond the control of the Contractor, such as equipment breakdown, or if the production of the replacement asphaltic concrete has been stopped by the Engineer and the Contractor is unable to comply with the requirements in the preceding paragraph, the Contractor shall provide and maintain

such traffic control devices that the Engineer deems necessary under the circumstances in order to provide safe and efficient passage through the work zone.

If the Engineer deems it to be warranted, the Engineer will require that the Contractor provide for the surface drainage of areas where the pavement surface has temporarily been removed.

Pavement, to be removed by milling, adjacent to manholes, valve boxes, small radius curbs and other fixed objects that produce confined areas shall be removed with milling equipment specifically designed to operate in restricted areas and capable of removing asphaltic concrete of the specified thickness without damage or displacement of the adjacent object. Such areas may be excluded from macrotexture testing at the discretion of the Engineer.

On projects with existing curb and gutter, any asphaltic concrete buildup in the gutter designated to be removed, shall be removed prior to the pavement removal operation by equipment and methods approved by the Engineer. The equipment and methods used shall be capable of removing the asphaltic concrete buildup without causing damage to the curb and gutter.

317.3 MEASUREMENT AND PAYMENT

REMOVE in its entirety and REPLACE with the following:

Payment for milling shall be based on plan quantities at the unit bid price in the bid schedule to include milling and proper disposal of the millings away from the site.

SECTION 321: PLACEMENT AND CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

321.2 MATERIALS AND MANUFACTURE

REMOVE in its entirety and REPLACE with the following:

The materials shall conform to Section 710 of these specifications for the type specified. Warm Mix Asphalt (WMA) technologies shall not be used. The specific required mix type shall be called out in the contract documents or as directed by the Engineer.

321.3 WEATHER AND MOISTURE CONDITIONS

REMOVE in its entirety and REPLACE with the following:

Asphalt concrete shall be placed only when the surface on which the material is to be placed is dry, unfrozen, the atmospheric temperature in the shade is at 40 degrees F and rising, and the temperature of the road surface or subsurface is at 50 degrees F and rising as measured in the shade. No asphalt concrete shall be placed when the weather is foggy or rainy, when precipitation is eminent, or when the base or sub base on which the material is to be placed is unstable. Asphalt concrete shall be placed only when the Engineer or the Engineer's authorized representative determines that weather conditions are suitable and sub base conditions on which the material is to be placed are acceptable.

321.4 APPLICATION OF TACK COAT

REMOVE the first and second paragraphs in their entirety and REPLACE with the following:

A tack coat shall be applied to all existing and to each new course of asphalt concrete prior to the placing of a succeeding lift of asphalt concrete.

The application of the tack coat shall comply with Section 329 of these specifications. The grade of emulsified asphalt shall be SS-1h as specified in MAG Specification 713.

321.6 MIX PRODUCTION

ADD the following:

(A) Stockpiling

(1) Sufficient virgin mineral aggregate material shall be stockpiled at the site of the hot plant to produce the quantity of asphalt concrete required for a minimum of two successive 8 hour shifts; however, this requirement will be modified during the last 2 days production, or under special conditions with the Engineer's approval.

(2) Mineral aggregate shall be stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

(B) Proportioning

(1) No fine material which has been collected in the dust collection system shall be returned to the mixture unless the Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized. If the Engineer so determines, he will authorize in writing the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are accurately and uniformly metered into the mixture.

(2) Mineral aggregate and bituminous material shall be proportioned by volume, by weight, or by a combination of volume and weight.

(3) When mineral aggregate and bituminous material are proportioned by weight, all boxes, hopper buckets or similar receptacles used for weighing materials, together with scales of any kind used in batching materials, shall be insulated against the vibration or movement of the rest of the plant due to the operation of any equipment so that the error in weighting with the entire plant operating shall not exceed 2 percent for any setting nor 1½ percent for any batch. Bituminous material shall be weighed in a heated, insulated bucket suspended from a springless dial scale system.

(4) When mineral aggregate and bituminous material are proportioned by volume, the correct portion of each mineral aggregate size introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder which will supply bituminous material and so arranged that the proportion of each mineral aggregate size can be separately adjusted. The continuous feeder for the mineral aggregate shall be mechanically or electrically actuated.

(C) Drying and Heating

(1) A recording pyrometer or other approved recording thermometric instrument sensitive to a rate of temperature change of not less than 10 degrees F per minute shall be so placed at the discharge chute of the drier in order to record mineral aggregate and to facilitate reading the recorded temperature. A copy of the recording shall be given to the Engineer. The moisture content of the asphalt concrete immediately behind the paver shall not exceed 1 percent.

(D) Mixing

(1) The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials. Mixing shall continue until the uniformity of coating, when tested

in accordance with the requirements of the American Association of State Highway and Transportation Officials (AASHTO) T 195, is at least 95 percent.

(2) A positive signal system shall be provided to indicate the low level of mineral aggregate in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

(3) The temperature of asphalt concrete upon discharge from the mixer shall not exceed 325 degrees F. If the asphalt concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of asphalt concrete will be minimized.

321.8 PLACEMENT

ADD the following:

(A) The Contractor shall stringline finish ABC grade in the presence of the Engineer or the Engineer's authorized representative to verify compliance to specified tolerances prior to the placement of asphalt concrete. Placement of asphalt concrete shall not begin until adjacent Portland cement concrete items have obtained 75 percent of design strength.

(B) The handling of asphalt concrete shall at all times be such as to minimize segregation. Any asphalt concrete which displays segregation shall be removed and replaced.

(C) All wheels and tires of compactors and other equipment shall be wiped when necessary with an approved product in order to prevent the picking up of the asphalt concrete.

(D) Before asphalt concrete is placed, the surface to be paved shall be cleaned of objectionable material.

(E) The base or subgrade upon which the asphalt concrete is to be placed shall be prepared in accordance with the applicable requirements for the material involved and maintained in a smooth and firm condition until placement.

(F) At any time, the Engineer or the Engineer's authorized representative may require that the work cease or that the work day be reduced in the event of weather conditions either existing or expected which would have an adverse effect upon the asphalt concrete.

(G) The temperature of asphalt concrete just prior to compaction shall be at least 250 degrees F but shall not exceed 300 degrees F, unless permitted by the Engineer.

(H) The asphalt concrete shall be placed as a surfacing course. Surfacing courses are defined as courses placed to serve either as a traffic surface or as a surface upon which a finishing course or seal coat is to be placed. The thickness of surfacing courses will be shown on the project plans.

(I) In order to achieve, as far as practicable, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant.

(J) Tapered sections exceeding 8 feet in width or widened sections not exceeding 4 feet in width may be placed and finished by other means approved by the Engineer.

321.8.5 Smoothness

REMOVE the second sentence in its entirety and REPLACE with the following:

Surfacing course surfaces shall not vary more than 1/8 inch from the lower edge of a 10 foot long straightedge when the straightedge is placed parallel to the center of the roadway.

321.9 QUALITY CONTROL

ADD the following:

Contractor Quality Control

(A) General Requirements

(1) It shall be the responsibility of the Contractor to administer a Quality Control Plan (hereinafter, within this section, referred to as "Plan") sufficient to assure a product meeting the requirements of these specifications. The Plan may be operated wholly or in part by a subcontractor or an independent organization; however, the Plan's administration, including compliance with the Plan and its modification, shall remain the responsibility of the Contractor.

(2) The Contractor is required to provide and maintain a Quality Control Plan, along with all the personnel, equipment, supplies and facilities necessary to obtain samples, perform tests, and otherwise assure the quality of the project.

(3) The Contractor shall submit the Plan to the Engineer or the Engineer's authorized representative at the preconstruction conference.

(4) The Contractor shall perform process control sampling, testing and inspection during all phases of the work and shall perform the process control sampling, testing, and inspection at a rate sufficient to assure that the work conforms to the contract requirements. The Contractor shall provide the Engineer a certification stating that all of the testing equipment to be used is properly calibrated and will meet the specifications applicable for the specified test procedures.

(B) Elements of the Plan

(1) The Plan shall address all elements which affect the quality of the asphalt concrete including, but not limited to the following: Mix Design, Aggregate Production, Quality of Components, Stockpile Management, Proportioning, Mixing (including addition of Mineral Admixture, if required), Placing and Finishing, Joints, and Compaction.

321.12 MEASUREMENT

ADD the following:

(A) Measurement under this item shall be to the nearest square yard.

(B) No separate measurement shall be given for the thickened edge, COP GES Detail 201Q and as detailed on project drawings. This work shall be considered incidental and included in the unit price bid in the contract documents. Payment shall be made at the unit price bid in the contract documents for the items complete in place, adjusted for compaction and thickness deficiencies as herein provided.

SECTION 329: TACK COAT

329.3 APPLICATION

REMOVE in its entirety and REPLACE with the following:

(A) The application rate shall be between 0.04 to 0.06 gallons per square yard of diluted material, 50 percent water and 50 percent emulsion, using SS-1h.

(B) The tack coat shall be applied only as far in advance of placing the asphalt concrete as ordered by the Engineer; however, in no event shall the tack coat be applied and not covered by the asphalt concrete in the same day.

329.6 MEASUREMENT

REMOVE in its entirety and REPLACE with the following:

Measurement shall be per ton diluted as placed, based on weight tickets.

SECTION 336: PAVEMENT MATCHING AND SURFACING REPLACEMENT

336.1 DESCRIPTION

REMOVE the second paragraph in its entirety and REPLACE with the following:

Asphalt concrete roadway pavement replacement shall be constructed in accordance with COP GES Detail 200Q-1 and as indicated on the plans.

REMOVE the fourth paragraph in its entirety and REPLACE with the following:

All other surface replacement in the right-of-way but not in paved roadways shall be constructed in accordance with COP GES Detail 200Q-1 and as indicated on the plans.

336.2.1 Pavement Widening or Extensions

REMOVE the second paragraph in its entirety and REPLACE with the following:

The existing pavement shall be cut and trimmed after placement of required ABC and just prior to placement of asphalt concrete for pavement widening or extension, and the trimmed edges shall be painted with a light coating of emulsified asphalt immediately prior to constructing the new abutting asphalt concrete pavements. No extra payment shall be provided for these items and all costs incurred in performing this work shall be incidental to the widening or pavement extension.

336.2.3 Temporary Pavement Replacement

REMOVE the first and second paragraphs in their entirety and REPLACE with the following:

Temporary pavement replacement with UPM in accordance with COP GES Detail 200Q-1 shall be required in right-of-way until permanent hot mix trench pavement replacement can be performed. The Contractor shall install temporary asphalt pavement or the first course of permanent pavement replacement in accordance with Section 336 of these specifications immediately following backfilling and compaction of trenches that have been cut through existing pavement. Except as otherwise provided in Section 336, this preliminary pavement shall be maintained in a safe and reasonably smooth condition until required backfill compaction is

obtained and final pavement replacement is completed. Temporary paving removed shall be hauled from the job site and disposed of by the Contractor at no additional cost to the Agency.

Permanent pavement replacement shall replace temporary repairs within 5 working days after completion of temporary work.

336.2.4.1 Permanent Asphalt Pavement Replacement

ADD the following:

(H) Asphalt concrete trench pavement replacement shall be a minimum 4 inch thickness compacted to 95 percent of laboratory density in accordance with COP GES Details 200P-2, 200Q-1 and MAG Specification 601.6.

(I) Permanent hot mix asphalt concrete pavement replacement shall be required for all trench cuts. Installation of UPM or other high performance cold mix shall not be permitted for permanent installation. The Contractor shall be required to maintain pavement trench cuts to the satisfaction of the Engineer.

(J) The Contractor shall coordinate with the Engineer a minimum of 2 working days in advance of trench paving.

REMOVE the last paragraph in its entirety.

336.3 TYPES AND LOCATIONS OF TRENCH SURFACE REPLACEMENT

REMOVE the first five paragraphs in their entirety and REPLACE with the following:

Normally, the type of pavement replacement and backfill required will be noted on the plans or specified in other portions of the contract documents and construction shall be in accordance with COP GES Detail 200Q-1. If a type is not noted on the plans or specified in the special provisions, the following criteria will govern:

T-Top trench repair will be utilized on all streets per COP GES Detail 200Q-1.

COP GES Detail 200Q-1 trench repair shall be utilized to repair surfaces other than asphalt concrete or Portland cement concrete pavement. It may also be used when the condition of the existing pavement does not justify construction of T-Top trench repair. Prior written approval of the Engineer is required for this condition.

336.4 MEASUREMENT

REMOVE items (A) and (B) in their entirety and REPLACE with the following:

(A) In computing pay quantities for replacement using COP GES Detail 200Q-1, pay widths shall not exceed the maximum widths as depicted on Table 601-1, plus 24-inches for the T-Top.

(B) In computing pay quantities for replacement using COP GES Detail 200Q-1, pay widths shall not exceed the maximum widths as depicted on Table 601-1.

336.5 PAYMENT

ADD the following:

Pavement matching and surfacing replacement shall include all saw cutting, removal and disposal of existing pavement, plus all labor and material for complete installation of permanent pavement replacement. No extra payment will be made for temporary pavement required for maintenance of utility trench cuts or for trench widths in excess of Section 336.4 of these specifications.

SECTION 340: CONCRETE CURB, GUTTER, SIDEWALK, CURB RAMPS, DRIVEWAY AND ALLEY ENTRANCE

340.2 MATERIALS

REMOVE the first sentence in its entirety and REPLACE with the following:

Concrete shall be Class AA unless otherwise noted.

340.2.1 Detectable Warnings

ADD the following:

Detectable warnings shall be Masco Detectable Warning Panels, or approved equal, and in the color Salem Red.

340.3.1 Subgrade Preparation

REMOVE the second paragraph in its entirety and REPLACE with the following:

The subgrade shall be constructed and compacted true to grades and lines shown on the plans and as specified in Section 301 of these specifications. All soft or unsuitable material shall be removed to a depth of not less than 6 inches below subgrade elevation and replaced as directed by the Engineer. Unsuitable material shall be measured and paid in accordance with Section 205.2 of these specifications. The subgrade shall be compacted to not less than 95 percent of the maximum dry density.

All concrete items in this section shall be constructed on a minimum of 4-inches of aggregate base course unless noted otherwise, whether shown on the standard details or not. Aggregate base course shall be compacted to not less than 98 percent of maximum dry density.

ADD the following subsection to 340.3.3 Concrete Placement:

340.3.3.1 Concrete Curb, Gutter, and Curb Terminations

The pavement section (base and sub-base) shall extend to the back of curb.

ADD the following subsection to 340.3.3 Concrete Placement:

340.3.3.1a Single Curb

All single curb shall be constructed to MAG Detail 222.

ADD the following subsection to 340.3.3 Concrete Placement:

340.3.3.2 Concrete Sidewalk, Sidewalk Landing, and Ramp

Concrete sidewalk, sidewalk landings, and ramps shall be in accordance with COP GES Details or as otherwise modified on the plans.

ADD the following subsection to 340.3.3 Concrete Placement:

340.3.3.3 Concrete Driveway Entrances and 6 Inch Concrete Slabs

Portland cement concrete pavement shall contain 6 percent ±1 percent entrained air. Slump shall be a maximum of 3½ inches.

Construction Joints shall be a maximum of 15 feet apart. The Contractor shall submit a jointing pattern for review and approval prior to construction.

Driveways shall include the curb returns to the existing grades as shown on MAG Detail 251 and modified by the driveway details in the plans. All concrete used in the driveways and adjacent sidewalk crossings shall be 6 inches thick.

Match up construction shall include 10 feet of replacement driveway surfacing from the new top of sidewalk to the existing driveway elevations behind the sidewalk unless otherwise shown on the plans.

ADD the following subsection to 340.3.3 Concrete Placement:

340.3.3.4 Concrete Valley Gutter

All concrete valley gutter shall be constructed on a minimum 8 inch thick aggregate base course, whether shown on the standard details or not.

340.3.10 Deficiencies

REMOVE in its entirety and REPLACE with the following:

Any section of the work deficient in depth or not conforming to the plans or specifications shall be removed and replaced by the Contractor at no additional cost to the City. Replacement or reconstruction shall be from joint to joint.

Concrete work that does not comply with tolerance requirements of MAG Specification 340.3.9 shall be removed and replaced. Remove and replace gutters that exceed the ponding tolerance. Grinding shall only be allowed if approved by the Engineer.

No placement of asphalt shall occur unless the Contractor receives acceptance from the Engineer for all concrete work, such as, but not limited to: curb and gutter, gutter, raised median, concrete sidewalks and ramps, and valley gutter.

It shall be the Contractor's responsibility to submit for approval in advance of any paving operations such that concrete work can be inspected, and deficient work can be removed and replaced by the Contractor. The Contractor shall make necessary removals, replacements and corrections at no additional cost to the City. The Contractor shall not receive any time extension for removal, replacements and corrections of deficient work unless approved by the Engineer. The Contractor shall not receive any time extension for failure to notify the City in a timely manner for inspection before paving operations.

Approval shall be a written document from the Engineer. Verbal approval shall not be accepted.

340.5.2 Concrete Flat Work

REMOVE in its entirety and REPLACE with the following:

Sidewalks, driveways, alley intersections, valley gutters, curb ramps and aprons, to include spandrels, will be measured to the nearest square foot complete in place. When concrete sidewalks, sidewalk ramps, driveways, alley intersections, valley gutters, curb ramps, aprons and/or spandrels are cut during trenching operations, the square foot measurement for payment will be in accordance with Section 336 of these specifications.

340.5.3 Curb Ramp Installation

REMOVE in its entirety and REPLACE with the following:

Curb ramp installation shall be measured in accordance with Section 340.5.2 of these specifications. Detectable warnings are an integral part of curb ramp installations and shall not be measured or paid separately.

Perpendicular curb ramps shall include the area from the back of curb between the outer edges of the ramp wings to the top of the curb ramp, ending prior to and excluding the top landing. The top landing area shall be measured as sidewalk in accordance with Section 340.5.2. Ramp curbs area an integral part of the perpendicular curb ramp installation and shall not be measured or paid separately.

Parallel and combination curb ramps shall include the ramp area between the ramp curb and the back edge of the roadway curbing. Ramp curbs are an integral part of parallel curb ramp and combination curb ramp installations and shall not be measured or paid separately.

ADD the following subsection to 340.5 Measurement:

340.5.4 Aggregate Base Course

Aggregate base course shall be considered incidental to all items in this section.

340.6 PAYMENT

ADD the following:

Aggregate base course shall be considered incidental to all items in the section.

No separate measurement or payment for the curb returns and transition curbs for driveways shall be made.

SECTION 345: ADJUSTING FRAMES, COVERS AND VALVE BOXES

345.1 DESCRIPTION

REMOVE the second paragraph in its entirety and REPLACE with the following:

All frames, covers, valve boxes, manholes, etc., shall be adjusted to finished grade after placement of asphalt concrete surface course by the Contractor in accordance with the standard details. Adjustments shall be completed within 15 working days of completion of paving.

The Contractor shall remove old frames and covers and install new frames and covers in accordance with the contract documents.

345.3 ADJUSTING FRAMES

REMOVE the second paragraph in its entirety and REPLACE with the following:

Frames shall be set to the elevations and slopes established by the Engineer and shall be firmly blocked in place in accordance with COP GES Detail 422Q. Spaces between the frame and the old seat shall be sealed on the inside to prevent any concrete from entering the hand hole or manhole. Class AA concrete shall be placed around and under the frames to provide a seal and properly seat the frame at the required elevation and slope.

A single No. 4 rebar hoop will be placed in each concrete collar in accordance with the respective detail. The hoop diameter shall be such that its placement is centered between the edge of the manhole frame or valve box, and the outer edge of the concrete collar, the depth of the hoop shall be centered in the thickness of the collar. Each concrete ring shall be scored radially at quarter-circle points. Score lines shall be ¼ -inch wide by ½ - inch deep. The concrete collar surface shall be rough broom finished. (See COP GES Details 270Q and 422Q)

Existing frames and covers shall be salvaged to the City. All salvaged items shall be delivered to the City Wastewater Collections facility, located at 1505 Sundog Ranch Road, and placed as directed by the Engineer.

REMOVE the fourth paragraph in its entirety and REPLACE with the following:

After removal of the temporary asphalt pavement in the area of adjustment, and prior to placement of the final concrete collar ring (as shown on COP GES Details 270Q and 422Q) the asphalt pavement in proximity of the adjustment shall be rolled with a self-propelled steel wheel roller if requested by the Engineer.

Traffic shall not be allowed on the concrete collars until the concrete has reached a minimum compressive strength of 2,500 psi on residential and 3,000 psi on collector and major streets. On major streets the Contractor shall use "high-early" in the concrete mix, approved by the Engineer, to minimize delay in reopening the street(s) to traffic.

345.4 ADJUSTING VALVE BOXES

REMOVE in its entirety and REPLACE with the following:

Valve boxes shall be adjusted to the new elevations indicated on the plans, or as established by the Engineer.

New valve box top risers and caps shall be furnished by the Contractor at existing water valve locations and placed as directed by the Engineer. New valve box top risers and caps shall be considered incidental to the cost of adjustment.

Existing valve box risers and caps shall be salvaged to the City. All salvaged items shall be delivered to the City Water Operations facility, located at 1481 Sundog Ranch Road, and placed as directed by the Engineer.

A single No. 4 rebar hoop will be placed in each concrete collar in accordance with the respective detail. The hoop diameter shall be such that its placement is centered between the edge of the manhole frame or valve box, and the outer edge of the concrete collar, the depth of the hoop shall be centered in the thickness of the collar. Each concrete ring shall be scored radially at quarter-circle points. Score lines shall be ¼ inch wide by ½ inch deep. The concrete collar surface shall be rough broom finished. (See COP GES Detail 391Q)

Traffic shall not be allowed on the concrete collars until the concrete had reached a minimum compressive strength of 2,500 psi on residential and 3,000 psi on collector and major streets. On major streets the Contractor shall use "high-early" in the concrete mix, approved by the Engineer, to minimize delay in reopening the street(s) to traffic.

Add the following subsection to 345.4 Adjusting Valve Boxes:

345.4.1 Adjusting Meter Boxes

Meter boxes shall be adjusted to the new elevations indicated on the plans, or as established by the Engineer.

Additional meter box sections, concrete, and miscellaneous items required to protect the utility in accordance with the respective standard detail shall be considered incidental to adjusting the meter box.

345.5 ADJUSTING MANHOLE AND VALVE COVERS WITH ADJUSTMENT RINGS

REMOVE in its entirety and REPLACE with the following:

Existing sanitary sewer manhole and covers shall be salvaged to the City. All salvaged items shall be delivered to the City Wastewater Collections facility, located at 1505 Sundog Ranch Road, and placed as directed by the Engineer.

Adjusting rings may be used to raise manhole covers in conformance to the dimensions noted on COP GES Detail 420Q-1. The amount of adjustment, thickness of seal or overlay, and cross slope will be considered when using adjusting rings. Each location where an adjusting ring is used must have a sufficient depth of asphalt to assure the proper installation and operation of the ring. The rings shall be made of concrete and installed per the manufacturer's specifications. The rings shall be approved by the Engineer.

The concrete collar ring around the frame or valve box shall be circular, shall be a minimum of 8 inches thick, struck off and finished ¼ inch below with the adjacent new pavement surface. Concrete shall be a minimum of Class AA. All concrete shall be obtained from plants approved by the Engineer.

A single No. 4 rebar hoop will be placed in each concrete collar in accordance with the respective detail. The hoop diameter shall be such that its placement is centered between the edge of the manhole frame or valve box, and the outer edge of the concrete collar, the depth of the hoop shall be centered in the thickness of the collar. Each concrete ring shall be scored radially at quarter-circle points. Score lines shall be ¼ inch wide by ½ inch deep. The concrete collar surface shall be rough broom finished. (See COP GES Detail 270Q)

Traffic shall not be allowed on the concrete collars until the concrete has reached a minimum compressive strength of 2,500 psi on residential and 3,000 psi on collector and major streets. On major streets the Contractor shall use "high-early" in the concrete mix, approved by the Engineer, to minimize delay in reopening the street(s) to traffic.

All machined surfaces on the frame and cover shall be such that the cover will lie flat in any position in the frame and have a uniform bearing through its entire circumference. Any frame and cover which creates any noise when passed over by automobiles shall be replaced by the Contractor at the Contractor's expense.

345.6 MEASUREMENT

ADD the following:

Measurement for adjusting existing frames, covers, valve boxes, and water meter boxes to finished grade shall be the actual number of each type adjusted and accepted.

Measurement for adjusting new frames, covers, valve boxes, and water meter boxes shall not be measured as adjustment to finished grade is considered incidental to installation of the respective item.

SECTION 350: REMOVAL OF EXISTING IMPROVEMENTS

REMOVE the section in its entirety and REPLACE with the following:

350.1 DESCRIPTION

The work under this section shall consist of the removal, wholly or in part, and satisfactory disposal of all structures and obstructions within the right-of-way which have not been designated on the project plans or specified in the special provisions to remain, except for those structures and obstructions which are to be removed and disposed of under other items of work in the contract. The work shall also include salvaging of designated materials and backfilling the resulting cavities.

Existing structures, pavement, sidewalks, curbs, gutters and other existing improvements which are to become an integral part of the planned improvements shall remain even though not specifically noted.

Materials removed and not designated to be salvaged or incorporated into the work shall become the property of the Contractor.

All existing utilities not designated for removal shall remain in place and be protected against damage.

The removal of existing improvements shall be conducted in such a manner as not to damage active utilities or any portion of the improvement that is to remain in place.

350.2 CONSTRUCTION REQUIREMENTS

Bridges, culverts and other structures in use by traffic shall not be removed until l satisfactory arrangements have been made to accommodate the traffic. Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to commencing the new work.

Items designated to be salvaged shall be carefully stockpiled or stored by the Contractor at locations designated in the special provisions or as directed by the Engineer.

Items which are to be salvaged or reused in the new construction and are damaged or destroyed as a result of the Contractor's operations shall be repaired or replaced by the Contractor at no additional cost to the City.

Holes, cavities, trenches and depressions resulting from the removal of structures or obstructions, except in areas to be excavated, shall be backfilled with suitable material which shall be compacted to a density of not less than 95 percent of the maximum density as determined in accordance with the requirements of Section 601 or Section 211 of these specifications. Backfill of all excavated areas below structures shall be in accordance with MAG Specification and COP Supplement 206.4.

350.3 REMOVAL OF PAVEMENT

(A) Portland Cement Concrete Pavement: Unless otherwise specified in the special provisions, concrete pavement designated on the project plans to be removed shall be removed from the job site and disposed of at a site secured by the Contractor.

Where new construction is to join the existing concrete pavement, the pavement shall be saw cut to a true line perpendicular to the centerline of the pavement with straight vertical edges free from irregularities.

(B) Bituminous Pavement: Unless milling is noted on the plans or is a bid item, all bituminous pavement designated on the project plans to be removed, shall be completely removed down to the underlying base course or subgrade. The pavement material shall be removed and disposed of at a site secured by the Contractor.

Where new construction is to join existing bituminous pavement, the existing pavement shall be cut to a true line perpendicular to the centerline of the pavement with straight vertical edges free from irregularities. The removal of asphaltic concrete at the approaches to structures shall be accomplished in a manner approved by the Engineer.

350.4 REMOVAL OF STORM PIPE AND CULVERTS

All removed pipe which is to be salvaged or re-laid shall be cleaned of all earth and other material inside and outside prior to being stockpiled or reused. Pipe to be reused shall be stored when necessary to avoid damage or loss before relaying.

Existing pipe to be partially removed shall be cut with straight and smooth edges on a plane perpendicular to the center line of the pipe.

Pipe that is not salvaged shall become property of the Contractor, removed from the project, and disposed of properly.

350.5 REMOVAL OF MISCELLANEOUS CONCRETE

Miscellaneous concrete shall be defined as all or portions of mortared rubble masonry, curbs, gutters, sidewalks, driveways, aprons, slope paving, island paving, retaining walls, spillways, drainage structures, concrete box culverts, foundations, footings and all other Portland cement concrete or masonry construction, except bridges and pavement. All existing miscellaneous concrete shall be removed to a depth of at least 5 feet below finished subgrade elevation unless otherwise noted on the project plans or special provisions. Other specification sections that discuss removal of concrete items shall supersede the provisions in this section.

Where new concrete is to join existing concrete, the existing concrete shall be saw cut to a true line with straight vertical edges free from irregularities.

Concrete removal operations shall be performed without damage to any portion that is to remain in place. All damage to the existing concrete, which is to remain in place, shall be repaired to a condition equal to that existing prior to the beginning of removal operations. The repairing of existing concrete damaged by the Contractor's operations shall be at no additional cost to the City.

Existing reinforcement that is to be incorporated in new work shall be protected from damage and shall be thoroughly cleaned of all adhering material before being embedded in new concrete.

Concrete shall be disposed of as provided in 350.3(A).

The floors of concrete basements, pits and structures that are located within the right-of-way shall be completely removed.

350.6 REMOVAL OF UTILITIES

Removal of water mains, sewer mains, and related appurtenances shall be in accordance with COP Supplement 650 and 651, respectively.

All existing utilities not designated for removal shall remain in place and be protected against damage.

A utility may be abandoned in place below a new major structure that is part of the work only if approved by the Agency and solidly filled with grout using methods approved by the Agency. All abandoned utilities to remain and the approved abandonment method shall be noted on the installation record drawings.

Utilities to be removed by the Contractor shall be disconnected and taken out in accordance with the requirements of the utility owner to the limits shown on the plans. Utility removal shall not be performed until a release has been obtained from the utility stating that their respective service connection and appurtenant equipment have been disconnected, removed or sealed and plugged in a safe manner.

The Engineer shall be notified when utilities are encountered that are not shown on the plans.

350.6.1 Removal and Disposal of Asbestos Cement Pipe

(A) Background

Asbestos Cement Pipe (ACP) is a mixture of Portland cement and asbestos fibers. It was introduced into North America in 1931 and by 1953 the American Water Works Association (AWWA) had established standards for ACP. Along with many other cities, ACP water mains were installed in the city of Prescott and as a consequence, we have a considerable quantity of this material in service. Some of these mains are old and need to be replaced; some are undersized and need to be upsized; and others are in conflict with new utility installations and need to be relocated. These actions require all or part of the existing ACP system to be removed and disposed. Subsequent to ACP's introduction into the United States, the EPA determined that asbestos, in an airborne condition, is a hazardous material and established laws/guidelines for the handling and disposal of the material. The Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) establishes requirements for the removal and disposal of regulated asbestos containing materials. This policy statement establishes procedures and identifies responsibilities for the proper handling of asbestos-cement pipe in conformance with the Asbestos NESHAP requirements in effect as of November 1990.

NOTE: As used herein, the term “Excavator” shall refer to that entity (individual or contractor) which actually excavates and exposes the pipe. The term “Generator” means any owner or operator of a source (covered by the regulation) whose act or process produces asbestos containing waste material. The term “extra cost” shall refer to the cost over and above the removal and disposal of the pipe in a non-friable state.

(B) Policy

(1) It is the intent of the City to comply with the requirements of the Asbestos NESHAPS found at 40 CFR Part 61, Subpart M. This Policy Statement will establish procedures to be used by all Excavators in the removal and disposal of ACP in compliance with NESHAPS. Nothing in this Policy Statement shall be construed to void any provision of a contract or other law, ordinance, regulation or policy whose requirements are more stringent.

(2) ACP is defined under NESHAPS as a Category II, non-friable, non-regulated material in its intact state but which may become friable upon removal, demolition, and/or disposal. Consequently, if the removal/disposal process renders the ACP friable, it is regulated under the disposal requirements of 40 CFR 61.150. If more than 260 linear feet of ACP is removed which on removal will become friable, a NESHAPS notification must be filed with the Yavapai County Environmental Services Department. The notification must be filed at least 10 days prior to removal of the material. If it remains in its non-friable state, as defined by the NESHAPS, it can be disposed as a conventional

construction waste. EPA defines friable as material, when dry, which may be crumbled, pulverized or reduced to powder by hand pressures.

(3) The Generator of the hazardous material is responsible for the identification and proper handling, transportation, and disposal of the material. Therefore, it is the policy of the City that if the actions of the Excavator cause the material to become friable, and therefore subject to the regulations, that the Excavator becomes the Generator.

(4) The requirements of A.R.S. § 40-360.21 through 40-360.32 (Blue Stake Law) are important with respect to implementation of this policy statement. The Blue Stake Law mandates the owner of the facility (in this case the City) to maintain installation records and, upon request, to properly locate the underground facility. The law also places requirements on the Excavator to:

(a) Call Arizona 811 at least 2 working days prior to the start of excavation.

(b) Mark the boundaries of the location to be excavated.

(c) Excavate in a careful and prudent manner, including hand digging within 24 inches of the underground facility.

(d) Notify the City if the Excavator encounters an underground facility that has not been located and marked or has been marked in the wrong location.

If the Excavator does not comply in full with Arizona 811 requirements and therefore causes non-friable ACP to become friable, any and all extra costs incurred to handle, containerize, transport, and dispose of the asbestos containing waste shall not be paid or reimbursable by the City. If Arizona 811 requirements are met and ACP is accidentally or unknowingly disturbed thereby causing it to become friable, the Excavator may seek reimbursement from the City for additional costs to handle, containerize, transport and dispose of the material following the procedures described herein.

(5) The Contractor shall retain the services of an independent, qualified, licensed asbestos abatement Consultant. All removal and disposal of ACP shall be under the cognizance of the Consultant. The Excavator is responsible to contact the Consultant a minimum of 2 working days prior to the initiation of removal/disposal operations.

The Consultant will monitor the Excavator's work. If the ACP was not planned for removal and the Excavator accidentally disturbs the pipe, the Excavator will cease all work and notify the Engineer immediately for further instructions.

(6) It is the intent of the City that all ACP shall be removed in such careful and prudent manner that it remains intact and non-friable. The Excavator is responsible to deploy the means, methods, techniques, and sequences to ensure this result. When it is a practical impossibility, as determined by the Engineer, to remove the ACP without creating a friable material, the City will pay the Excavator for the removal of friable material in accordance with the measurement and payment section. The Excavator shall take steps to minimize the amount of the friable waste and abide with all asbestos regulatory requirements. The Consultant shall be available to provide recommendations or suggestions, which the Excavator may or may not choose to deploy. The Consultant shall measure or otherwise assess and recommend to the Engineer the amount or percentage of friable waste for which the City should pay for removal and disposal with the remainder being the responsibility of the Excavator. If the ACP is caused to become friable, the Consultant shall conduct perimeter air monitoring upon request by the City. If the Excavator fails to notify the Consultant, fails to excavate and remove the ACP in a careful and prudent manner creating friable material or fails to abide with all asbestos regulatory requirement, the Excavator shall be deemed to be the Generator responsible to handle, transport and dispose of the ACP in accordance with the NESHAPS requirements and will not be reimbursed for any cost incurred. This will include all penalties and associated legal fees of the Generator as well as any penalties assessed against the City, and any associated legal fees incurred by the City for violation of any of the asbestos regulatory requirements that are caused by the Excavator.

(7) ACP shall NOT be crushed and left in place.

(8) Compliance with all aspects of worker safety and health regulations including but not limited to the OSHA Asbestos Standard is the responsibility of the Excavator. The City assumes no responsibility for compliance programs which are the responsibility of the Excavator.

(9) Payment for removal of non-friable existing asbestos cement pipe shall be at the unit bid price shown in the bidding schedule for complete removal, proper disposal and trench backfill in accordance with the specifications.

(10) Payment for removal of friable existing asbestos cement pipe shall be a contingent item at the unit bid price shown in the bidding schedule for complete removal, proper disposal and trench backfill as determined by the Engineer in accordance with this section and other provisions of the specifications.

350.7 REMOVAL OF SIGNS AND DELINEATORS

Street signs, traffic control signs, traffic signal material and control devices shall be removed as designated on project drawings, salvaged and delivered to the City at the site designated by the Engineer. The Contractor shall dismantle the sign panels and delineators and remove the sign posts from the ground in such a manner as to prevent damage to the posts. The Contractor shall not remove the existing signs prior to the completion of the new sign installation, but shall remove them within 5 working days after the installation of the new signs or as directed by the Engineer.

350.8 REMOVAL OF FENCE

All fence to be removed, shall become the property of the Contractor unless designated for salvage on the project plans. If fence is designated to be removed and salvaged, all fence, including gates shall be salvaged in accordance with the requirements of 202-3.01.

When designated for salvage, fence and gates shall be carefully dismantled and neatly rolled or coiled. Posts shall be cleaned of all concrete and dirt.

In areas where new fence or relocated fence is to be installed, the Contractor shall perform the removals in such a manner as to prevent the escape of any livestock and/or domestic pets, including the placement and removal of temporary fence when necessary.

350.9 REMOVAL OF GUARDRAIL

All guardrail to be removed shall become the property of the Contractor unless otherwise specified on the project plans.

If guardrail is designated to be removed and salvaged, the Contractor shall carefully dismantle the guardrail and remove the blocks and posts in such a manner as to prevent any damage to the removed items. The guardrail, including panels, end sections, posts and all hardware shall be salvaged in accordance with the requirements of 350.2.

350.10 MEASUREMENT AND PAYMENT

No separate measurement or payment shall be made for removal of existing improvements unless otherwise noted on the plans or there being removal bid items. This work shall be considered incidental and included in the unit price bid for construction of the appropriate contract pay items.

Measurement for non-friable and friable asbestos cement pipe shall be by the linear foot of pipe removed.

Payment for removal of non-friable existing asbestos cement pipe shall be at the unit bid price shown in the bidding schedule for complete removal, proper disposal and trench backfill in accordance with the specifications.

Payment for removal of friable existing asbestos cement pipe shall be a contingent item at the unit bid price shown in the bidding schedule for complete removal, proper disposal and trench backfill as determined by the Engineer in accordance with paragraphs E and F and other provisions of the specifications.

PART 400 – RIGHT-OF-WAY AND TRAFFIC CONTROL

SECTION 401: TRAFFIC CONTROL

401.1 DESCRIPTION

REMOVE in its entirety and REPLACE with the following:

Traffic control is the responsibility of the Contractor and shall be performed in accordance with this section and the US Department of Transportation Federal Highway Administration's Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), latest edition with the latest revisions, Prescott Traffic Barricade Manual, and the project plans.

(A) Prior to beginning the project, the Contractor shall submit to the City, for approval, a traffic control plan for all activities connected with the proposed work. He must obtain approval from the Engineer for the traffic control plan and schedule prior to any construction. The Contractor shall submit the traffic control plan to the Engineer at or before the project preconstruction conference.

(B) Written notice shall be given to the Engineer or the Engineer's authorized representative on the job 48 hours prior to any changes in detours or routes of access. The notice shall give specific details with maps showing the access to all residences and businesses affected by the project.

(C) The City Police and Fire Departments shall be continually updated on access routes along and through the site during construction.

401.2 TRAFFIC CONTROL DEVICES

ADD the following:

(C) All traffic control devices required for the project shall be the responsibility of the Contractor.

(D) When required to cross, obstruct, or close a street, traffic way, or sidewalk for a short duration that is approved by the Director, the Contractor shall provide and maintain suitable bridges, detours or other approved temporary means for the accommodation of vehicular and pedestrian traffic.

(E) When traffic conditions at the construction site warrant the use of certified police personnel to direct traffic, arrangements shall be made with the City Police Department, Yavapai County Sheriff's Office, or Department of Public Safety for off-duty officers.

401.3 FLAGMEN OR PILOT CARS

REMOVE in its entirety and REPLACE with the following:

The Contractor shall provide sufficient certified flagmen, uniformed off-duty law enforcement officers and pilot cars to expedite the safe passage of traffic through the work zone as determined by the Engineer.

Any individual who is stationed in a work zone to provide temporary traffic control (flagmen) or to drive a pilot car shall have completed training and be certified in flagging through a program that meets the training and certification standards of the National Safety Council flagger training program, the American Traffic Safety Services Association (ATSSA) flagger program or an equivalent program that meets the same objectives. An equivalent program must be approved by the Director and meet the US Department of Transportation Federal Highway Administration's Standards for the control of traffic through highway work zones as defined in the manual on uniform traffic control devices for streets and highways. This training and certification shall be renewed at least once every 4 years. It is the Contractor's responsibility to provide the certifications to the Engineer before flagmen engage in the traffic control and/or temporary traffic control. This section does not apply to law enforcement personnel who are employed by governmental entities. Should appropriately trained flaggers not be present, the City, at its discretion may cease operations until appropriately trained flaggers can be provided on-site.

401.6 MEASUREMENT

REMOVE in its entirety.

401.7 PAYMENT

REMOVE in its entirety.

ADD the following subsection to Section 401- Traffic Control:

401.8 MEASUREMENT AND PAYMENT

Payment for traffic control shall be at the applicable unit price bid in the contract documents.

(A) Preparation of traffic control plan shall be inclusive of all submittals, reviews and if needed, re-submittals.

(B) Flaggers shall be per hour for actual time directing traffic. It does not include travel time or time spent setting up or taking down devices.

(C) In the event off-duty police personnel are required to direct traffic, the bid schedule includes an allowance for certified police personnel for the purpose of encumbering funds to cover the cost of certified police personnel. The amount of the allowance is determined by the Engineer and is not subject to individual bid pricing. All bidders shall incorporate the amount in the bid proposal and shall reflect the same in the total bid for the project.

It shall be understood that this allowance is an estimate only. The allowance shall be not used without approval of the Engineer.

Reimbursement for certified police personnel shall be based on actual cost, plus an allowable markup to the prime Contractor of 15 percent, for use of certified police personnel approved by the Engineer.

Flagmen, uniformed off-duty law enforcement officers or pilot cars, with driver, will be measured by the hour for each individual, including vehicle and equipment, required to perform traffic control. When an officer is

used less than 3 hours, a minimum of 3 hours will be charged. Anything over 3 hours will be measured by the hour.

Payment will be made at the contract bid price in the proposal for uniformed, off-duty law enforcement officer. If the officer is utilized in excess of 8 hours in any calendar day or in excess of 40 hours in any calendar work week, payment shall be at the rate of 1½ times the contract bid price for all hours worked in excess in either of the above time periods.

(D) Barricades and storage shall be at the lump sum bid and shall be inclusive of all temporary signs and devices in the traffic control plan and as required by the MUTCD, COP Traffic Barricade Manual and the Engineer.

(E) Message boards shall be measured by each per day as determined necessary by the approved traffic control plan and the Engineer.

(F) Pilot car and driver shall be per hour for actual time used as required by the approved traffic control plan and the Engineer. It does not include travel time or time spent setting up or taking down devices.

(G) Incidental traffic related items shall include all other pertinent tools, equipment, devices and or work required to provide safe and effective traffic control in accordance with the approved traffic control plan, the MUTCD and the Engineer.

ADD the following section to Part 400- Right-of-Way and Traffic Control:

SECTION 402: PAVEMENT MARKINGS AND STRIPING

402.1 THERMOPLASTIC PAVEMENT MARKINGS

Work under this item shall be performed per ADOT Specification 704.

(A) Stop Bars and Crosswalks: Work under this item shall consist of the application of thermoplastic striping material at the locations noted on the project plans. All stop bars shall be 18 inches in width unless otherwise specified. Crosswalks shall be 12 inches in width.

(B) Measurement shall be in accordance with ADOT Specification 704-5 (width times length divided by 4 inches equals LF as shown in bid schedule).

(C) Pavement Markings: Pavement markings shall be in accordance with ADOT Specifications 704-4, ADOT 4-M 1.12 through 4-M 1.17, and as modified herein. Work under this item shall consist of the application of thermoplastic striping material at the locations noted on the project plans.

402.2 TEMPORARY STRIPING

Work under this item, temporary striping (paint) where required, shall be performed per ADOT Specification 701-3.05.

402.3 PERMANENT PAVEMENT MARKINGS

Work under this item shall be performed per ADOT Specification 708.

402.4 MEASUREMENT AND PAYMENT

Measurement and payment for pavement markings shall be at the per each basis for each legend or marking installed in accordance with ADOT Specification 704-5.

Measurement and payment for temporary striping shall be per ADOT Specifications 708-4 and 708-5.

Measurement for permanent pavement markings shall be in accordance with ADOT Specification 708-4 (width times length divided by 4 inches equals LF as shown in bid schedule). Payment for permanent pavement markings shall be in accordance with ADOT Specification 708-5.

ADD the following section to Part 400- Right-of-Way and Traffic Control:

SECTION 403: PERMANENT SIGNING, SIGN POSTS AND DELINEATORS

403.1 DESCRIPTION

Work under this item shall be done in accordance with the project drawings and requirements of the Manual MUTCD, MAG Detail 131, and ADOT Signing and Marking Standards.

403.2 GENERAL SIGNING GUIDELINES

(A) All signing shall conform to the most recent editions of the publications shown above with regard to size, color, shape and placement.

(B) All signs shall be new (other than those shown to be relocated). All new and relocated signs shall be mounted on new posts with new hardware. Signs designed for installation on existing street light poles shall be mounted with new hardware.

(C) Traffic sign dimensions, colors and lettering shall conform to the latest MUTCD Specifications. Traffic sign size shall be standard unless otherwise specified here or on the plans.

(D) All non mountable curb section signs shall be located at least 2 feet from the curb face to the nearest edge of the sign. All other roadways signs shall be mounted from 6 feet to 12 feet from the edge of the pavement to the nearest edge of the sign, unless otherwise noted in the sign summary table or on the plans.

(E) Roadways with guardrail signs shall be located at least 6 feet from the face of the guard rail to the nearest edge of the sign, unless otherwise noted in the sign summary table or on the plans.

(F) Sign location shall be coordinated with landscaping plans to ensure sign visibility per AASHTO Standards.

(G) Signs shall be mounted on street light poles whenever feasible.

(H) All signs installed in areas where parking or pedestrian movements occur shall typically be erected at a height of 7 feet above the normal edge of pavement or sidewalk to the bottom of the sign or to the lowest sign in a multiple sign installation assembly with the following exceptions:

(1) The height to the bottom of a secondary sign mounted below another sign may be up to 2 feet less than the height specified above.

(2) If the bottom of a secondary sign that is mounted below another sign is mounted lower than 7 feet above a pedestrian sidewalk or pathway, the secondary sign shall not project more than 4 inches into the pedestrian facility.

(3) Object markers shall be installed at least 4 feet above the normal edge of pavement.

(I) All R1-1 "STOP" signs and pedestrian warning signs shall be reflective with all reflective sheeting material to be diamond grade.

(J) All other signs are to be reflective with all reflective sheeting material to be high intensity prismatic meeting or exceeding ASTM D4956-04.

(K) Sign blanks shall be 5052-H38 alloy treated aluminum with Alodine 1200 conversion coating, 0.080 inch thick with rounded corners.

(L) Stop signs are to be shown at all local street intersections within a subdivision unless an engineering study shows that no control or yield control is warranted. Stop signs shall be designed and shown at all collector and non signalized arterial street intersections.

(M) Stop signs and Yield signs shall be a minimum of 30 inches in width. When specified by the City Traffic Engineer 36 inch and/or 48 inch signs may be required on major collectors and arterial streets.

403.3 SIGN POSTS

(A) Sign posts shall conform to the COP GES Detail 131Q.

(B) For new construction the Telspar, Uni-strut or approved equal 12 gauge, galvanized steel, 4 sided perforated square tubing is required. Two inch tubing shall be used for smaller signs while 2½ inch tubing shall be used for the larger signs.

(C) The post shall be tall enough to provide the minimum clearances specified in COP GES Detail 131Q.

(D) The base and sleeve system for the sign shall be anchored in a minimum of a 24 inch deep, 12 inch diameter foundation of concrete. The base shall have a breakaway slip base system. The exposed post from the base shall be 4 inches to 6 inches high.

(E) Signs over 48 inches wide shall be mounted on two, 2½ inch posts with a horizontal support frame.

(F) All station locations are approximate. The Contractor shall verify actual sign locations with the Engineer prior to the installation of all signs.

(G) The Contractor shall verify post lengths and elevations prior to installation.

403.4 MEASUREMENT AND PAYMENT

Measurement and payment shall be the unit price per each for posts and delineators and per square foot for sign panels, complete and in place.

ADD the following section to Part 400- Right-of-Way and Traffic Control:

SECTION 404: LOOP DETECTORS

404.1 QUADRUPOLE LOOP DETECTORS

(A) Loop detectors shall be installed in base course of asphalt concrete pavement and conform to ADOT Specifications 735 and 732-2.01, ADOT Traffic Signals and Lighting Standard Drawings (2010) 7-1. All

loop detectors shall be installed per ADOT Signals and Lighting Standard Drawing T.S. 7-1, Sheet 2. Installation shall include the home runs and installation of loop wiring into the existing signal cabinet. The hardwiring in the cabinet will be accomplished by City forces unless otherwise specified.

(B) Prior to bidding, the Contractor shall verify the location and layout of the existing detector loops and appurtenant home runs to ensure that home runs are re-established in their original configuration. Loop detectors shall be centered in lanes. The Contractor shall verify loop layout with the Inspector prior to installation.

404.2 MEASUREMENT AND PAYMENT

Measurement shall be a complete quadrupole loop installation. Payment shall be made on a per each installed basis.

SECTION 405: SURVEY MONUMENTS

405.1 DESCRIPTION

ADD the following:

All efforts shall be made to protect survey monuments from being disturbed or damaged. Monuments shall be: 1) re-established by a Registered Land Surveyor at the Contractor's expense if disturbed, damaged or covered, and 2) located by a Registered Land Surveyor where noted on plans.

All survey monuments, including but not limited to street centerline monuments, benchmarks, control points, and property corner monuments shall not be moved or otherwise disturbed by the Contractor until an authorized agent of the agency having jurisdiction over the survey monuments has witnessed or otherwise referenced their location, and only then in accordance with the requirements of the agency having jurisdiction. Any survey monuments uncovered, found, damaged, defaced, disturbed, removed, or displaced by the Contractor shall be replaced at the Contractor's expense.

405.2 MATERIALS

REMOVE the first paragraph in its entirety and REPLACE with the following:

The concrete portion of monuments shall be constructed in accordance with the provisions in Sections 725 and 505 of these specifications. Concrete shall be Class AA.

405.3 CONSTRUCTION

REMOVE the fourth paragraph in its entirety.

ADD the following:

Frames, covers and concrete shall be installed per COP GES Detail 120Q.

405.5 PAYMENT

ADD the following:

No separate payment shall be made for resetting property monuments. This work shall be considered incidental and included in the unit price bid for construction or installation of the appropriate contract pay items.

Payment for survey monuments shall be based on a per each unit complete in place.

SECTION 430: LANDSCAPING AND PLANTING

430.3.2 Seeding

REMOVE in its entirety and REPLACE with the following:

430.3.2 Seeding (Hydraulic)

(A) Seeding consists of furnishing and applying chemical fertilizer; furnishing and planting seed and furnishing, applying and affixing mulch. The areas to be seeded are disturbed or un-vegetated areas. Slopes are required to be seeded immediately upon completion; coordination with grading operations will be required.

Application rates of seed as specified are for Pure Live Seed (PLS). PLS is determined by multiplying the sum of the germination and hard or dormant seed by purity. Weed content of seed shall not exceed 0.5 percent. No substitution of species, strain or origin of seed will be allowed unless evidence is submitted in writing by the Contractor to the Engineer showing that the specified materials are not reasonably available during the contract period. The substitution of species, strains or origins shall be made only with the written approval of the Engineer, prior to making said substitution.

The seed shall be delivered to the project site in standard, sealed, undamaged containers. Each container shall be labeled in accordance with A.R.S. § 3-231 through 3-243 and the US Department of Agriculture rules and regulations under the Federal Seed Act. Labels shall indicate the variety or strain of seed, the percentage of germination, purity and weed content, and the date of analysis, which shall not be more than 9 months prior to the delivery date.

(B) Seed Mix

Botanical Name	Common Name	Seed/lb	Rate/Acre- PLS (Pure Live Seed)
Agropyron dasystachym	Thickspike Wheatgrass	154,000	3.0
Bouteloua gracilis	Blue Gramma	825,000	2.0
Koeleria crisata	Prairie Junegrass	825,000	1.0
Mulenbergia wrightii	Spike Muhly	1,000,000	1.5
Festuca arizonica	Arizona Fescue	500,000	2.0
Elymus elymoides	Squirrel Tail	192,000	4.0
Sporobolus cryptandrus	Sand Dropseed	5,298,000	0.75

(C) Seed Supply Agreement: The required species may be in short supply during the project. Therefore, the Contractor shall enter a contractual agreement with a seed collector/supplier that verifies that sufficient supply of specified plant materials will be available on or immediately prior to the seeding dates. This requirement shall be fulfilled within 45 days following the preconstruction conference in order to allow sufficient time for seed collection. The Contractor shall provide written notification to the Engineer verifying that the required species are available and secured for the project. The collection contractor shall test the seed for purity and viability and hold the seed in a manner which maintains its viability. The Contractor shall submit purity and viability test results to the Engineer for approval prior to the initiation of seeding operations. If it is required to be held for more than a year from initial testing the seed shall be tested again for viability. The Contractor shall compensate the seed supplier a percentage of the seed cost to hold seed material and for the seed tests as identified in Basis for Payment.

(D) General

The slurry for the hydroseed process shall be as follows:

Slurry Mix	Rate
Hydrofiber: Silva, Conwed or Spray mulch x-100 wood fiber or equivalent	800 lbs/acre
Tackifier	80 lbs active ingredient/acre
Starter fertilizer: Ammonium Phosphate	16-20-0 200 lbs/acre
Seed mix	As specified
Soil conditioner	1000 lbs/acre

The seed shall be applied within 30 minutes after being combined with the slurry mix.

Ingredients for Slurry Application	Percentages (Minimum)
Nitrogen	5
Phosphoric Acid	3
Water Soluble Potash	1
Humas	50
Humic Acids	15
Soluble Metallic Iron	1

(E) Wood Cellulose Fibers: Wood fiber mulch shall consist of a specially prepared wood fiber processed to contain no growth germination inhibiting factors. The mulch shall be virgin wood and be manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form a homogenous slurry. The mulch shall have a pH range between 4.5 to 6.5.

When hydraulically sprayed on the ground, the material will form a blotter-like cover impregnated uniformly with seed. The cover will allow the absorption of moisture and allow rainfall to percolate to the underlying area.

(F) Tacking Agent: Binder shall be free flowing, non-corrosive powder produced from natural plant gum marketed under M-Binder, M145 Binder, AZ-TAC or approved equal. It shall have gelling properties to inhibit the tendency of water and fiber to move downhill as they are sprayed on steep slopes.

(G) Construction Requirements

(1) General: The Engineer will regularly observe the weighing of seed, mixing of slurry mix and application of seed.

(2) Seeding: Seeding shall be done immediately following the final grading or disking of each cut slope and each fill slope. The soil surface shall be loose. The Contractor will be required to mobilize frequently to accomplish this goal. No seeding shall be carried out under wind conditions exceeding 5 mph Scheduling of seeding mobilization will be coordinated with the Engineer at the weekly construction meetings. In no case shall a decision by the Engineer relieve the Contractor from the requirement of seeding prior to measurable rainfall. If measurable rain falls prior to seeding, or if the surface of the graded area has formed a crust or slightly hardened surface, the Contractor shall be responsible for ripping, blading or loosening the ground surface, or otherwise repairing and/or preparing the affected areas for seed, after they adequately dry out and prior to seeding, at no cost to the City. The use of specialized equipment or manual methods may be required to prepare the surface for seeding, if seeding is not accomplished immediately after grading or disking.

Seed is to be accomplished during the window of June 1 to July 15 and November 1 to January 30. These windows are to allow expected seasonal rains to start germination process.

All areas disturbed by construction are to be seeded. This may be more area than shown on the plans. All areas are to be approved by the Engineer. The Contractor shall coordinate seeding operations with slope construction so that the tops of cuts and toes of fills can be reached with hydroseed equipment.

Hoses may be used where heavy equipment cannot access.

(3) Tillage: All slopes steeper than 3:1 shall either have a loose, friable soil depth of 2 inches or more or be tilled a minimum of 4 inches in depth as they are constructed.

Tillage shall be accomplished with a ripper bar, chisel plow or harrow tool or with other equipment which will provide thorough soil cultivation.

Tillage shall be performed along the contour. The slopes behind guardrail and in the ditch line in cut shall be left with roughened surface to aid in water absorption. Seeded areas which are not behind guardrail or between the ditch line and the roadway on a cut shall be left in a firm surface free of foreign material that would interfere in the seeding operation.

No work shall be done when the moisture content of the soil is unfavorable or the ground is otherwise in a condition not conducive to tillage.

(4) Planting: The Contractor shall submit a batch (tank) mix for the Engineer's approval prior to mixing any seed/mulch slurry. Batch mixing and coverage will be monitored throughout seeding operations. The Contractor is to coordinate monitoring with the Engineer in advance of mixing.

After the tillage is complete and accepted by the Engineer, seed shall be planted by slurry mix (cut slopes steeper than 3:1).

All areas to be seeded shall have a starter fertilizer of ammonium phosphate 16-20-0 applied at a rate of 200 pounds per acre and soil condition at the rate of 1,000 pounds per acre.

Any material sprayed on non-designated areas shall be immediately removed by the Contractor at the Contractor's expense. Non-designated areas include pavement, guardrails, signs, plants and existing vegetation.

(5) Anchorage by Tacking: Mulch shall be anchored by tacking using a slurry consisting of a minimum of 150 pounds of binder, 400 pounds of wood fiber mulch and 700 gallons of water per acre.

(6) Preservation of Seeded Areas: Any material sprayed on non-designated areas shall be immediately removed by the Contractor at the Contractor's expense. Non-designated areas include pavement, guard rails, signs, plants, and existing vegetation.

(7) Warranty: The Contractor shall guarantee that 75 percent of the applied tackifier remains in place for a period of 30 days after acceptance of the seeding application. Any areas that have less than 75 percent of the tackifier remaining shall be reseeded, re-mulched and re-tacked at the Contractor's expense.

Areas that require reseeding and re-mulching under the warranty shall be done at no additional cost to the City. The 30 day period(s) shall be within the allotted contract time.

Measurement and Payment: Seeding will be measured by the acre, to the nearest tenth acre, measured along the ground surface for the areas which have been planted and mulched, as determined by the Engineer. The Contractor may be reimbursed a partial payment based on the invoice amount for the cost to hold and test the seed in conformance with the Seed Supply Agreement.

The accepted quantities of seeding, measured as provided above, will be paid for at the contract price per acre for the full performance of the work herein described, which price shall be full compensation for the work completed including all equipment, labor and materials required.

ADD the following section to Part 400- Right-of-Way and Traffic Control:

SECTION 431: LANDSCAPE ROCK

431.1 REMOVE AND REPLACE LANDSCAPE ROCK

Landscaping shall be protected and restored in accordance with Section 107.9 of these specifications. Existing landscaping rock shall be removed, stockpiled, and replaced in its original position as closely as possible.

Measurement and Payment: Payment shall be per lump sum amount.

PART 500 – STRUCTURES

SECTION 505: CONCRETE STRUCTURES

505.1.1 Minor Structures

REMOVE in its entirety and REPLACE with the following:

Concrete structures such as manholes, catch basins, median barriers, headwalls, cattle guards, and other miscellaneous structures as defined by the Engineer are hereby defined as minor structures. Minor structures

shall be precast units. MAG Type D Catch Basins shall be cast-in-place. Cattle guards, median barriers, and headwalls, at the option of the Engineer, may be either constructed of cast-in-place concrete, or furnished as precast units. Precast units shall be fabricated in accordance with shop drawings submitted by the Contractor and approved by the Engineer, in accordance with the requirements of MAG Specification and COP Supplement 105.2. All structures not defined as minor structures shall be classified as major structures.

(A) Concrete Drainage Outlet/Structure: The work consists of constructing a concrete drainage outlet(s) and structure(s) as designated on the project drawings in accordance with Sections 505 and 725 of these specifications, and as modified herein. All cast-in-place concrete shall be Class AA, 4,000 psi. Subgrade and base materials under the structure shall be compacted to not less than 95 percent of the maximum dry density as determined by AASHTO T 99. No additional payment will be made for aggregate base materials required under concrete structures. The base material shall be considered incidental to the construction of this item and provided for in the unit price for the work. Measurement and payment under this item shall be to the nearest square foot complete in place in accordance with the respective detail for flat work, and per each unit installed for structures.

(B) Concrete Headwall: Work under this item shall be in accordance with COP Supplement 505 and 725, MAG Specifications 726 and 727; MAG Details 501-1 and 501-2; and the project drawings. Concrete shall be Class AA, 4,000 psi. Payment shall be made per each headwall installed complete in accordance with the respective detail.

(C) Concrete Catch Basin: Work under this item shall be in accordance with MAG Details 530 through 540-2; COP Supplement 505 and 725; and above mentioned specifications for Portland Cement Concrete. All grates shall be bicycle safe type. Measurement and payment under this item shall be per each catch basin complete in place in accordance with the respective detail, to include grates.

(D) Scupper: Work under this item shall be in accordance with MAG Details 203 and 206. Concrete shall be Class AA, 4,000 psi. Measurement and payment under this item shall be per each scupper installed complete in place in accordance with the respective detail.

(E) Concrete Retaining Wall: Work under this item shall be in accordance with the project drawings. Measurement and payment under this item shall be to the nearest square foot of the retaining wall measured from the top of the footing to the top of the wall complete in place in accordance with the respective detail.

505.6.2 Adverse Weather Concreting

REMOVE in its entirety and REPLACE with the following:

Adverse weather concreting shall be in accordance with COP Supplement 725.

PART 600 – WATER, SEWER, STORM DRAIN AND IRRIGATION

SECTION 601: TRENCH EXCAVATION, BACKFILLING AND COMPACTION

601.1 DESCRIPTION

ADD the following:

(A) Unless specifically identified, no investigation of subsurface soil conditions for water or sewer main installation has been made for project limits.

(B) Excavation, backfilling and compaction shall be in accordance with this section and standard details as noted.

(C) All water encountered during the work shall be disposed of by the Contractor in a manner such that it will not damage public or private property or create a public nuisance or health problem. The costs of furnishing pumps, pipes, special bedding, and over excavation as required to provide a stable foundation, and other equipment and materials shall be incidental to the work in accordance with COP Supplement 200.1.

601.2.3 Trench Grade

REMOVE in its entirety and REPLACE with the following:

All construction staking shall be in accordance with Section 105.8 of these specifications.

For all pipe, the Contractor shall excavate for and provide an initial granular bedding at least 6 inches thick. This bedding material shall be placed at a uniform density with minimum compaction and fine graded as specified below.

601.2.5 Over-excavation

REMOVE the second paragraph in its entirety and REPLACE with the following:

Unauthorized excavation below the specified grade line shall be refilled at the Contractor's expense with bedding material compacted to a uniform density of not less than 95 percent of the maximum density as determined by AASHTO T 99 and T 191 or ASTM D6938. When AASHTO T 99, method A or B, and T 191 are used for density determination, ADOT Procedure ARIZ 227c will be used for rock correction.

ADD the following subsection to 601.2 Excavation:

601.2.11 Rock Excavation for Utility and/or Drainage Construction

(A) Definition of Rock: When rock is encountered, it shall be stripped of earth and shale, and the Engineer notified in order that he may measure or cross-section the same. In lieu of stripping the earth overburden prior to excavation/blasting, the Engineer and the Contractor may mutually agree on a method to define the vertical limits of rock. Any rock excavated before such measurement or agreement is made, will not be estimated, allowed, or paid for. Rock excavation shall be defined to include: all hard, solid rock in ledges; bedded deposits and unstratified masses; all natural conglomerate deposits so firmly cemented as to present all the characteristics of solid rock; and masonry or concrete structures not shown on the plans. Shales, hard pan, masonry and concrete rubble boulders less than 1 cubic yard which are not a part of or attached to substrata of rock, shall not be considered rock excavation. Additionally, material to be considered "rock" shall be of such hardness that it cannot be excavated using hydraulic backhoe with combined breakout force, for bucket and stick cylinders, of at least 100,000 pounds.

(B) Blasting

(1) It is the Contractor's responsibility to determine the type of material he will encounter and whether blasting will be necessary.

(2) Blasting shall be done only by experienced, qualified blasters. Blasting shall be done in accordance with the recommendations for best practice in Section 9 of the Associated General Contractors of America (AGC) Manual of Accident Prevention in Construction and in accordance with the recommendations for best practices of the Institute of Makers of Explosives. Also, all blasting must comply with the requirements of the Division of Industrial Safety and OSHA and all other Federal, State and local ordinances.

(3) When work requires blasting or explosive conditions, precautions shall be taken to protect life and property, and give proper warning to persons who may be in vicinity of work before blast is set off.

(4) Blasting shall be performed in such a manner that no damage will result to any building, structure, pipeline, or facility on or off the site of work, above or below ground. Any damage suffered as a result of blasting shall be immediately settled, including repair or replacement.

(5) Blasting shall be done in such a manner that the earth is not loosened or disturbed below the footing or foundation of any proposed structure. Loosened material below footings or foundations shall be replaced with Class C concrete.

(6) The stemming of each hole or cover over explosive shall be sufficient to prevent surface blast wave, but in no case less than 3 feet, 6 inches. Multiple holes shall be shot using millisecond delays.

(7) The Contractor shall enlist the services of an experienced explosives engineer for advice on blasting methods and for the protection of existing structures or facilities.

(8) Blasting procedures shall comply with all rules and regulations as specified and determined by the City Fire Marshall or the Director.

601.4.2 Bedding

REMOVE in its entirety and REPLACE with the following:

Bedding shall be a minimum of 6 inches and shall be in accordance with COP GES Detail 200Q-1 for paved and unpaved areas. Bedding/shade material shall be of granular consistency such as sand or crushed aggregates conforming to the following gradation and plasticity requirements:

Sieve Size	Percentage Passing By Weight
1 in	100
No. 200	< 25
PI	10 Max.

Volcanic cinders or glass materials are not acceptable.

Use of open graded rock (i.e. 3/8 inch pea gravel or ¾ inch rock) must be approved by the Engineer prior to placement and will be considered only in special circumstances.

Water consolidation by any means shall not be permitted.

Bedding and shading material shall not be considered “corrosive” or “aggressive” soil per the definitions in AWWA (including C105), Ductile Iron Pipe Research Association (DIPRA) and other similar standards and industry accepted documents. The Contractor shall submit material certification documents from the bedding and shading material supplier indicating that the bedding and shading material to be provided is not considered “corrosive” or “aggressive” soil to ferrous metals, and shall include the pH, resistivity, oxidation/reduction, and sulfide values of the material within the certification package. Upon delivery of the material, the Contractor’s geotechnical engineer shall provide Quality Control testing by testing samples of the bedding/shading material for corrosivity. The Contractor’s geotechnical engineer shall provide a letter

sealed by a registered professional engineer, licensed in the State of Arizona, that the bedding/shading material is not corrosive to ferrous metals as defined by AWWA C105. If the material is found to be corrosive, the Contractor must install polyethylene encasement per MAG Specification 610.6 at no additional cost to the City. Testing shall occur a minimum of every 1,000 linear feet of pipe installed.

601.4.4 Initial Backfill

REMOVE in its entirety.

601.4.5 Final Backfill

REMOVE in its entirety and REPLACE with the following:

601.4.5 Backfill

Backfill material shall be in accordance with COP GES Detail 200Q-1 for paved areas and COP GES Detail 200Q-1 for unpaved areas. In paved areas, backfill from 1 foot above the pipe to the bottom of the base course shall be non-shrink CLSM backfill. In unpaved areas, backfill from 12 inches above the pipe to 6 inches below existing grade shall be minus 3 inch native material similar in nature to material existing prior to excavation.

Trench backfill Quality Control testing frequency shall be 1 per soil type for Proctor Density testing and 1 per 1 foot vertical lift per 200 linear feet of trench.

601.4.6 Compaction Densities

REMOVE in its entirety and REPLACE with the following:

All backfill material with the exception of non-shrink slurry backfill shall be compacted to 95 percent maximum dry density per ASTM D698.

601.4.7 Water Consolidation

REMOVE in its entirety and REPLACE with the following:

Water consolidation by any means shall not be permitted.

601.7 PAYMENT

REMOVE in its entirety.

ADD the following subsection to Section 601- Trench Excavation, Backfilling and Compaction:

601.8 MEASUREMENT AND PAYMENT

No separate measurement or payment shall be made for trench excavation, backfilling, compaction, or placement of temporary pavement. This work shall be included in the respective unit bid price for water, sewer, or storm main and lateral construction.

Rock excavation within the roadway excavation limits shall not be measured separately. It will be included in roadway excavation. No separate payment will be made for roadway rock excavation. It shall be combined as one item under roadway excavation.

Rock excavation within structural excavation limits shall not be measured separately. It will be considered incidental and shall be included in the appropriate bid item.

Rock excavation within trenches shall be measured in accordance with the following:

(1) Width of trench for rock excavation shall be based on pipe outside diameter plus 24 inches.

(2) Depth for rock excavation shall be actual depth from top of rock to bottom of rock, or to bottom of normal bedding section, whichever depth occurs first.

Payment for rock trenching shall be at the unit price bid per cubic yard which shall include the cost of blasting, excavation, removal, hauling and disposal.

SECTION 610: WATER LINE CONSTRUCTION

610.1 DESCRIPTION

REMOVE in its entirety and REPLACE with the following:

Water main construction shall be in accordance with all applicable standard specifications and standard details.

610.3 MATERIALS

REMOVE item (A) in its entirety and REPLACE with the following:

(A) Water Main piping shall be bell and spigot Class 350 ductile iron unless otherwise noted on the project plans, in accordance with COP Supplement 610 and MAG Specification 750. Trace wire per COP GES Detail 319Q-1 shall be required for all water main installations. Water main piping shall be furnished new in full lengths with manufacturer, class rating, and all other applicable information clearly marked on the barrel. Water main piping for 2 inch shall be copper in accordance with MAG Specification 754 and encased in polyethylene protective wrapping in accordance with Section 610.6 of these specifications.

REMOVE the fourth paragraph in its entirety and REPLACE with the following:

Ductile iron water pipe and fittings per: MAG Specification 750. Concrete pressure pipe-steel/cylinder type per: MAG Specification 758.

ADD the following:

(C) All ductile iron water main and fittings shall be encased in polyethylene protective wrapping in accordance with Section 610.6 of these specifications where called for on the plans or after the Contractor's testing of bedding and shading material is found to be corrosive in accordance with AWWA C105.

All copper and brass water main and fittings shall be encased in polyethylene protective wrapping in accordance with Section 610.6.

(D) All water mains shall have "NSF-PW" seal clearly marked on each barrel and installed with trace wire in accordance with COP GES Detail 319Q-1.

(E) Thrust restraint shall generally be accomplished through the use of restrained joints in lieu of thrust blocking. The preferred joint restraint system shall be "Field-Lok" gasket or approved equal except that vertical deflections, tees, valves and bends shall be restrained utilizing Mega-Lug, as manufactured by Ebba Iron, or equal.

(F) Joint restraint shall be required at piping configurations as show on COP GES Detail 303Q-1. Required minimum lengths of joint restraint shall be per COP GES Detail 303Q-2, or as noted on the plans. In "Tee" locations where perpendicular branch mains are shown as restrained, the main line run (LRN) shall be restrained for a minimum of 10 feet or 1 joint, whichever is greater, each side of the "Tee".

Concrete thrust blocking will be required at connections to existing lines at the locations noted on the plans. Thrust blocks placed at these connections shall be in conformance with MAG Specification 610.14 and MAG Detail 380, and shall be adequately braced to allow system operation during curing of the concrete thrust blocks. Fittings to be restrained with thrust blocks shall be wrapped and taped with heavy polyethylene sheeting per Section 610.6 to prevent covering with concrete on nuts and threading on fittings.

(G) All lateral water main connecting piping, valves and fittings shall be constructed using restrained joints from the main line "Tee" to the connection point at the existing water main at the locations shown on the plans.

(H) Prior to ordering of materials and scheduling connections to existing water mains and services, the Contractor shall complete investigations to verify the size, type and location of the existing water mains and services.

(I) The technical specification for "Air Release Valves" is expanded to include Combination Air Release-Vacuum Breaker valves at the locations shown on the plans constructed as shown in COP GES Detail 317Q-1.

(J) Payment for water main shall be at the unit price in the bidding schedule and shall include all connections, fittings, joints, flanges, thrust restraint and incidentals unless specifically itemized in the bidding schedule.

610.4.1 Trenching/Cover

REMOVE in its entirety and REPLACE with the following:

All water mains shall have a minimum cover of 48 inches over the top of the pipe.

Cover for water mains will be measured from existing or proposed finished grade of pavement or from natural ground, whichever is deeper.

No water main shall be deflected, either vertically or horizontally, in excess of 50 percent of the manufacturer's recommendation for the pipe or coupling, without the appropriate use of bends or offsets.

Except as otherwise required in this specification, the special provisions, or by the Engineer, trench excavation, backfilling and compaction shall be in accordance with the requirements of Section 601 of these specifications. Backfilling may be accomplished as soon as the pipe line has been installed to the satisfaction of the Engineer, subject to the requirements for testing per Section 611 of these specifications.

610.4.3 Blocking and Restraints

REMOVE the first four paragraphs in their entirety and REPLACE with the following:

All pipe lines, valves and fittings shall be restrained using mechanical joints, mechanical joint restraints, or gasket joint restraints in accordance with COP GES Details 303Q-1 through 303Q-4.

If irregular soil or pressure conditions are encountered, a thrust block design revision or an alternate joint restraint system may be required. Thrust block installation or alternate joint restraint will require approval from the City.

610.4.5 Testing

REMOVE the last sentence of this section and REPLACE with the following:

All corporation stops used for testing and chlorination shall be removed and a stainless steel full circle repair clamp shall be installed.

610.5 SEPARATION

REMOVE all references to the Maricopa County Environmental Services Department.

610.5.1 General

ADD the following:

Concrete encased water mains that cross storm drains and/or other dry utilities which clear the crossed line by less than 12 inches shall incorporate a 6 inch sand pad to break the frictional contact.

610.9 FIRE HYDRANTS

ADD the following:

(A) Hydrant installation shall be in accordance with COP GES Details 360Q, 362Q, 363Q and 364Q, and as specified on the project plans. Hydrants shall be Waterous, Mueller, East Jordan, or as approved by the Engineer.

(B) All ductile iron water pipe used in fire hydrant installation shall be Class 350.

(C) All new fire hydrants and connecting piping shall be constructed using restrained joints from the main line "Tee" to the hydrant.

(D) Payment for hydrant installation shall be at the unit price in the bidding schedule and shall include the hydrant, piping, valve, box and cover, and all appurtenant fittings, as noted for a complete assembly.

610.11 CONNECTION TO EXISTING MAINS

ADD the following:

The existing water main shall not be taken out of service prior to completion and ADEQ Approval to Operate the replacement water main and connection of all water services and fire hydrants to the replacement system.

The existing water system shall not be taken out of service at any time without the approval of the Engineer. With the approval of the Engineer, the existing water main may be taken out of service for limited periods to facilitate project construction. City Water Operations shall be contacted a minimum of 48 hours prior to a planned water service disruption.

The Contractor shall prepare and submit to the Engineer a plan for each connection to the existing system which demonstrates the ability to complete all work within the allowed period.

All temporary connections and/or elements which must be placed in service prior to full system disinfection, testing and approval shall be disinfected in accordance with Section 4.7 of AWWA C651 after approval of the Engineer.

All existing water service connections shall be replaced in accordance with the provisions of the COP General Engineering Standards.

610.13 METER SERVICE CONNECTIONS

REMOVE items (A) and (B) in their entirety and REPLACE with the following:

(A) Type K soft copper pipe or tubing shall be used except as otherwise called for on the plans.

(B) When the existing main is not abandoned and the existing meter is to be connected to the new line, the corporation stop and saddle shall be removed and a stainless steel full circle repair clamp shall be installed.

ADD the following:

(E) Water Service Connection

(1) New Water Service shall be in accordance with COP GES Detail 316P. All service piping and fittings from main tap to meter box shall be encased in polyethylene protective wrapping in accordance with Section 610.6 of these specifications. Existing water service shall be abandoned in place and existing meter box and cover shall be salvaged and delivered to the City's Maintenance Yard and placed as directed by the Engineer. The Contractor shall supply all necessary materials for new water service including service saddle, corporation stops, piping, meter yoke, boxes and covers, plus all appurtenant fittings to connect to customers existing service line. The Contractor shall maintain a minimum 4 feet of cover material over water service and set new box and yoke as indicated on plans.

(2) The Contractor shall take all necessary steps to maintain water service. Customers affected by water disruption due to water service installation/connection shall be notified by written flyer delivered by the Contractor a minimum of 24 hours in advance of scheduled water service disruption. The Contractor shall not disconnect or disrupt water service until new water main and services pass hydrostatic and disinfection tests and is accepted by the Engineer. Customers shall not be without water service for a total time period greater than 4 hours. The Contractor shall supply bottled potable water and temporary water service meeting all State health requirements for periods of water service disruption exceeding 4 hours. No separate payment will be made for water service maintenance or Contractor written notification of water service disruption.

(3) No separate measurement or payment will be made for adjustment of new water meter boxes to finished grade. This work is considered as incidental to the construction of the water service replacement.

(4) The Contractor shall install water service line from the main to the new water meter location and continue to a point after the existing water meter location. This point of connection shall be a maximum of 10 feet from the existing meter location. The Contractor shall remove existing valves, pressure regulators, nipples, connectors, etc. and replace per specifications. All private service lines shall be Type "K" copper in accordance with MAG Specification 754 and encased in polyethylene protective wrapping in accordance with Section 610.6. The Contractor shall maintain a minimum of 4 feet of cover material, including ditch inverts, over new private water service line and utilize

existing in-situ material for backfill. The Contractor shall supply all necessary material for new private water service installation including a curb stop, plus an approved type pressure regulator, in an accessible box per COP GES Detail 316P at the new meter box location and all appurtenant fittings to connect to existing service line.

(5) The Contractor shall remove the existing water meter and reinstall in the new yoke at the new meter box location with all appurtenant fittings and adapters. The City shall supply the Contractor with new meters for use in new locations that were not previously served or there is no existing meter to remove.

(6) The Customer Box called out in COP GES Detail 316P for the curb stop and pressure regulator on the customer side of the meter box shall be minimum #1 box, and the curb stop, regulator, box and lid shall be provided and installed by the Contractor.

(7) The Contractor shall be required to distribute written notices approved by the Engineer to all customers 24 hours in advance of proposed private service line reconnection work.

(8) Existing improvements disturbed by the Contractor shall be restored in "like kind" to the satisfaction of the Engineer. No extra payment will be made for restoring existing improvements in "like kind" to include concrete walkways, retaining walls, landscape improvements, etc.

(9) It shall be the Contractor's responsibility to review existing water meter location and points of private service line reconnection locations and ascertain all work including existing improvement restoration costs to perform the private service line reconnection work as specified. Costs associated for private service line reconnection work shall be at the appropriate unit bid price in the bidding schedule and shall include private service line piping, curb stop and pressure regulator, plus all appurtenant fittings and existing improvement restoration work as specified.

(10) The pressure regulators shall be set at 65 psi. The Contractor shall bench-test or otherwise provide written verification from the supplier prior to installation that the pressure regulators have been set at the required psi.

(11) Payment for new water service and reconnection shall be at the appropriate unit bid price shown in the bidding schedule and shall include service saddle, corporation stops, curb stops, piping, meter yoke, adapters, boxes, pressure regulator, plus all appurtenant fittings for complete assembly for connection to existing service line. The Contractor shall supply and install all fittings necessary to install meter into new yoke.

(F) Commercial Water Service (Greater than 2 inches)

(1) The Contractor shall install water service line from the main to the new water meter location and continue to a point after the existing water meter location. This point of connection shall be a maximum of 10 feet from the existing meter location. The Contractor is to furnish and install gate valve and Pressure Regulating Valve (PRV) after meter vault. PRV shall be installed in accordance with the International Building Code as adopted by the City. All commercial service lines shall be a minimum of 4 inch Class 350 Ductile Iron Pipe in accordance with Section 610 of these specifications. The Contractor shall maintain a minimum of 4 feet of cover material over new water service line and may utilize existing in-situ material for backfill provided it meets the project specification. The Contractor shall supply all necessary material for commercial water service installation including a customer shutoff valve and PRV, in an accessible vault per COP GES Detail 321Q at the new meter vault location and include all appurtenant fittings to connect to existing service line.

(2) The Contractor shall be required to distribute written notices approved by the Engineer to all customers 24 hours in advance of proposed private service line reconnection work.

(3) Existing improvements disturbed by the Contractor shall be restored in "like kind" to the satisfaction of the Engineer. No extra payment will be made for restoring existing improvements in

"like kind" to include concrete walkways, retaining walls, landscape improvements, etc. It shall be the Contractor's responsibility to review existing water meter location and points of service line connection locations and ascertain all work including existing improvement restoration costs to perform the service line connection work as specified.

(4) Measurement and Payment for commercial water service shall be at the applicable unit bid price in the bidding schedule and shall include piping, customer shutoff valve, PRV and vault, including all appurtenant fittings and existing improvement restoration work as required.

(G) Traffic Rated Concrete Meter Box

(1) Meter boxes located within traffic areas shall be Christy model B1324 by Christy Concrete Products or approved equal.

(2) Pre-cast concrete meter boxes shall have H-20 loading and be constructed of high density reinforced concrete with a minimum compressive strength of 4,000 psi. Covers to be furnished with the boxes shall be a steel checker plate, H-20 loading, and lid.

610.16 MEASUREMENT AND PAYMENT

REMOVE item (E) in its entirety.

SECTION 611: WATER, SEWER AND STORM DRAIN TESTING

611.2 FLUSHING AND HYDROSTATIC TESTING

REMOVE the first and second paragraphs and REPLACE with the following:

Water lines, fire lines and force mains, including all fittings and connections to the water mains shall be tested for water tightness by subjecting each section to hydrostatic testing in accordance with applicable provisions of AWWA C600, except as modified below, and the City Water Line Testing and Acceptance Procedures, and shall consist of pressure testing and allowance testing.

Testing shall be performed by the Contractor and shall be witnessed by the Engineer for approval.

Payment for testing of water mains shall be included in the unit bid price for water main construction.

611.3 DISINFECTING WATER MAINS

ADD the following:

Water main and services shall be disinfected in accordance with Section 611 of these specifications and the City Water Line Testing and Acceptance Procedures. The City shall perform the sampling for bacteriological and residual chlorine testing. The Contractor shall notify the City 24 hours in advance to coordinate disinfection testing.

All valves in the lines being disinfected shall be opened and closed several times during the 24 hour period of disinfection.

Payment for disinfection of water mains shall be included in the unit bid price for water main construction.

611.4 SEWER LINE TESTING

ADD the following to the first paragraph:

Force mains shall be pressure tested at a minimum of 50 psi above the maximum design working pressure for 2 hours in accordance with AAC R18-9-E301, 4.01.

ADD the following to (A) Low Pressure Air Test:

Sanitary sewers shall be low pressure air tested in accordance with ADEQ Engineering Bulletin 11, Chapter IV and in accordance with the Arizona Administrative Code, Title 18, Chapter 9, Part E301(D)(2)(j)(i). 100 percent of the total length of pipe shall be tested.

ADD the following to (C) Deflection Test for HDPE and PVC Pipe:

100 percent of new sewer main construction, regardless of pipe material shall be deflection tested in accordance with the following:

(1) The pipe section to be tested shall be cleaned free of dirt, sand, water, or other foreign materials.

(2) Backfill and compaction will have been completed prior to testing. Initial tests may be done immediately upon completion of the first reach of pipe for each diameter to ascertain if the Contractor's means, materials and methods are producing the desired quality within permissible tolerances.

(3) Final acceptance mandrel pull shall be no sooner than 30 days after backfill and compaction unless authorized by the City.

(4) Test mandrels shall be solid sleeve or cage type with outside diameter and type of pipe permanently and clearly identified on the mandrel body. Worn, damaged or deformed mandrels will not be allowed. The mandrel shall have a cable attached at each end to enable removal if it becomes stuck.

(5) For acceptance, the mandrel must pass through the entire section between manholes or other structures in one pass when pulled by hand, without the use of excessive force. All testing shall be witnessed by the Engineer or the Engineer's authorized representative and the Engineer reserves the right to order additional tests in excess of 20 percent of new main installed.

(6) Any section of the installation which fails to pass the deflection test will be repaired and retested.

REMOVE item (D) in its entirety and REPLACE with the following:

(D) Closed Circuit Television Inspection

(1) Description

This section defines the requirements for internal television inspection of the sewer main and service laterals after they have been installed for all new construction and shall include the connection point to the existing system. The Contractor shall inspect the sewer interior using a color Closed Circuit Television (CCTV) camera and document the inspection on video with audio location and date information, video title information and hard copy inspection logs.

Upon completion of sewer main rehabilitation, the Contractor shall perform CCTV inspection for 100 percent of the newly rehabilitated sewer main to provide a video record and associated written report to become the property of the Engineer. The Engineer shall be notified a minimum of 48 hours in advance of proposed scheduled sewer camera inspection, so the Engineer may witness the video recording. Any inspection completed without the Engineer witnessing will not be accepted.

(2) Submittals

(a) The Contractor shall submit samples of main and lateral (if separate) inspection logs and reports for approval in accordance with MAG Specification and COP Supplement 105.2.

(i) The Contractor shall be responsible for modifications to the Contractor's equipment and/or inspection procedures to achieve report material of acceptable quality. No work shall commence prior to approval of the material by the Engineer. Once accepted, the report material shall serve as a standard for the remaining work.

(ii) The Contractor shall maintain a copy of all inspection documentation (reports, DVD, etc) for the duration of the work and warranty period.

(iii) Mainline inspection reports shall be provided by the Contractor and shall show all observations, at a minimum: project title, name of owner, time of day, manhole-to-manhole pipe section, pipe segment length, pipe material, line size, compass direction of viewing, lateral identification and clock position, direction of camera's travel, pipe depth, name of operator and footage counter reading at the beginning and end of each manhole-to-manhole pipe segment. Report shall identify any deficiencies observed.

(iv) Video of sewer mainlines shall at a minimum include the following information: project title, time of day, pipe material, line size, compass direction of viewing, direction of camera's travel, and footage counter reading continuously through-out each manhole-to-manhole pipe section. The video shall pause at and identify all observations.

(v) Service lateral inspection reports shall be provided by the Contractor and shall show all observations, at a minimum: project title, time and date, property address of service, manhole-to-manhole pipe section, pipe segment length, pipe material, line size, direction of camera's travel, name of operator and footage counter reading at the beginning and end of each service. Report shall identify any deficiencies observed.

(vi) Video of sewer lateral shall show, at a minimum: project title, street address, time and date, pipe material, line size, direction of camera's travel, and counter reading at the beginning and end of each service. The video shall pause at and identify all observations including the connection point to the existing service line.

(b) The Contractor shall supply finished video recordings upon completion of sewer construction. 4 sets of the videos (DVD) and reports shall be submitted to the City.

(3) Equipment

(a) Cameras: For inspection of sewer, the camera shall be equipped with a rotating head, capable of 90 degree rotation from the horizontal and 360 degree rotation about its centerline. Minimum camera resolution shall be 400 vertical lines and 460 horizontal lines. The camera lens shall not have less than 140 degree viewing angle and shall have automatic or remote focus and iris controls. The focal distance shall be adjustable through a range of from 2 inches to infinity. Camera(s) shall be intrinsically safe and shall be operative in 100 percent humidity conditions. Lighting intensity shall be remote controlled and shall be adjusted to

minimize reflective glare. Lighting and camera quality shall provide a clear, in-focus picture of the entire inside periphery of the sewer.

(b) Recording Media: Video recordings of all sewer line inspections shall be made on DVD. The audio portion of the composite video shall be sufficiently free from electrical interference and background noise to provide complete intelligibility of the oral report. Each video shall be identified with labels showing the Owner's name, Contractor's name, Engineer's name and each manhole-to-manhole pipe segment of sewer line represented on the video. Each video shall be submitted at the completion of the project for records.

(c) Footage Counter: A footage counter device which measures the distance traveled by the camera in the sewer device shall be accurate to plus or minus 2 feet in 1,000 feet.

(d) Depth Gauge: The camera shall be fitted with a depth gauge to identify sags present in the main lines. The gauge shall have ¼ inch increment markings to measure the depth of the pipe sag. The depth of the sag and location shall be noted as an observation and recorded on the report.

(e) Video Titling: Video recording equipment shall include genlocking capabilities to the extent that computer generated data, (i.e. footage, date, size, etc) as determined by the City can be overlaid onto video, and both indicated on the television monitor and permanently recorded on the inspection video recording.

(4) Flow Control

(a) Flow control is required for TV inspection and for sewer line rehabilitation. Limited sewage flow, as defined below, is acceptable for TV inspection.

(b) Depth of flow shall not exceed 40 percent of pipe diameter as measured in the manhole when performing television inspection.

(c) Bypass pumping, if required, shall conform to the requirements of COP Supplement 200.2 and shall be incidental to CCTV Inspection.

(5) Inspection Methods

(a) The Engineer and the City's Wastewater Collection Representative shall have access to observe the video monitor and all other operations at all times. The system of cabling employed to transport the camera and transmit its signal shall not obstruct the camera's view.

(b) The Contractor shall physically measure and record on the inspection log, the length of each sewer reach from the centerline of its terminal manholes.

(c) The camera may travel through the sewer in either direction. Maximum rate of travel shall be 30 feet per minute when recording.

(d) The camera image shall be down the center axis of the pipe when the camera is in motion. The Contractor is required to provide a 360 degree sweep of the pipe interior, at points of interest, in order to more fully document the existing condition of the sewer. Points of interest may include, but are not limited to, defects, encrustations, mineral deposits, debris, sediment and any location determined not to be clean or part of a proper line installation and defects in the liner including, but not limited to, bumps, folds, tears, dimples, etc.

(e) The video and all inspection documentation should include the sewer line and manhole identifiers shown on the plans. After the rehabilitation of the sewer main is complete, the Contractor shall use the upstream manhole as the identifier in conjunction with the distance meter.

(f) The City will review videos and logs to ensure compliance with the requirements listed in this specification and contract documents. If the sewer line, in the sole opinion of the City, is not adequately clean, it shall be cleaned and re-inspected by the Contractor at no additional cost to the City. If the construction work, in the sole opinion of the City, has not been properly installed, it shall be reinstalled and re-inspected by the Contractor at no additional cost to the City.

Final acceptance of the project will not be granted until sewer line video results, including any re-inspection of deficient sewer main, meet the satisfaction of the Engineer and are in accordance with this section.

611.5 POST INSTALLATION INSPECTION OF NEW MAINLINE STORM DRAINS

REMOVE the first sentence of item (A) in its entirety and REPLACE with the following:

The Contractor shall provide the Engineer with an annotated video inspection record (DVD format only) of the new mainline storm drain pipeline.

REMOVE the last sentence of item (A) in its entirety and REPLACE with the following:

This video shall be provided to the Engineer for review and approval prior to the Contractor being allowed to place the first lift of pavement over the storm drain line.

611.6 PAYMENT

REMOVE the second paragraph in its entirety and REPLACE with the following:

All low pressure air, hydrostatic, and deflection testing shall be considered incidental to the unit price bid for sewer main installation and no additional payment shall be made for these items.

Measurement and payment shall be for the complete work of Sewer CCTV inspection at the unit price in the bid schedule. All cleaning and bypass pumping required for a clear and complete CCTV inspection shall be incidental to the cost of video inspection.

ADD the following section to Part 600- Water, Sewer, Storm Drain and Irrigation:

SECTION 612: TEMPORARY WATER MAINS (FLY LINES)

612.1 DESCRIPTION

This section describes the requirements and procedures for the installation, testing and maintenance of temporary water main systems where required to maintain service to customers during the shutdown or removal of existing City water mains for new construction. *All* existing water services shall be moved to the temporary main so that customer service interruptions are avoided.

(A) Materials: All pipe valves, fittings, hose and connections furnished by the Contractor shall be of good quality, clean, meet National Sanitation Foundation (NSF) Standard 61 requirements for potable water. The City shall be the final arbiter if any questions arise regarding the suitability of any materials to meet these criteria. Previously used pipe that has been used in sanitary sewer, force main or effluent applications is specifically NOT allowed, regardless of any disinfection procedures or results submitted.

Temporary mains 6 inches or greater shall be constructed of HDPE solid wall pipe conforming to AWWA C906 with a minimum DR ration based on 150 psi. Higher rated pipe may be required based on analysis of the City water system for the construction area.

Temporary mains less than 4 inches may be constructed of either HDPE or PVC with the appropriate pressure rating for system and testing pressures.

(B) Installation and Protection: The temporary line may be installed above grade as necessary to facilitate the construction of new waterline. The temporary pipe shall be installed in such a manner that it will not present a hazard to vehicle traffic or pedestrians and will not interfere with access to homes, businesses and driveways along its route. Cover plates shall be installed as necessary. Where installed at driveway or street crossings the line shall be protected from traffic loads and displacement. During seasons with potential for freezing the lines shall be insulated to the degree necessary to prevent damage to the line or fittings and to maintain service.

Valves shall be installed at the beginning and end of the temporary line and at 300 foot intervals, or as directed by the City. The use of pressure reducing valves for individual service connections may be required as directed by the City.

All temporary piping, fittings and service connections shall be furnished, installed and maintained by the Contractor for the duration of the construction. The Contractor shall make connections to a water source designated by the City or as shown on the plans. Alternative connection points may be considered by the City.

(C) Testing

(1) Disinfection and Testing: The Contractor shall be responsible to disinfect all pipe, connections and fittings in accordance with MAG Specification 611.3. Disinfection of the line, if not connected to the City's existing system at either end, may be treated as a closed vessel for purposes of the disinfection period and combined with the pressure test. If the temporary line is connected to the City's existing system the line shall be disinfected, flushed and then pressure tested after a bacteriological sample is obtained and tested.

(2) Pressure Testing: All temporary water mains shall be pressure tested to ensure integrity of the system supplying water to the City's customers. Test pressure shall be a minimum of 50 psi over normal system operating pressure for the area served by the temporary line and shall be maintained for 2 hours. Pressure test results should be provided to the Inspector responsible for the project. A single length of HDPE line with no joints will not require a pressure test.

(3) Bacteriological Testing: Following disinfection, pressure testing and flushing of the temporary line, the Contractor shall obtain water samples from the line and submit to a certified laboratory for bacteriological testing. Results shall be provided to the Inspector responsible for the project. The City's Utility Engineer will review test results prior to connection of existing customers to the temporary line.

(D) Maintenance and Repairs

(1) Maintenance: Following acceptance of the temporary system as a potable system by the City, the Contractor shall maintain continuous service through the temporary piping to all customers normally served both directly and indirectly by the pipe line. Once the temporary pipe has been accepted, the Contractor shall request the City to shut down the existing system piping and the Contractor shall remove the existing system piping in conflict with the new mains or as shown on the project plans.

Upon completion of the work, the Contractor shall remove the temporary piping and appurtenances and shall restore all ground surfaces and water service connections to the satisfaction of the City.

(2) Repairs: If repairs to temporary piping are necessary the Contractor shall make such repairs in a timely manner as directed by the City. If progress in making repairs is inadequate, as determined

by the City, or in the event of an emergency, the City may take immediate corrective measures, which may include the performance of repair work by City forces or another contractor. All costs for corrective measures shall be borne by the Contractor.

(3) Fire Hydrants: Fire hydrants not on the temporary main that are taken out of service shall be covered with a bag to be easily recognized as being out of service until they are removed or until they are brought back into service. The Contractor shall notify the City Fire Marshal and the Water Operations Division of any fire hydrants that will be taken out of service.

(E) Measurement and Payment: Measurement for the installation, testing and maintenance of temporary water mains shall be for each separate main installation.

Payment shall be made at the unit price contained in the bid schedule. Such payment shall be full compensation for furnishing and installing the pipe, fittings valves, adaptors, service connections, and all miscellaneous fittings, complete in place, standard details, and/or Temporary Water Main Plan submittal and approval, and shall include all costs of excavation, removal of obstructions, shoring, bracing, bedding, backfilling, compaction, maintenance of traffic, testing, disinfection, connections to existing mains and services, disposal of existing pipes and materials. Disposal of asbestos cement pipe, lead joints and other potential hazardous materials shall be disposed of in accordance with applicable Federal, State and local regulations and shall be considered incidental to the payment for Temporary Mains unless specifically identified in other bid items.

SECTION 615: SANITARY SEWER LINE CONSTRUCTION

615.2 MATERIALS

REMOVE in its entirety and REPLACE with the following:

Pipe used for sewer line construction, including specials, joints, and gaskets, shall be according to the following sections, or as modified by the special provisions.

HDPE pipe shall conform to MAG Specification 738. Vitrified clay pipe shall conform to MAG Specification 743. Polyvinylchloride (PVC) pipe and fittings shall conform to MAG Specification 745. Ductile iron pipe shall conform to MAG Specification 750.

(A) Sanitary sewer main construction shall be in accordance with all applicable standard details and MAG Specification 750. All sanitary sewer piping and fittings shall be ASTM D3034 SDR 35 PVC or AWWA C151 Ductile Iron, Class 350, with an epoxy coating (Protecto Coat 401, Series 431 Perma-Shield, or approved equal). Sewer pipe shall be furnished new in full lengths with manufacturer, class, rating and other pertinent information clearly marked on the barrel. All ductile iron sewer main shall be encased in polyethylene protective wrapping in accordance with MAG Specification 610.6 where called for on the plans or after the Contractor's testing of bedding and shading material is found to be corrosive in accordance with AWWA C105.

(B) Field cuts and taps of ductile iron pipe shall be re-coated with Protecto Coat 401, Series 431 Perma-Shield, (or approved equal) field kit in accordance with the manufacturer's recommendations.

(C) Where noted on project plans, mechanical joint or restrained joint, Class 350, ductile iron sewer main shall be installed 10 feet (minimum) each direction from water/sewer interface where vertical separation is less than 2 feet or until 6 feet of horizontal separation is attained per MAG Detail 404.

(D) The method of construction of manhole and sewer main replacements is of prime importance to the City. Maintenance of sewage flows is critical and shall be the responsibility of the Contractor. The

Contractor's construction schedule shall be phased as to allow for minimal pumping of sewage flows for manholes and sewer main under construction.

(E) Payment for sanitary sewer main will be at the applicable unit bid prices for sewer main, as shown in the bidding schedule and shall include all excavation, backfill and compaction in accordance with trench details and all materials necessary for installation of the new sewer main.

615.8 SANITARY SEWER SERVICE TAPS

REMOVE the last sentence of the fourth paragraph in its entirety.

ADD the following:

All new or replacement sewer services, and any existing sewer services disturbed during construction, shall be replaced to the location indicated on project plans with a new minimum 4 inch ASTM D3034 SDR 35 PVC or AWWA C151 Ductile Iron, Class 350, with an epoxy coating (Protecto Coat 401, Series 431 Perma-Shield, or approved equal) sewer pipe, backwater valve, manufactured wye, and appurtenances in accordance with COP GES Details 405Q, 414P, 440P-1, 440P-2 and 440P-3, except as modified herein.

If individual sewer service disruption is anticipated, the Contractor shall notify the property owner 24 hours in advance. Sewer service must be restored within 4 hours or some alternate means of sewage disposal provided to allow for the resumption of individual sewer service.

Payment for sanitary sewer service shall be at the unit price indicated on the bidding schedule for the sewer service installation, and shall include connecting each existing sewer service including all labor, material, equipment, removal of existing pipe, new pipe, coupling concrete reinforcement, new concrete encasement, fittings, by-pass pumping and other work required to connect the existing yard line service to the new sewer main.

615.10 MANHOLES

ADD the following:

(A) The Contractor is to provide to the Engineer a detailed written description of the method of construction for manhole and sewer replacement for each individual area of work. This should include, but is not limited to the following:

(1) Maintenance of sewage flows during construction and curing of concrete.

(2) Type of concrete for manhole bases (i.e. pre-cast, "high-early", etc.)

(3) Method of curing concrete (i.e. protection against freezing, development strength before barrels and cones are set, etc.)

(4) What steps will be taken to ensure the grade around the manholes will not sink when complete (i.e. compaction testing, special base preparation, etc.)

Sanitary sewer manholes shall be constructed per COP Supplement 625.

SECTION 618: STORM DRAIN CONSTRUCTION

618.1 DESCRIPTION

ADD the following:

Work under this item shall be in accordance with COP Supplement 601 and as modified herein.

REMOVE the second paragraph in its entirety.

618.2 MATERIALS

REMOVE the first paragraph in its entirety and REPLACE with the following:

Pipe used for storm drain construction, including specials, joints, and gaskets, shall be according to the following sections, or as modified by special provisions.

The concrete pipe, HDPE pipe, corrugated metal pipe (CMP), specials, joints, gaskets, and testing shall be according with MAG Specifications 621, 735, 736 and 738, except as specified below or as modified by special provisions.

ADD the following:

All CMP shall have $2^{2}/_{3}$ inch x ½ inch corrugations with a minimum gauge of 14. Steel lined or paved CMP will not be allowed.

(1) Rubber Gasket Joints

All joints for CMP shall conform to MAG Specification 621.3.1 and shall be watertight.

618.3 CONSTRUCTION METHODS

REMOVE the first paragraph in its entirety and REPLACE with the following:

Excavation, bedding, backfilling, and compaction of backfill and bedding of trenches shall be accomplished in accordance with COP Supplement 601 and MAG Specification 603 for HDPE pipe, or as modified by special provisions.

SECTION 625: MANHOLE CONSTRUCTION AND DROP SEWER CONNECTIONS

625.1.1 Manholes

ADD the following:

Sanitary sewer manhole construction shall be in accordance with COP GES Details 420Q-1, 420Q-2, 421Q, 422Q, 423P-1, 423P-2, 426Q-1, 426Q-2 and 427Q.

625.1.2 Sanitary Drop Sewer Connections

ADD the following:

Sanitary sewer drop connections shall be constructed per COP GES Detail 426Q-1.

625.2 MATERIALS

REMOVE the second paragraph in its entirety and REPLACE with the following:

Brick shall not be used for maintenance and adjustment of the existing sanitary sewer manhole or ring and cover.

REMOVE the seventh paragraph in its entirety and REPLACE with the following:

Manhole steps, where approved by the City shall be in accordance with COP GES Detail 412Q. Plastic manhole steps shall conform to OSHA and ASTM C487 requirements. The manufacturer shall furnish a written certification indicating conformance.

625.3 CONSTRUCTION METHODS

REMOVE in its entirety and REPLACE with the following:

625.3.1 Manholes

Manholes shall be constructed of precast concrete sections, frames and covers, in accordance with the standard details. The invert channels shall be smooth and semi-circular in shape, conforming to the inside of the adjacent sewer sections. Changes in direction of flow shall be made with a smooth curve, having a radius as large as the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly.

Invert channels may be formed of concrete having a smooth mortared surface, or may be constructed by laying a full section of sewer pipe through the manhole and cutting out the portion of pipe above the floor after the surrounding concrete has hardened. The floor of the manhole outside the channels shall be smoothed and shall slope towards the channels.

Existing manholes shall be totally removed, including the bases, and disposed of by the Contractor. Existing rings and covers shall be salvaged and delivered to the City Wastewater Collection Yard located at 1505 Sundog Ranch Road. No separate payment will be made for removing manholes or salvaging manhole rings and covers. The cost of this item of work shall be included in the cost of manhole construction.

The excavation shall be made cylindrical to a diameter sufficient in size to permit sheeting if necessary and leave room that the precast concrete sections may be properly assembled.

Concrete foundations shall be Class A concrete and in accordance with the standard details and COP Supplement 505 for both poured-in-place and pre-cast bases. Cast-in-place concrete bases and inverts shall cure for a minimum of 72 hours, depending on concrete development strength before barrels and cones can be placed and before sewage flows across the inverts.

Frame and Cover: All machined surfaces on the frame and cover shall be such that the cover will lie flat in any position in the frame and have a uniform bearing through its entire circumference. Any frame and cover which creates any noise when passed over by automobiles shall be replaced. Frames shall be set in accordance with COP GES Detail 420Q-1.

Watertight Ring and Cover: Installation of watertight ring and cover shall be in accordance with COP GES Detail 420Q-1 as indicated on the plans. Watertight rings and covers shall be approved by the City prior to installation and cost shall be incidental to the manhole construction.

All water encountered during the work shall be disposed of by the Contractor in a manner such that it will not damage public or private property or create a public nuisance or health problem in accordance with MAG Specification 220.1. The costs of special bedding and over excavation as required to provide a stable foundation, and other equipment and materials shall be incidental to the work.

Backfilling shall be done in accordance with the requirements for trench backfilling as stated in COP Supplement 601. Quality Control density testing shall be 1 test per 16 inches of fill, beginning at 2 feet above the crown of the pipe. A minimum of 2 density tests are required for each manhole. Each density test taken shall be in a different quadrant of the manhole as the previous test. If 4 tests are required, each quadrant shall have a density test.

625.3.2 Sanitary Sewer Drop Connections

Drop manholes that intercept existing mains (upper invert) shall not have a block-out for the pipe during the casting process. Said manholes shall be core drilled in place once the appropriate invert elevation has been verified in the field.

Core drilling shall not commence without approval from the Engineer.

The pipe shall be sealed at the penetration using a Link-Seal Modular Seal or approved equal.

(A) Internal Drop

(1) Internal drop systems shall be installed in drop manholes where indicated on the plan sheets and accordance with COP GES Detail 426Q-1.

(2) Internal drop systems shall be constructed using Reliner Inside Drop System as manufactured by Reliner/Duran Inc., or approved equal.

(3) Manholes with internal drop systems require Internal Manhole Coating, and shall have the protective coating installed and tested prior to the installation of the drop system. Manhole coating shall be in accordance with COP Supplement 626.1.

625.3.3 Sanitary Sewer Manhole Testing

All manholes installed shall be tested by exfiltration or by vacuum testing as determined by the City. Testing shall be per ASTM C1244-3 and in accordance with Arizona Administrative Code, Title 18, Chapter 9, Part E301(D)(3)(e).

Testing of sanitary sewer manholes is considered incidental to the price bid for manhole installation and no additional payment shall be made.

625.4 MEASUREMENT

REMOVE in its entirety and REPLACE with the following:

Measurement of manholes shall be per manhole installed, complete in place regardless of depth.

Measurement of drop manholes shall be per manhole installed, complete in place regardless of depth.

Measurement for internal drops shall be per drop installed, complete in place regardless of depth.

625.5 PAYMENT

REMOVE in its entirety and REPLACE with the following:

Payment for each accepted manhole installation shall be at the contract unit bid price in the bidding schedule and shall include all excavation, backfill, installation, grade ring adjustment, all necessary materials and testing for a complete manhole installation.

Payment for each accepted drop manhole installation shall be at the contract unit bid price and shall include all excavation, backfill, installation, internal coating, internal drop assembly, core drilling, grade ring adjustment, all necessary materials, and testing for a complete manhole installation

Payment for internal drop systems installed in existing manholes shall be at the bid unit price and shall include complete installation of the internal drop assembly, and internal coating in accordance with COP GES Detail 426Q-1 and all materials necessary for installation of the new drop sewer connections.

ADD the following section to Part 600- Water, Sewer, Storm Drain and Irrigation:

SECTION 626: MANHOLE COATINGS

626.1 DESCRIPTION

This section specifies the coating system used for the lining of the manholes as indicated on the drawings. The Contractor shall furnish all labor, materials and equipment required to clean, modify and coat the manholes. The Contractor shall comply with the local authority and all OSHA requirements for confined space entry. The coating shall yield a hard, durable chemical resistant coating and shall be specifically designed to be applied on a dry surface. The finish coating shall provide a watertight seal and shall adhere to all components of pipeline liner systems.

(A) Specific coating terminology used in this section is in accordance with definitions contained in ASTM D16, ASTM D3960 and the following definitions:

(1) Dry Film Thickness (DFT): The thickness of one fully cured continuous application of coating.

(2) Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.

(3) Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of erection or fabrication, where the field or finishing coat is applied.

(4) Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.

(5) Photochemically Reactive Organic Material: Any organic material that will react with oxygen, excited oxygen, ozone or other free radicals generated by the action of sunlight on components in the atmosphere giving rise to secondary contaminants and reaction intermediates in the atmosphere which can have detrimental effects.

(6) Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon is photochemically reactive and evaporates during drying or curing, expressed in grams per liter or pounds per gallon.

(7) Touch-Up Painting: The application of a paint on areas of painted surfaces to repair marks, scratches and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

(B) Quality Assurance

(1) References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

- ASTM D16-93 Standard Terminology Relating to Paint, Varnish, Lacquer and Related Products
- ASTM D3359 A-92 Standard Test Methods for Rating Adhesion by Tape Test
- ASTM D3960-92 Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings

(2) Standardization: Materials and supplies provided shall be the standard products of manufacturers. Materials in each coating system shall be the products of a single manufacturer.

(C) Delivery and Storage

(1) Materials shall be delivered to the job site in their original, unopened containers. Each container shall bear the manufacturer's name, coating type, batch number, date of manufacture, storage life and special directions.

(2) Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Flammable materials shall be stored in accordance with State and local codes. Materials exceeding storage life recommended by the manufacturer shall be removed from the site.

626.2 MATERIALS

(A) The pre-approved coatings for the lining of manholes include: Sewer Shield Liner 150 as manufactured by Environmental Coatings, Mesa, Arizona; Sauereisen No. 210 as manufactured by Sauereisen, Inc., Pittsburgh, Pennsylvania; or Raven 405 as manufactured by Raven Lining Systems, Broken Arrow, Oklahoma. The coating color shall be approved by the owner.

(B) Primer shall be as recommended by the manufacturer for each application.

(C) Defect filler shall be as recommended by the manufacturer for each application. The coating shall contain no more than 20 percent filler, sand; no fiberglass fillers.

(D) Applicator Experience and Qualifications: The coating applicator must have a minimum of 2 years experience in applying either the specified coating or an equivalent coating and shall be certified as an applicator by the manufacturer. They shall submit a successful performance history for the application of either the specified coating or a similar coating in the wastewater industry:

(1) The coating applicator shall submit 3 references relating to the quality of workmanship performed on other projects using the same coating being proposed or an equivalent coating.

(2) The coating applicator shall be an Arizona licensed contractor with an AE License or equivalent.

(3) The coating contractor shall submit a manufacturer's certification to apply the coating specified herein for each applicator involved in the coating process.

(E) Product Data: Before materials are delivered to the job site, the Contractor shall provide the following information in accordance with these specifications.

(1) For the filler, primer and finish coating, the Contractor shall furnish a Material Safety Data Sheet (MSDS).

(2) For the filler and finish coating, the Contractor shall provide the manufacturer's application instructions, which shall include the following:

(a) Surface preparation recommendations

(b) Primer type, where required

(c) Maximum dry and wet mil thickness per coat

(d) Minimum and maximum curing time between coats, including atmospheric conditions for each

(e) Curing time before submergence in liquid

(f) Thinner to be used with coating material

(g) Ventilation requirements

(h) Minimum atmospheric conditions during which the coating shall be applied

(i) Allowable application methods

(j) Maximum allowable moisture content

(k) Maximum storage life

(3) List of materials proposed to be used under this section and manufacturer's data for each material.

626.3 COATING

(A) Coating products shall not be used until the City has inspected the materials and the coating manufacturer's technical representative has instructed the Contractor and the City in the surface preparation, mixing and application of the coating. The coating manufacturer's technical representative must be a factory representative, not a local representative or an affiliate of the Contractor.

(B) Field coats shall consist of 1 or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until all previous coats have been inspected.

(C) All items of equipment, or parts and surfaces of equipment, which are immersed when in service, with the exception of pumps and valves shall have all surface preparation and coating work, performed in the field.

(D) Preparations

(1) Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings and other foreign substances shall be removed except as specified. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free of contaminants, which might interfere with the adhesion of the coatings. The air used for blast cleaning shall be sufficiently free of oil and moisture to not cause detrimental

contamination of the surfaces to be coated. The Contractor shall examine all surfaces to be coated and shall correct all surface defects as required by manufacture before application of any coating.

(2) The Contractor shall protect the sewer from debris, overspray or any detrimental activity due to restoration of the manholes.

(3) Holes shall be filled using a grout as recommended by the coating manufacturer, and approved by the Engineer. The grout filler shall be used to bring all areas of holes and pitting up to the nominal surface of the manhole so that there is an even interior surface in the manhole without waves, pits or holes. Any exposed rebar shall be cleaned, and all areas of corrosion removed, prior to application of the grout as recommended by the coating manufacturer and approved by the Engineer.

(4) After surface preparation is complete, all loose material shall be removed from the sewer and manholes.

(5) The Contractor shall repair all defects in the coating system where directed by the Engineer.

(6) Surface preparations for each type of surface shall be in accordance with the specific requirements of the coating system specification sheet (COATSPEC). The COATSPEC shall be supplied by the manufacturer.

(E) Application

(1) The surface of the installed coating will be cleaned and prepared to permit visual inspection by the Engineer. Any areas of the coating showing poor adhesion, excessive air inclusion or edge or seam defects shall be properly repaired and re-inspected.

(2) Coated surfaces shall be free from runs, drops, ridges, waves, laps and brush marks. Coats shall be applied so as to produce an even film of uniform thickness completely coating corners and crevices. Painting shall be done in accordance with the requirements of SSPC: The Society for Protective Coatings, Paint Application Specification No. 1. The SSPC Paint Application Specification shall be supplied by the manufacturer.

(3) The Contractor's equipment shall be designed for application of the materials specified. The coating shall be obtained with the proper thickness and surface characteristics as recommended by the coating manufacturer.

(4) Each coat shall be applied evenly and sharply cut to line. Care shall be exercised to avoid over-coating or spattering on surfaces not to be coated.

(5) Film Thickness and Continuity: Coating system thickness is the total thickness of the finished coats. The surface area covered for various types of surfaces shall not exceed those recommended by the manufacturer. Coatings shall be applied to the thickness specified, and in accordance with these specifications. In testing for continuity of coating about welds, projections (such as bolts and nuts), and crevices, the City will determine the minimum conductivity for smooth areas of like coating where the dry mil thickness has been accepted. This conductivity shall then be taken as the minimum required for these rough or irregular areas. Pinholes and holidays shall be repainted to the required coverage.

(6) Safety and Ventilation: Requirements for safety and ventilation shall be in accordance with SSPC Paint Application Guide No. 3. The SSPC Paint Application Guide shall be supplied by the manufacturer.

(7) Cleanup: Upon completion of coating, the Contractor shall remove surplus materials, protective coverings and accumulated rubbish and thoroughly clean all surfaces and repair any over spray or other paint-related damage.

(F) Testing

(1) Spark Testing: All coated surfaces shall be spark tested for holes. The spark tester used shall provide 14,000 volts. If pinholes are found, the Contractor shall repair the coating as recommended by the manufacturer and retest. All testing and repair work shall be at the Contractor's expense.

(2) Adhesion Testing: The Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that the specified field coatings adhere to the substrate. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on all other surfaces shall be considered acceptable.

626.4 DEFECT REPAIR

The Contractor shall repair all defects in the coating system where directed by the Engineer.

Where unacceptable adhesion test results are obtained, the Contractor shall be responsible for removing and reapplying the specified coatings at no expense to the City.

626.5 WARRANTY

The coating applicator shall supply a minimum 5 year warranty, for the coating that has been approved through the submittal process. The coating applicator shall also supply a warranty from the coating manufacturer addressed to the City. The warranty shall state, at a minimum, that the coating is applied in accordance with the manufacturer's instruction and that the coating will not fail for a period of 5 years. The definition of coating failure is that blistering, cracking, embrittlement or softening of the coating is starting to occur.

All structural rehabilitation work performed by the Contractor shall be guaranteed against faulty workmanship and/or materials for a period of 2 years after final acceptance of work.

626.6 MEASUREMENT AND PAYMENT

Payment for manhole coating shall be per square foot as measured from the invert to the ring and cover. The unit price shall include by-pass pumping and all materials necessary for internal coating of manholes specified on the plan sheets.

SECTION 630: TAPPING SLEEVES, VALVES AND VALVE BOXES ON WATER LINES

630.3.1 General

ADD the following:

Valves shall be resilient wedge gate valves, Waterous 2500 series, Clow, Mueller, or equal, suitable for use in line and in wet tapping water mains in conjunction with tapping sleeves. Gate valves shall be mechanical joint except where flange joints are specifically detailed in project plans or where required for tapping sleeves and hydrant installation.

Valve blocking shall be provided on all valves in accordance with Quad City Detail 301Q. No separate payment will be made for valve blocking and the cost shall be included in the water main unit price.

Valve boxes shall be in accordance with COP GES Detail 391Q.

Debris caps shall be installed on all valves within project limits according to MAG Detail 392 and shall be color-coded according to COP GES Detail 391Q. Debris caps shall be SW Services DC600 or approved equal.

The Contractor shall notify customers of scheduled water service disruption a minimum of 24 hours in advance of construction. Customers shall coordinate water shut-down with City Water Operations in accordance with Quad City Detail 103P.

630.3.2 Specific Valve Size Requirements

REPLACE item (A) with the following:

(A) Valves 2 inches through 12 inches:

REMOVE item (B) in its entirety and REPLACE with the following:

(B) Valves 14 inches and larger:

Valves shall be iron body resilient-seated gate valves in accordance with the latest revision of AWWA C515.

Valves shall be for operation in a horizontal position. The valve shall have bevel gears. The gears and stuffing box shall be enclosed in a watertight iron case, for operation in a buried location. The case shall be filled with grease at the factory.

By-pass valves shall be furnished and installed on each valve unless otherwise indicated on the approved plans. See Table 630-1 for by-pass valve sizes.

630.4 TAPPING SLEEVES AND VALVES

ADD the following:

The City Utility Operations shall be notified 48 hours in advance to schedule water main tap. If the Contractor is not ready for the tap at the scheduled time, the tap will be rescheduled. City crews will not remain on standby until the Contractor is ready for the tap. The rescheduled tap shall include a new 48 hour notification.

630.4.1 Tapping Valves

REMOVE the third paragraph in its entirety and REPLACE with the following:

Once the tap has been installed, the Contractor shall not operate the valve.

ADD the following:

Debris caps shall be installed on tapping sleeve valve according to MAG Detail 392 and shall be color-coded according to COP GES Detail 391Q. Debris caps shall be SW Services DC600 or approved equal.

630.5 BUTTERFLY VALVES

REMOVE item (A) and REPLACE with the following:

(A) 18 inches and larger:

REMOVE item (A) (1) in its entirety and REPLACE with the following:

(1) Valve body shall be of cast iron or ductile iron with connecting ends one of or a combination of flanged (short body) or mechanical joint.

REMOVE item (B) in its entirety and REPLACE with the following:

(B) 3 inches through 16 inches:

Butterfly valves shall not be used.

630.6 AIR RELEASE AND VACUUM VALVES

ADD the following:

(C) Air/vacuum release valves shall be in accordance with COP GES Detail 317Q-1 or 317Q-2.

(D) Combination Air Valves

(1) Air valves shall be standard combination style. Cast iron air valves shall comply with AWWA C512 except as modified herein. Valves shall be of the size shown and shall have threaded or flanged ends to match piping. Bodies shall be of high-strength cast iron, conforming to ASTM A126, Class B, or NSF 61 certified reinforced nylon. Floats of cast iron air valves shall be heavy stainless steel, suitable to withstand 1,000 psi external pressure. Seats of cast iron air valves shall be Buna-N. Other internal components of cast iron air valves shall be constructed of stainless steel, bronze, delrin, or cast iron as appropriate. Internal components for reinforced nylon valves shall be NSF 61 certified nylon, polypropylene, EPDM or NBR 70. Inlet and outlet ports for large orifice valves shall be baffled to prevent the action of high volume airflows from interfering with valve operations. Interior and exterior carbon steel surfaces shall be epoxy coated. Valves shall be designed for a minimum of 300 psi water working pressure, unless otherwise shown.

(2) Internal protective coatings shall be provided in accordance with AWWA C550.

(a) Liquid epoxy lining and coating materials shall be listed in the NSF Listing for Drinking Water Additives, Standard 61, certified for use in contact with potable water.

(b) The minimum dry film thickness for epoxy linings shall be 0.203 mm (0.008-inch or 8 mils). Liquid epoxy lining shall be applied in 2 coats in accordance with AWWA C210.

(3) Combination air valves shall be in accordance with COP GES Detail 317Q-1 or 317Q-2, unless shown otherwise. They shall have both large and small orifices in a single body. The large orifice shall serve to vent large quantities of air during filling operations and shall automatically open to relieve vacuum conditions. The small orifice shall vent small quantities of air under full line pressure that may become entrained in the system and collect at high points. Valves shall be APCO Series 140, Val-Matic Corp. Series 200, or equivalent

ADD the following subsection to 630.6 Air Release and Vacuum Valves:

630.6.1 Blow Off Installation

Blow off installation shall be in accordance with Quad City Detail 318P. The Contractor shall be required to provide Mega-Lug restraint for all joints for a distance specified per Quad City Detail 303Q-1 and 303Q-2.

630.8 MEASUREMENT

REMOVE in its entirety and REPLACE with the following:

Measurement will be by the unit each of the various kinds and sizes of valves, manholes, vaults, or tapping sleeves and valves, including valve boxes and covers, retrofit debris covers, air release valve assemblies, combination valve assemblies, and blow off assemblies.

630.9 PAYMENT

ADD the following:

Payment for valves, box and cover shall be per each at the unit bid price shown in the bidding schedule. Valves on tapping sleeves and hydrant installations shall be included in the appropriate bid item in the bidding schedule.

Debris cap specified on existing valves shall be incidental to the project work.

Payment for tapping sleeves shall be at the unit price bid in the bidding schedule and include the tapping sleeve, valve, box and cover, and all appurtenant fittings for complete assembly.

Payment for air release and vacuum valve installation shall be at the unit price bid in the bidding schedule and shall include all materials and appurtenant fittings as noted for a complete installation.

Payment for combination air valve assembly shall be at the unit price bid in the bidding schedule and shall include all materials and appurtenant fittings as noted for a complete installation.

Payment for blow off installation shall be at the unit price bid in the bidding schedule and shall include all materials and appurtenant fittings as noted for complete installation. No extra payment shall be made for Mega-Lug restraint.

ADD the following section to Part 600- Water, Sewer, Storm Drain and Irrigation:

SECTION 650: ABANDONMENT AND REMOVAL OF WATER MAIN

650.1 WATER MAIN ABANDONMENT

(A) Abandonment of existing water main shall not commence until hydrostatic and disinfection test results for the new main have been accepted by the Engineer. The Contractor shall contact the Engineer a minimum of 48 hours in advance of abandonment activities to schedule City water crews to coordinate valve operation. Water customers affected by water service disruption due to water main abandonment shall be notified by written flyer delivered by the Contractor a minimum of 24 hours in advance of scheduled water service disruption. Scheduled water service disruptions are limited to a maximum of 4 hours.

(B) Abandonment of existing main shall include the removal of all valves, hydrants, and appurtenances within the reach to be abandoned. All valves and hydrants to be abandoned shall be salvaged to the City unless otherwise noted on the plans or special provisions. All salvaged items shall be delivered to the City

Water Operations facility, located at 1481 Sundog Ranch Road, and placed as directed by the Engineer. Removed materials not identified to be salvaged shall become the property of the Contractor and properly disposed of. Removed or salvaged materials shall not be used in new main installation.

At all locations indicated on the plans, a minimum of 4 feet of water main shall be removed capped and the appropriate thrust restraint installed.

Existing valves to be abandoned shall include removing the valve, valve box, and cover in its entirety. Abandonment of appurtenances located in any structure (manhole, vault, etc.) shall include the complete removal and proper disposal of the appurtenance and the structure.

Abandonment of valves, hydrants, and appurtenances shall include the installation of the requisite number of mechanical joint caps as necessary to seal all pipe remaining in place.

(C) Restoration for water main abandonment shall include excavation, backfilling, compaction and re-surfacing in accordance with COP Supplement 601.

(D) Pavement matching and surface replacement shall be incidental to water main abandonment.

650.2 WATER MAIN REMOVAL

(A) Removal of water main shall not commence prior to authorization from the Engineer.

(B) Water main removal shall include the complete removal of all existing water main, valves, hydrants, structures, and appurtenances within the reach as indicated on the plans. All valves and hydrants to be removed shall be salvaged to the City unless otherwise noted on the plans or special provisions. All salvaged items shall be delivered to the City Water Operations facility, located at 1481 Sundog Ranch Road, and placed as directed by the Engineer. Materials not otherwise identified to be salvaged shall become the property of the Contractor and properly disposed of. Removed or salvaged materials shall not be used in new main installation.

(C) Removal of water main shall include excavation, backfilling, compaction, disposal and salvage in accordance with COP Supplement 601.

(D) Pavement matching and surface replacement shall be measured and paid accordance with COP Supplement 336. Any other restoration shall be considered incidental.

650.3 MEASUREMENT

Measurement for abandonment of water main and laterals shall be by the linear foot of pipe abandoned, measured horizontally through valves and fittings. Hydrants, valves, fittings, vaults, services, and other appurtenances shall be considered incidental to water main abandonment.

Measurement for removal of water mains and laterals shall be by the linear foot of pipe removed, measured horizontally through valves and fittings. Hydrants, valves, fittings, vaults, services, and other appurtenances shall be considered incidental to water main abandonment.

650.4 PAYMENT

Payment for water main abandonment shall be at the applicable unit bid price and shall include all work and appurtenant fittings necessary for complete abandonment. Pavement matching and surface replacement shall be incidental to water main abandonment.

Payment for water main removal shall be at the applicable unit bid price and shall include all work and appurtenant fittings necessary for complete removal. Pavement matching and surface replacement shall be

measured and paid accordance with COP Supplement 336. Any other restoration shall be considered incidental.

ADD the following section to Part 600- Water, Sewer, Storm Drain and Irrigation:

SECTION 651: ABANDONMENT AND REMOVAL OF SANITARY SEWER

651.1 SANITARY SEWER ABANDONMENT

(A) Abandonment of sanitary sewer shall not occur until all existing sanitary sewer services have been transferred to another main or lateral, and abandonment is approved by the Engineer.

(B) Abandonment of sanitary sewer shall include gravity and/or force mains, manholes, vaults, wet wells, and other appurtenances within the reach noted on the plans to be abandoned.

(C) Manhole frames, covers, vault access hatches, and clean-out frame and covers shall be salvaged to the City unless otherwise noted on the plans or special provisions. All salvaged items shall be delivered to the City Wastewater Collections facility, located at 1505 Sundog Ranch Road, and placed as directed by the Engineer. Materials not otherwise identified to be salvaged shall become the property of the Contractor and properly disposed of. Removed or salvaged materials shall not be used in new sewer installation.

(D) Restoration for sanitary sewer abandonment shall include all excavation, backfilling, compaction, and resurfacing in accordance with COP Supplement 601.

651.1.1 Sanitary Sewer Mains

(A) Abandonment of sanitary sewer mains shall include all gravity mains, laterals, and force mains, and shall be accomplished by pipe bursting or grout filling as indicated on the plans.

(1) Pipe bursting shall be performed using industry standard methods and equipment.

A pipe bursting plan including equipment used, means and methods shall be submitted and approved in accordance with Section 105.2 of these specifications prior to beginning bursting operations.

Valves shall be removed and disposed of prior to pipe bursting, and shall become property of the Contractor. All valves shall be properly disposed of in accordance with these specifications.

(2) Grouting shall be accomplished following industry standard methods, using a cement based grout to fill the void of the existing sanitary sewer main. The grouting material must have a minimum compressive strength of 100 psi and shall have flow characteristics appropriate for filling a sanitary sewer.

Injection of the grout material shall be done with sufficient pressure and injection locations to fill the existing sanitary sewer line. The method shall adequately provide for the removal and legal disposal of existing sewage in the lines and any pipe materials removed, and release of air from the system to facilitate proper abandonment.

A grouting plan including equipment used injection locations, grout mix design, and means and methods shall be submitted and approved in accordance with Section 105.2 prior to beginning grouting operations.

651.1.2 Manholes, Vaults and Wet Wells

(A) Abandonment of manholes, vaults, wet wells and other structural appurtenances shall include the complete removal of each structure within the reach to be abandoned as indicated on the plans.

(B) All items removed and not salvaged shall become property of the Contractor and properly disposed of in accordance with these specifications.

(C) Backfilling after removal shall be in accordance with COP Supplement 601.

(D) Pavement matching and surface replacement shall be incidental to sewer abandonment.

651.2 SANITARY SEWER REMOVAL

(A) Removal of sanitary sewer shall not commence prior to authorization from the Engineer.

(B) Removal of sanitary sewer shall include the complete removal of gravity and/or force mains, manholes, vaults, wet wells, and other appurtenances within the reach noted on the plans to be removed.

Existing sanitary sewer that is removed coincident with the installation of new sanitary sewer shall be considered incidental to the installation and shall not be measured or paid for under this section.

(C) Manhole frames, covers, vault access hatches, and clean-out frame and covers shall be salvaged to the City unless otherwise noted on the plans or special provisions. All salvaged items shall be delivered to the City Wastewater Collections facility, located at 1505 Sundog Ranch Road, and placed as directed by the Engineer. Materials not otherwise identified to be salvaged shall become the property of the Contractor and properly disposed of. Removed or salvaged materials shall not be used in new sewer installation.

(D) Removal of sewer main, laterals, or force main that tie into an existing manhole that is to remain in service shall include complete removal of the penetrating pipe and grouting the hole with lean, non-shrink grout. A water stop shall be used to ensure the integrity of the manhole.

The water stop proposed shall be submitted for review and approval prior to removal activities in accordance with Section 105.2 of these specifications.

(E) Removal of sanitary sewer shall include excavation, backfilling and compaction in accordance with COP Supplement 601. Disposal, salvage, and bypass pumping shall be considered incidental to sewer removal.

(F) Pavement matching and surface replacement shall be measured and paid in accordance with Section 336 of these specifications. Any other restoration shall be considered incidental.

651.3 MEASUREMENT

Measurement for abandonment of sewer main, laterals, and force main shall be by the linear foot of pipe abandoned, measured horizontally through manholes, vaults, valves, and fittings. Valves, fittings, services, cleanouts, and other appurtenances shall be considered incidental to sewer abandonment.

Abandonment of manholes and wet wells shall be the number of each abandoned. Vaults shall be considered incidental to sewer abandonment unless otherwise noted in the special provisions.

Measurement for removal of sewer main, laterals, and force main shall be by the linear foot of pipe abandoned, measured horizontally through manholes, vaults, valves, and fittings. Valves, fittings, services, cleanouts, and other appurtenances shall be considered incidental to sewer removal.

Measurement for manholes and wet wells shall be the number of each removed. Vaults shall be considered incidental to sewer abandonment unless otherwise noted in the special provisions.

651.4 PAYMENT

Payment for abandoning sewer mains, laterals, and force main shall be made at the contract unit price. Said price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work. Pavement matching and surface replacement shall be incidental to sewer abandonment.

Payment for abandoning manholes and wet wells shall be made at the contract unit price. Said price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work. Pavement matching and surface replacement shall be incidental to sewer abandonment.

Payment for removing sanitary sewer shall be made at the contract unit price. Said price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work. Pavement matching and surface replacement shall be measured and paid in accordance with Section 336 of these specifications. Any other restoration shall be considered incidental.

Payment for removing manholes and wet wells shall be made at the contract unit price. Said price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work. Pavement matching and surface replacement shall be measured and paid in accordance with Section 336. Any other restoration shall be considered incidental.

PART 700 – MATERIALS

SECTION 701: AGGREGATE

701.4 RECLAIMED CONCRETE MATERIAL (RCM)

REMOVE in its entirety and REPLACE with the following:

Use of Reclaimed Concrete Material (RCM) is not allowed.

701.5 RECLAIMED ASPHALT PAVEMENT (RAP)

REMOVE in its entirety and REPLACE with the following:

Reclaimed asphalt pavement (RAP) shall not be allowed.

SECTION 703: RIPRAP

703.1 GENERAL

REMOVE the second paragraph in its entirety and REPLACE with the following:

Aggregate shall be color-matched with adjacent landscape aggregate or as specified on the plans or in the special provisions, and approved by the Engineer. Payment for riprap shall include all work associated with providing color samples.

SECTION 710: ASPHALT CONCRETE

710.2.1 Asphalt Binder

REMOVE in its entirety and REPLACE with the following:

(A) The approved asphalt binder shall be either Performance Grade (PG) 64-22, PG 70-22, PG 70-22TR, or PG70-22TR+ asphalt conforming to the requirements of AASHTO M 320-09 Performance-Graded Asphalt Binder. The binder grade shall be as specified in the contract documents or as directed by the Engineer.

(B) The Engineer may review a request by the Contractor to change from the approved binder grade.

710.2.3 Reclaimed Asphalt Pavement (RAP):

REMOVE in its entirety and REPLACE with the following:

Reclaimed asphalt pavement (RAP) shall not be allowed.

710.3.1 General

REMOVE item (11) in its entirety.

710.3.2 Mix Design Criteria

ADD the following:

(A) The intent of this supplement is to use only ½ inch or ¾ inch Marshall or Gyratory Mix Designs within the specification unless specifically called out in the project specifications.

(B) The asphalt mix design shall be for high traffic volume, unless otherwise specified.

710.3.2.1 Marshall Mix Design

REMOVE item (5) in Table 710-3 Marshall Mix Design Criteria and REPLACE with the following:

(5) Tensile Strength Ratio: % Min.

Minimum percent requirement is changed to 75. A tensile strength ratio of 75 percent may require more than 1 percent mineral admixture.

REMOVE item (7) in Table 710-3 Marshall Mix Design Criteria and REPLACE with the following:

(7) Stability: pounds, Minimum

Minimum requirement is changed to 3500 for ½ inch mix and ¾ inch mix.

SECTION 725: PORTLAND CEMENT CONCRETE

725.1 GENERAL

ADD the following:

All Portland cement concrete placed under this contract shall be Class AA with a maximum water/cement ratio of 0.45.

ADD the following subsection to 725.1 General:

725.1.1 Adverse Weather Concreting

(A) Hot Weather Concreting: Hot weather is defined as any combination of high ambient temperature, low relative humidity, and wind velocity which would tend to impair the quality of fresh concrete. These effects become more pronounced as wind velocity increases. Since last minute improvisations are rarely successful, preplanning and coordination of all phases of the work are required to minimize these adverse effects.

(1) Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:

(a) Cool ingredients before mixing to maintain concrete temperature below 90 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is the Contractor's option.

(b) Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

(c) Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

(2) As an absolute minimum, the Contractor shall ensure that the following measures are taken:

(a) An ample supply of water, hoses, and fog nozzles are available at the site.

(b) Spare vibrators are on hand in the ratio of 1 spare vibrator for each 3 in use.

(c) Pre-planning has been accomplished to ensure prompt placement, consolidation, finishing, and curing of the concrete.

(d) Concrete temperature on arrival should be approximately 60 degrees F and in any event shall not exceed 90 degrees F. The use of cold water and ice is recommended.

(e) The subgrade is moist, but free of standing water.

(f) Fog spray is utilized to cool the forms and steel. Under extreme conditions of high ambient temperature, exposure to the direct rays of the sun, low relative humidity, and wind, even strict adherence to these measures may not produce the quality desired and it may be necessary to restrict concrete placement to early morning only. If this decision is made, then particular attention must be directed to the curing process since the concrete will be exposed

to severe thermal stresses due to temperature variation; heat of hydration plus midday sun radiation versus nighttime cooling.

(B) Cold Weather Concreting: Comply with ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

(1) When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement.

(2) Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

(3) Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

(C) Wet Weather Concreting: Placing of concrete shall be discontinued when the quantity of rainfall is such as to cause a flow or wash to the surface. Any concrete already placed and partially cured shall be covered to prevent dimpling. A construction joint will be installed prior to shut down.

(D) Replacement of Damaged or Defective Concrete: Upon written notice from the Engineer, all concrete which has been damaged or is defective, shall be replaced by the Contractor at no cost to the Contracting Agency.

(E) References

(1) ACI-305 Hot Weather Concreting

(2) ACI-306 Cold Weather Concreting

(3) ACI-308 Recommended Practices for Curing Concrete

(F) No separate payment shall be made for adverse weather concreting. The work shall be considered incidental and included in the unit price bid for construction or installation of the appropriate contract pay item.

725.5 ADMIXTURES AND ADDITIVES

REMOVE the third paragraph in its entirety and REPLACE with the following:

Air entraining admixtures incorporated into the approved concrete mix design shall meet the requirements of ASTM C260. All Portland cement concrete shall contain 6 percent, plus or minus 1 percent, entrained air of evenly dispersed air bubbles at the time of placement. The air-entraining agent shall contain no chlorides. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air entrainment in the concrete shall be tested in accordance with AASHTO T 152. Air entrainment shall be tested at time of sampling in accordance with ASTM C143 and C231 respectively. The cost of this testing shall be the responsibility of the Contractor.

725.8.1 Field Sampling and Tests

REMOVE the fourth paragraph in its entirety and REPLACE with the following:

The slump of Portland cement concrete shall be tested in accordance with the requirements of AASHTO T 119, ASTM C143 and ASTM C231 respectively. Concrete that does not meet the specification requirements as to slump shall not be used, but shall be removed from the job at no cost to the City. Slump tests shall be

taken in the field by a representative of the Contractor's Quality Control firm. The cost of this testing shall be the responsibility of the Contractor.

725.8.2 Concrete Cylinder Test:

ADD the following:

Concrete cylindrical specimens for compression tests shall be taken in the field by a representative of the Contractor's Quality Control firm in accordance with AASHTO T 141 and T 23. These samples will be tested for compressive strength in accordance to AASHTO T 22. Concrete samples will be taken in accordance with this section and MAG Specification 725.8.3, except as noted hereinafter. 1 set of not less than 4 cylinders per 50 cubic yards or ½ days pour shall be prepared and retained to verify compressive strength of the mixture. 1 cylinder shall be tested at 7 days and 2 at 28 days. The fourth cylinder shall be retained for up to 60 days. If the 28 day test does not meet the minimum strength requirement, cores shall be taken as provided herein and the cost of such will be the responsibility of the Contractor. Acceptance shall be based on minimum 28 day strength requirements. The cost of testing shall be the responsibility of the Contractor.

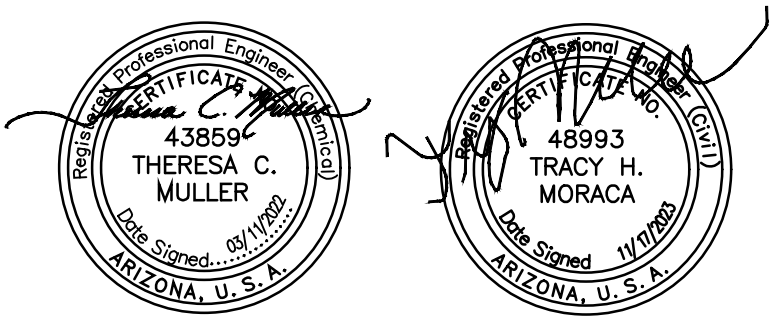
CITY OF PRESCOTT

ZONE 41 (MINGUS) PUMP STATION, TANK, AND PIPELINE PROJECT
PROJECT NO: CIP 17-009

TECHNICAL SPECIFICATIONS

CONSTRUCTION SET

NOVEMBER 2023



Prepared by

Brown AND Caldwell

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CITY OF PRESCOTT
ZONE 41 (MINGUS) PUMP STATION, TANK, AND PIPELINE PROJECT
PROJECT NO: CIP 17-009
TECHNICAL SPECIFICATIONS

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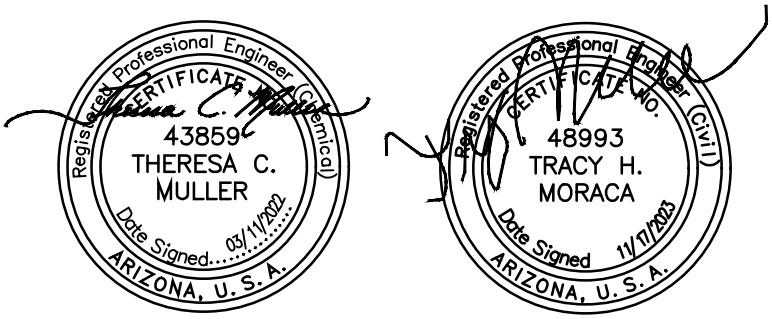

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APPENDIX A GEOTECHNICAL REPORTS:

1. ENGINEERING AND TESTING CONSULTANTS INC. SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT – ZONE 41 PUMP STATION AND WATERLINE
2. ENGINEERING AND TESTING CONSULTANTS INC. ADDENDUM TO SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT – ZONE 41 PUMP STATION AND WATERLINE
3. ENGINEERING AND TESTING CONSULTANTS INC. 2ND ADDENDUM TO SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT – ZONE 41 PUMP STATION AND WATERLINE

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. These Technical Specifications, including Appendix A, Geotechnical Report, shall be for the work performed at the site of the City of Prescott Zone 41 (Mingus) Pump Station (PS), Tank and Pipeline.

B. Work is also being performed along the new waterline alignment and roadway improvements as shown in the Contract Documents and specified in the Special Provisions and the City of Prescott Supplement to the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction as shown in the Contract Documents.

C. In the case of conflict between City of Prescott Supplement to the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction and the Technical Specifications, the more stringent requirement shall prevail as determined by the Owner.

1.02 DESCRIPTION OF OWNER'S PROJECT

A. The overall project will consist of water system improvements in the City of Prescott's Zone 41.

B. The existing Zone 41 (Mingus) storage tanks are located on the hilltop within Yavapai County Assessor Parcel Number 116-15-033. The existing Zone 41 (Mingus) PS is located to the east of Willow Creek Road and encompasses a portion of Douglas Avenue within Yavapai County Assessor Parcel Number 116-16-012A. The Zone 41 (Mingus) PS and Mingus Tanks will be replaced with new facilities and the existing facilities will be demolished. Generally, the improvements are to replace the two existing 200,000-gallon storage tanks with a single 0.75 million-gallon water storage tank, replace the existing 500 gallon per minute (gpm) Mingus PS with a new 2,250 gpm Zone 41 PS, and upsize the existing water supply pipe.

C. The Zone 41 (Mingus) PS will connect to an existing supply line from Zone 0, with new piping to replace existing piping from the new PS to the new Zone 41 (Mingus) Tank. New piping will also connect the PS to existing Zone 41 piping near the intersection of Douglas Avenue and Northside Drive. There will be a common water main from the discharge of the new PS, which will split to discharge to either the new tank or connect to the Zone 41 distribution system.

1.03 WORK OF THIS CONTRACT

A. The work to be performed under this Contract includes the construction of the new Zone 41 (Mingus) PS and Tank, pump station and the associated building, heating, ventilation, and air conditioning, drainage improvements, electrical, controls, and instrumentation, surge tank, stand-by generator, the new waterline, and roadway improvements. Work also includes demolition and removal of the existing Zone 41 (Mingus) PS and Tanks.

END OF SECTION

SECTION 01 11 80

ENVIRONMENTAL CONDITIONS

PART 1 GENERAL

1.01 ENVIRONMENTAL CONDITIONS

A. This Section describes the environmental conditions which have been observed at the site of the work and which may reasonably be anticipated throughout the life of the project.

1.02 CLIMATE CONDITIONS

A. The site of the work is at an elevation range of approximately 5,500 to 5,700 feet above mean sea level.

B. Climate conditions are described as follows:

Description	Range of Conditions
Winter	Average high temperature of 51-55°F; Average low temperature of 23-26°F, with average snowfall of 13 inches and average monthly snowfall of 2 to 4 inches.
Summer	Average high temperature of 76-90°F; Average low temperature of 53-60°F, with average rainfall of 18 inches and average monthly rainfall of 0.3 to 3 inches.
Relative Humidity, percent	
• Average Outdoors	Ranges from 6-99%, with typical ranges from 13-80%.
Air Temperature, degrees F	
• Outdoors	Average high temperature is 70°F; Average low temperature is 40°F.
Barometric Pressure, inches, mercury	30

1.03 ADDITIONAL CONDITIONS

A. Additional conditions which may be applicable are specified in other Sections.

END OF SECTION

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SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 CONTINUITY OF OPERATIONS

A. The existing water distribution system is currently and continuously supplying water to customers, and those functions shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of equipment and supply of water.

B. The Contractor shall provide the labor, materials and supervision to provide temporary systems required to maintain normal operation of the existing water distribution system.

C. Temporary water mains (fly lines) shall be in accordance with the City of Prescott Supplement to the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details for Public Works Construction Technical Specifications, Section 612.

1.02 NOT USED

1.03 SUBMITTAL

A. In accordance with Section 01 33 00, the Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a pump, tank, pipeline, channel, electrical circuit, equipment, or structure from service. The schedule shall be coordinated with the construction schedule specified in the General Conditions of the Contract Documents and shall meet the restrictions and conditions specified in this Section. The detailed plan shall describe proposed dates and times of outages; the Contractor's method for taking equipment/piping out of service; the length of time required to complete said operation; and equipment, both temporary and permanent, and sequence and specific times of activities which the Contractor shall incorporate in order to limit the disruption of service. The Contractor will prepare a bill of materials and a list of equipment and supplies required to complete the work, including piping removal, disinfection and reinstatement of service. The plan will include an hour-by-hour schedule with detailed tasks and responsibility for each task as well as Lock-out/Tag-out procedures to be implemented during the Contractor’s activities.

B. The Contractor shall observe the following restrictions:
   1. A separate shutdown plan will be submitted for each anticipated shutdown.
   2. No work will commence until the shutdown plan has been reviewed by Brown and Caldwell and the City of Prescott and is approved for execution.
   3. The Contractor is responsible for systems or individual equipment items that shall be isolated, dewatered, decommissioned, deenergized, or depressurized in accordance with the detailed outage plan and schedule.
   4. The Construction Manager shall be notified in writing at least 1 week in advance of the planned operation.

C. The design of the temporary system and construction sequencing approach shall be prepared by the Contractor and submitted for review. Means and methods of accomplishing the bypassing shall be the responsibility of the Contractor.

1.04 SEQUENCE AND SCHEDULE OF CONSTRUCTION

A. To assure continuous supply of water to the City of Prescott's customers, the construction schedule sequencing required in in the General Conditions of the Contract Documents shall provide for the following specific conditions:

1. The existing Zone 41 (Mingus) Pump Station (PS) must remain in service until the new Zone 41 (Mingus) PS has successfully completed the 7-day commissioning period and has been accepted by the City of Prescott. The electrical room of the new PS will be positioned immediately adjacent to the existing PS. The Contractor must ensure that any construction, especially the northwest portion of the new Zone 41 (Mingus) PS electrical room, is adequately planned in advance and does not affect existing PS operation. In addition, it shall be understood that the existing Zone 41 (Mingus) PS maintains the Zone 41 (Mingus) Tanks' levels and can only be taken out of service for very short periods of time. All new waterlines must be in service.

   Shutdowns for connections and cut-overs must be coordinated and scheduled with the City prior to taking the station out of service. Duration of the outages will depend on current customer demand and will dictate allowable length of outage.

2. The new standby generator and associated masonry wall at the Zone 41 (Mingus) PS cannot be constructed until the existing Zone 41 (Mingus) PS has been demolished and the new PS has been successfully commissioned and accepted. As part of the project, the Contractor will be required to provide temporary power as required should power failure occur before the permanent emergency generator is installed and fully operational. The Contractor shall provide a temporary, fully operational generator appropriately sized to meet all power demands of the new pump station including all cabling, connections and programming, fuel and maintenance.

B. A detailed sequence of construction and demolition is provided as an example of how the new PS may be integrated into the system while maintaining the existing Zone 41 (Mingus) PS. The Contractor may use this strategy if it believes this is the best approach or may develop an alternate strategy for review and approval.

   This project involves the replacement of three primary components of the pressure Zone 41 system: the Mingus PS, the Mingus Tanks, and significant portions of the water transmission main between them. As the existing system does not have the capacity nor the capability to completely isolate all three components at once for demolition and construction, each of the construction tasks will need to be phased so that appropriate operation is maintained throughout the construction process.

1. The Zone 41 PS and waterline will be constructed first and concurrently, as both components can be installed and constructed adjacent to existing facilities.
2. To maintain the supply to Zone 41, the existing Mingus PS will remain in operation during the new Zone 41 PS construction. The placement of the new PS is extremely close to the existing station. The Contractor may need to make modifications to the existing PS building to allow for construction of the new station, while continuing to maintain operation of the existing Mingus pumps. Existing supply and discharge piping conflict with the location of the new pump station so temporary piping will be required. All temporary piping greater than 2-inches shall be fused high-density

polyethylene solid wall pipe conforming to AWWA C906 with a minimum DR ratio based on 150 psi and NSF 61 certified. Buried temporary pipe shall have a minimum of 3 feet of cover. The Contractor shall restrain the temporary piping as necessary. Additionally, there are water services served by existing discharge pipe that need to be maintained as the new water main is installed using temporary fly lines. Temporary fly lines that are 2-inches and smaller will be PEX.

The following approach is an example of how the new PS may be integrated into the system while maintaining the existing Zone 41 (Mingus) PS. Generally, the existing 8" discharge pipe from the PS and the tank will be used to continue to supply existing customers. While portions of the existing 6" discharge pipe will need to be isolated and removed from service to allow for installation of the new 16" W pipe, some of the 6" W pipe will be used to maintain supply to customers. Specifically, the 6" W pipe from the reservoir south to APN 116-56-071, over to Northside Road and then south to Douglas Road will remain in service until the installation of the new pipe is complete.

Temporary piping will need to be installed to provide continuous service and the Contractor may need to make modifications to the install of the new pipe up the Tank Site Road to accommodate keeping the 8" W pipe in service during construction. The Contractor shall make necessary modifications to the existing Mingus PS to accommodate the temporary bypass piping. This approach is also shown graphically in the figures at the end of this Section.

a. Close the isolation valve on the existing 24" W supply pipe.
b. Tie in a temporary 16" HDPE supply pipe into the existing 24" W pipe and install temporary pipe to the existing 14" supply pipe near the existing pump station.
c. Install the new 4" water pipe as shown in the Contract Documents, including the five new water service connections.
d. Install a temporary 8" HDPE discharge pipe from the existing 6" W discharge pipe near the existing PS to the existing 8" supply pipe.
e. After installation, the Contractor shall successfully pressure test, clean and flush per the requirements of Section 40 05 01 and the City of Prescott Supplement to MAG Technical Specifications.
f. After the new 4" water pipe and temporary discharge pipes are installed, tested, and ready for use, provide a cap with a 2" plug that can be used for a 2" temporary PEX pipe that is connects the new 4" water pipe to the existing 8" water pipe to maintain supply to existing water meters. A saddle with a 2" tap can be installed before the cap for testing and flushing. Also provide a temporary 1" PEX pipe from the new 4" water pipe to the existing water meters at APNS 116-16-168A and 116-16-067A as shown on the Contract Drawings.
g. When the temporary connections are installed and ready for use, cap the existing 6" discharge pipe near the new temporary pipe connection.
h. Provide a temporary 1" PEX pipe from the existing 8" water pipe to supply water to the meter located at 815 Douglas Avenue (APN 116-16-068B). The temporary connection should be located to the east of the intersection of Douglas Avenue and the Tank Site Road.

3. The footprint of the new backup generator pad overlaps the footprint of the Mingus PS. Once construction of the new electrical room and pump room is complete, the Zone 41 PS will be tested and complete a 30-day commissioning period. Once that commissioning period is completed, Zone 41 PS will become the sole source of supply to Zone 41. At that time, the Mingus PS will be taken offline and demolished

to allow space for construction and installation of the new backup generator, pad, and wall. During the interim period of the construction and installation of the new backup generator, a temporary generator will be provided for back-up power to the Zone 41 PS.

4. A significant portion of the new waterline alignment will be adjacent to the existing waterline that currently supplies the Mingus Tanks. During the installation of the new line, the existing waterline will remain in service.
    a. An 8" supply pipe located near the existing tanks must remain in service as it is used to supply water to customers north of the site.
5. The new Zone 41 Tank will be built on the same footprint of the Mingus Tanks. As a result, prior to any work being done on the tank site, the existing tanks will need to be drained and taken offline. This work will not begin until the Zone 41 PS is through the 30-day commissioning period. Constructing the Zone 41 Tank after the commissioning of the Zone 41 PS will allow for service to be maintained throughout the construction of this project.
6. To ensure that appropriate system pressure is maintained in Zone 41 during the construction of the Zone 41 Tank, the VFDs installed with the Zone 41 PS will be programmed to maintain a range of system pressure while the Mingus tanks are offline, and the PS is supplying directly to distribution. Refer to Specification 40 61 96.
7. The temporary systems shall be removed by the Contractor when no longer needed.

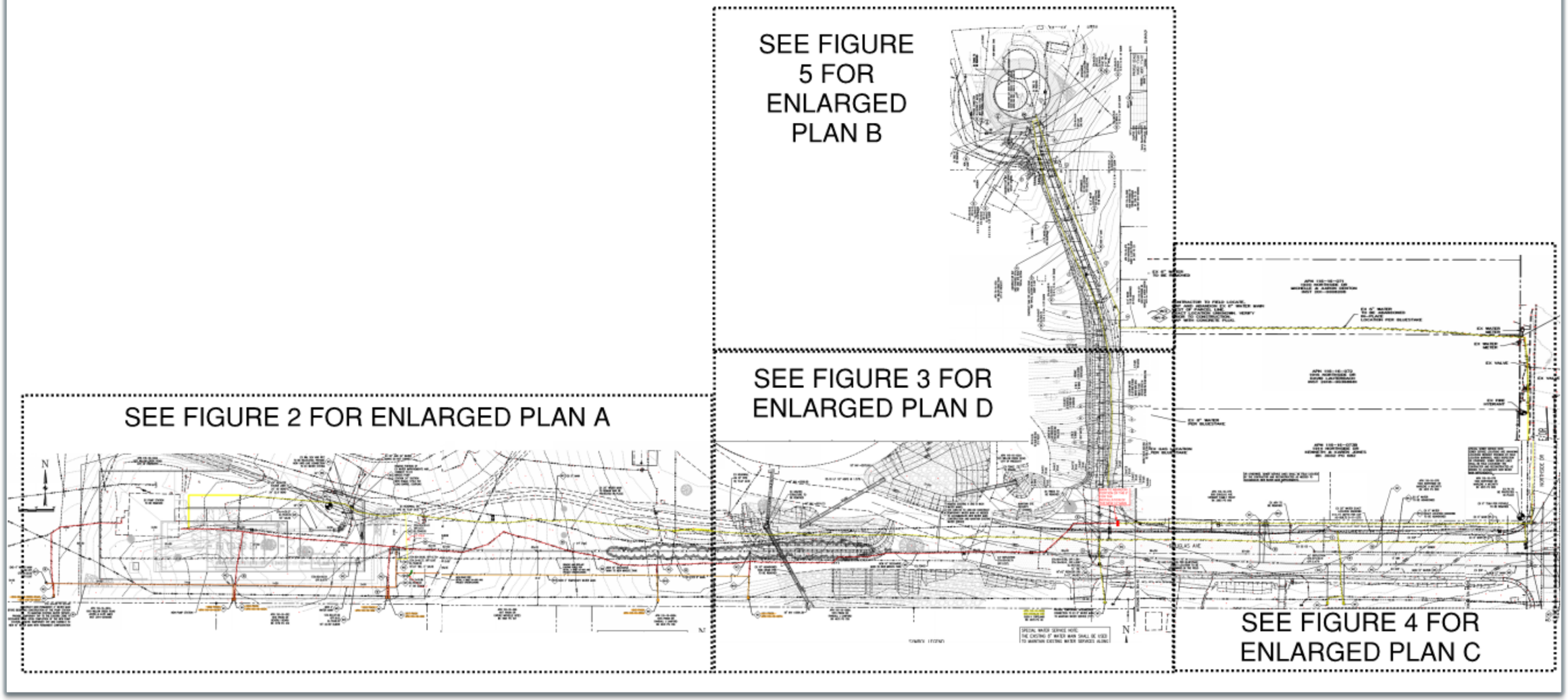

FIGURE 1: OVERVIEW

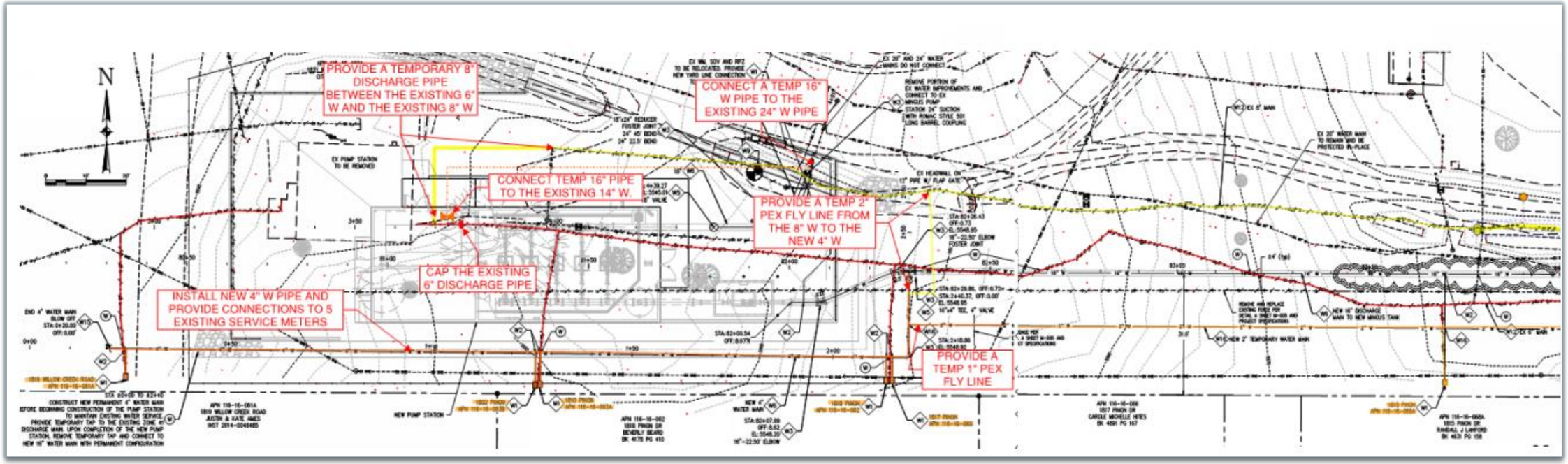

FIGURE 2: ENLARGED PLAN A

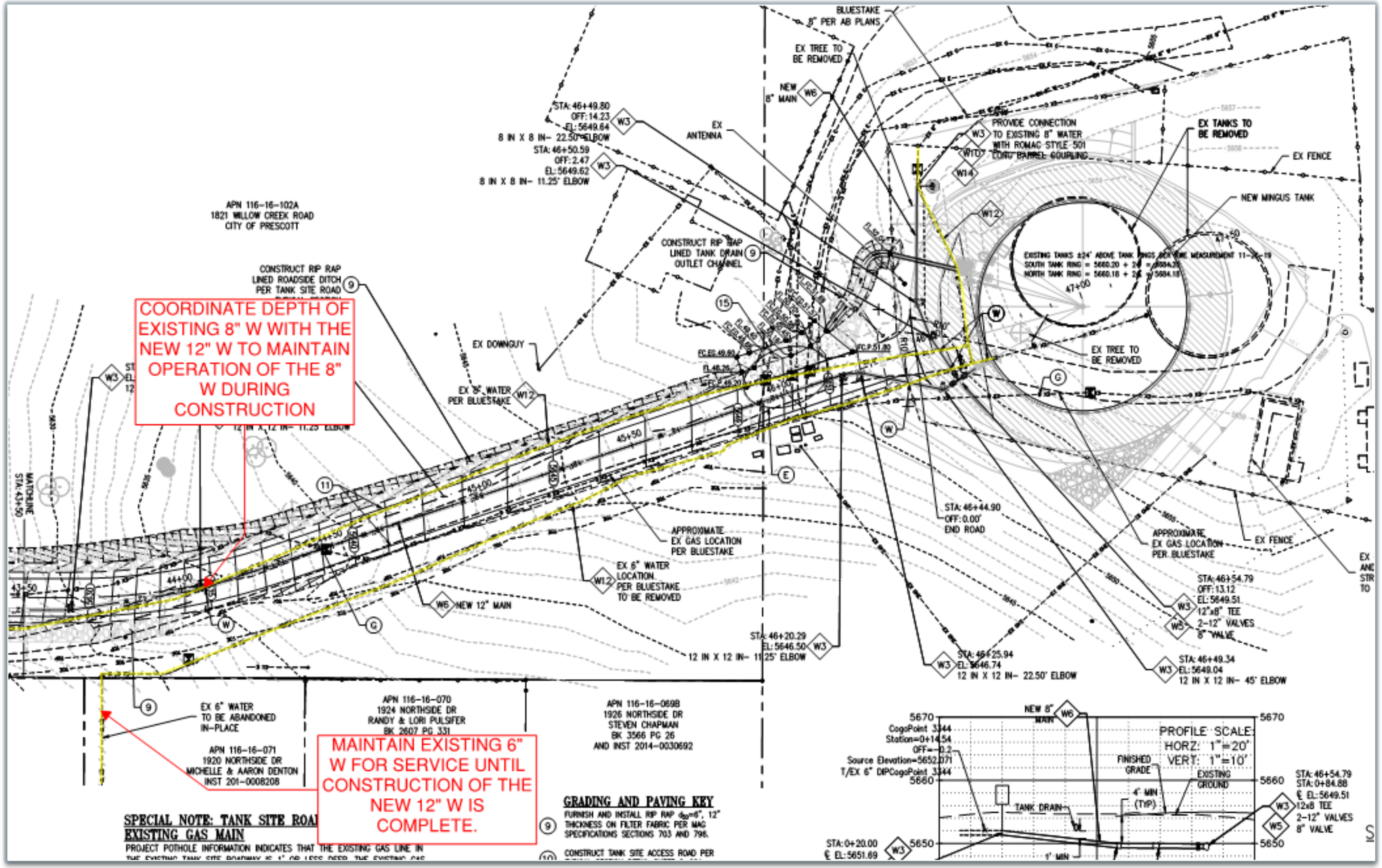

FIGURE 3: ENLARGED PLAN B

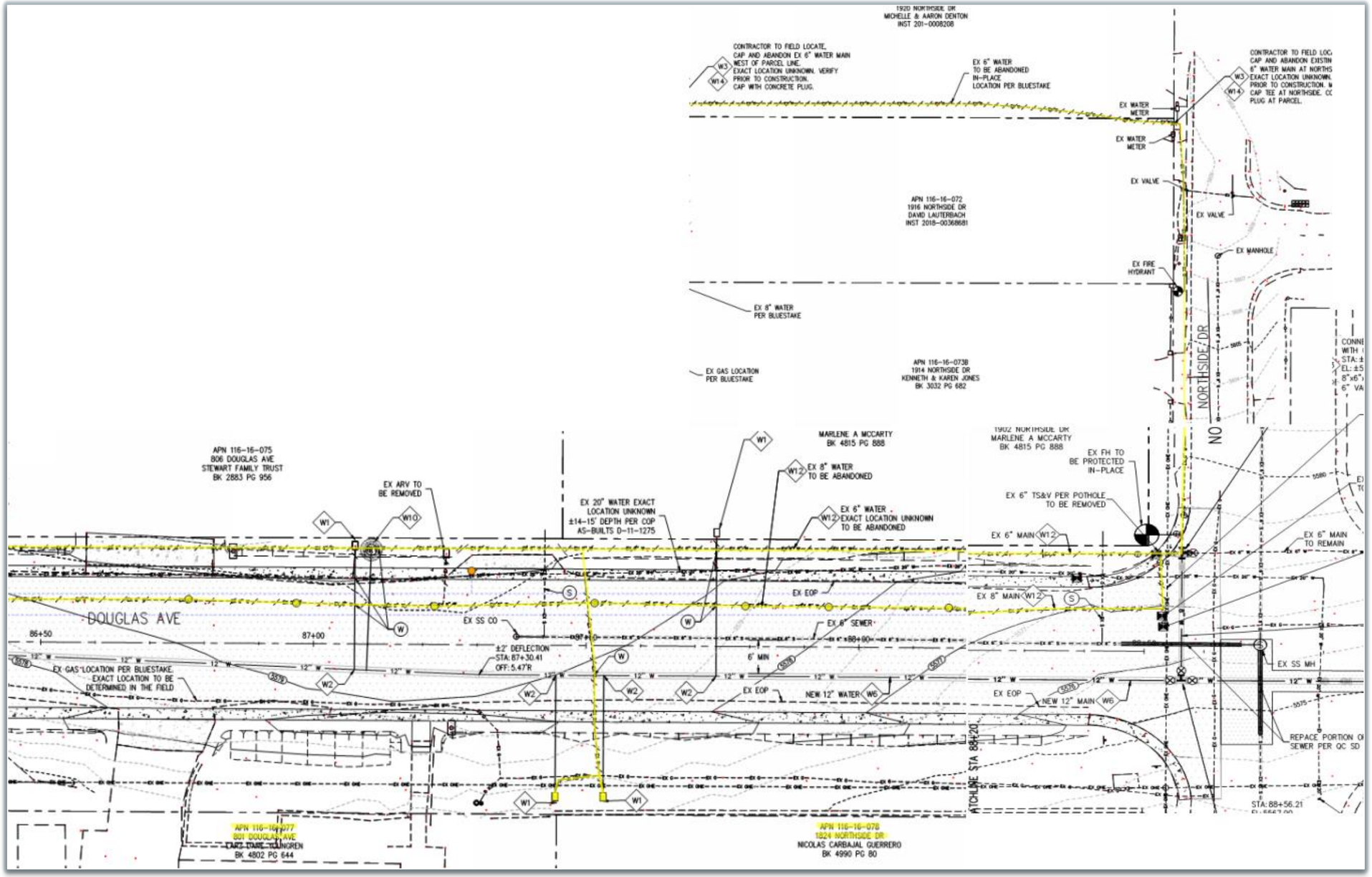

FIGURE 4: ENLARGED PLAN C

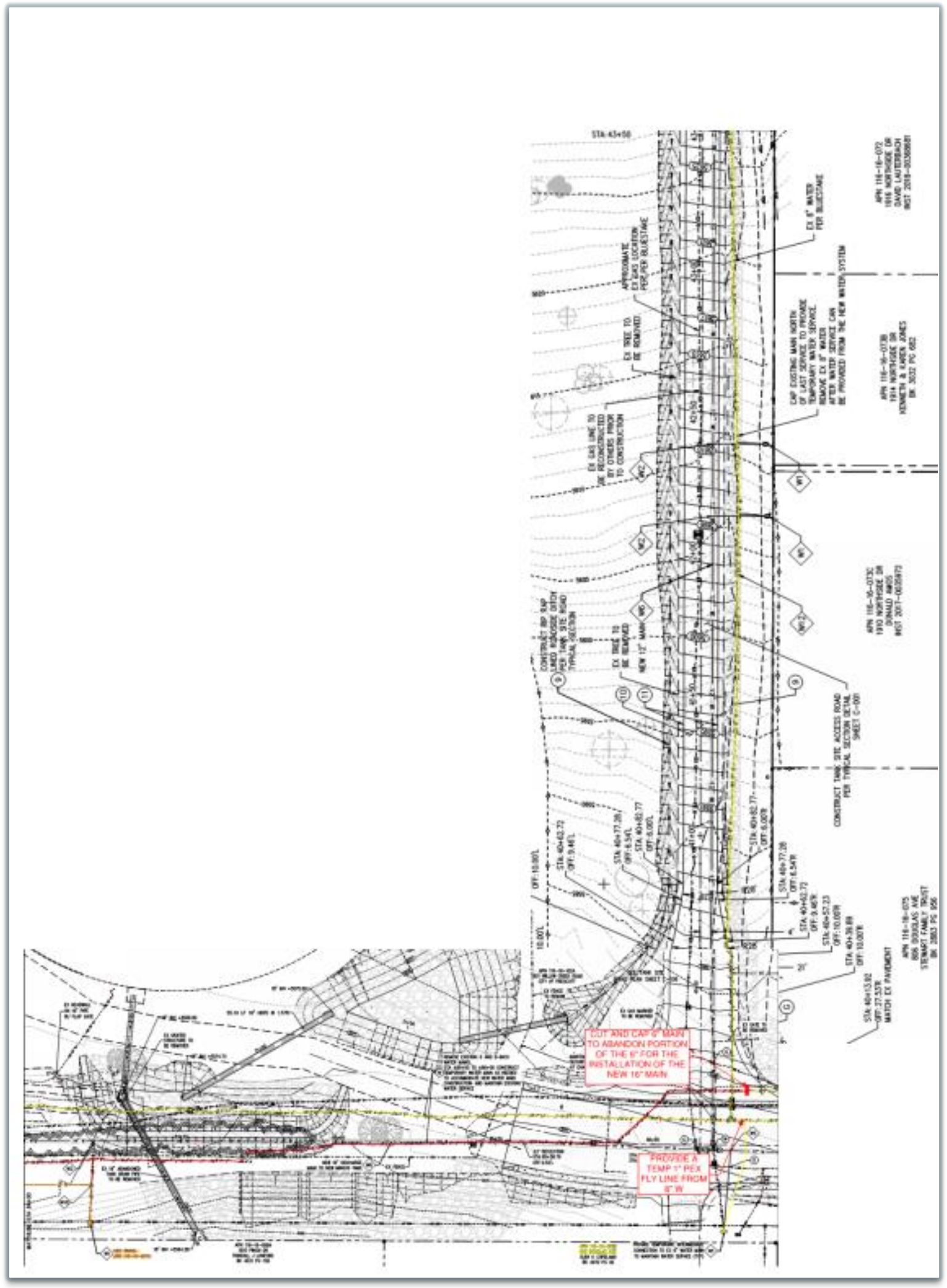

FIGURE 5: ENLARGED PLAN D

END OF SECTION

SECTION 01 14 19

USE OF SITE

PART 1 GENERAL

1.01 SUMMARY

A. The Owner's operating personnel will be responsible for operating the pump station throughout the execution of this Contract. Equipment presently installed in the pump station must be available to the City of Prescott personnel at all times required for use, maintenance, and repair. If it is necessary in the course of operating either the existing pump station or the new Zone 41 (Mingus) Pump Station for the Contractor to move its equipment, materials, or any material included in the work, it shall do so promptly and place that equipment or material in an area that does not interfere with pumping operation. The Contractor shall not adjust or operate serviceable or functioning equipment or systems, except as specifically required by this Contract.

B. The existing pumps will remain in operation until the commissioning period of the new Zone 41 (Mingus) Pump Station has been completed. Access to any operational pumps and supporting equipment is required at all times.

C. The Contractor shall notify the Construction Manager and Owner, in accordance with Section 01 12 16, 2 weeks in advance of the time it is necessary to take out of service any existing tank, pipeline, channel, electrical circuit, equipment or structure. The Contractor shall be responsible for providing whatever temporary piping, pumping, power, and control facilities as are required to maintain continuous pumping operation and complete water distribution, except as otherwise specified.

END OF SECTION

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SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SCOPE

A. This Section specifies the procedures for preparing and revising the critical-path method construction schedule used for planning and managing construction activities. The schedule provides a basis for determining the progress status of the project relative to specific dates and completion time.

1.02 DESCRIPTION

A. The Contractor shall provide a graphic construction schedule prepared by the critical-path method of analysis. The critical-path schedule shall be prepared from estimates of the required duration and sequence for each item of work and function to be performed. A general guide for preparing such a schedule is contained in "The Use of CPM in Construction, A Manual for Contractors," published by the Associated General Contractors of America.

B. The schedule shall depict all significant pre-construction and construction activities and all items of work listed in the breakdown of Contract Prices submitted by the Contractor in accordance with the General Conditions of the Contract Documents. The schedule shall include separate activities for development and review of all submittals believed to be on the critical path of the schedule. The dependencies between activities shall be indicated so that it may be established what effect the progress of any one activity has on the schedule.

C. Time for completion and all specific dates as specified in the Contract Documents and sequencing requirements described in Section 01 12 16 shall be shown on the schedule. Activities making up the critical path shall be identified.

D. No activity on the schedule shall have a duration longer than 21 days or assigned value greater than $100,000, except activities comprising only fabrication, and delivery may extend for more than 21 days. Activities which exceed these limits shall be divided into more detailed components. The schedule duration of each activity shall be based on the work being performed during the normal 40-hour workweek, with allowances made for legal holidays and normal weather conditions.

1.03 SUBMITTAL PROCEDURES

A. Per the City of Prescott Supplement to MAG Section 108.4, the Contractor shall submit a baseline construction schedule conforming to paragraph 1.02 and representing, in detail, all planned procurement and on-site construction activities at the pre-construction meeting. Upon completion of the baseline schedule by the Construction Manager, the Contractor shall submit one electronic file and two copies to the Construction Manager in accordance with Section 01 33 00.

B. Within 7 days after receipt of the submittal, the Construction Manager shall review the submitted schedule and return one copy of the marked-up original to the Contractor. If

the Construction Manager finds that the submitted baseline schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy, returned to the Contractor for corrections, and resubmitted as specified in Section 01 33 00.

C. Once this schedule has been accepted by the Construction Manager and Owner, the Contractor shall not deviate from it until a revised schedule has been submitted and accepted by the Construction Manager and Owner.

1.04 SCHEDULE REVISIONS

A. Revisions to the accepted critical path construction schedule may be made only with written approval of the Contractor and Owner. Changes in timing for activities which are not on the critical path may be modified with a written agreement between the Contractor and Construction Manager. A change affecting the Contract Value of any activity, the timing of any activity on the critical path, the completion time and specific dates as specified in the Contract Documents, and work sequencing (Section 01 12 16) may be made only in accordance with applicable provisions of the General Conditions of the Contract Documents.

1.05 PROJECT STATUS UPDATE

A. The Contractor will provide monthly progress updates to the project baseline schedule. Included in the monthly updates will be changes to the schedule. This will include written reports which identify all changes to schedule logic and justification for the logic change; all changes to activity durations and justification for the change in activity duration; successor/predecessor reports; critical-path activity report; and the Substantial and Final Completion Date of the Project. Project status review and update shall be provided each month as specified in the General Conditions of the Contract Documents. Both electronic and hard copy of the schedule updates will be provided as part of the pay application. Review and acceptability of the pay application will be in part contingent on the acceptability of the baseline schedule and monthly updates to the baseline schedule.

B. The Contractor will provide two-week look ahead schedules to the City at the weekly progress meetings during Construction.

END OF SECTION

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 PRECONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide preconstruction digital photographs prior to commencement of work on the site. The photographs shall be provided in electronic (jpeg) form with an index print of the images which shows the date, name of work, and the location where the photograph was taken. Before construction may start, a CD, DVD or USB along with the index print containing all images shall be delivered to the Construction Manager. Preconstruction photographs shall be taken at locations to be designated by the Construction Manager. The photographer shall be equipped to photograph either interior or exterior exposures, with lenses ranging from wide angle to 135-mm.

1.02 CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide construction photographs showing the progress of the work. The photographs shall be taken of such subjects as may be directed, shall be provided in electronic (jpeg) form with an index print of the images which shows the date, job title and brief description of the photograph, including the location where the photograph was taken. Starting one week after the date of the preconstruction photographs and continuing as long as the work is in progress, weekly photographs shall be taken.

B. Upon acceptance of the work, digital photographs shall be made of the work where directed by the Construction Manager. The photographs shall be submitted in electronic form (CD, DVD or USB). The photographer shall be equipped to take either interior or exterior exposures, with lenses ranging from wide angle to 135-mm.

C. The digital photographs on CD, DVD or USB shall be delivered to the Construction Manager. with an index print of the images which shows the project name, submittal type, and the time period covered within 10 days following each set of exposures.

END OF SECTION

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SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Submittals covered by these requirements include manufacturer's information, shop drawings, test procedures, test results, samples, requests for substitutions, and miscellaneous work-related submittals. Submittals shall also include, but not be limited to, all mechanical, electrical and electronic equipment and systems, materials, reinforcing steel, fabricated items, and piping and conduit details. The Contractor shall furnish all Drawings, Specifications, descriptive data, certificates, samples, tests, methods, schedules, and manufacturer's installation and other instructions as specifically required in the Contract Documents to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the Contract Documents.

1.02 CONTRACTOR'S RESPONSIBILITIES

A. General:

1. The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The Contractor shall verify that all features of all products conform to the specified requirements. Submittal documents shall be clearly edited to indicate only those items, models, or series of equipment, which are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Contractor shall ensure that there is no conflict with other submittals and notify the Construction Manager in each case where its submittal may affect the work of another contractor or the Owner. The Contractor shall coordinate submittals among its subcontractors and suppliers, including those submittals complying with unit responsibility requirements specified in Section 43 05 11-1.02 and applicable Technical Sections.
2. The Contractor shall coordinate submittals with the work so that work will not be delayed. It shall coordinate and schedule different categories of submittals so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals. The Contractor shall not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment shall be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."
3. The Contractor shall certify on each submittal document that it has reviewed the submittal, verified field conditions, and complied with the Contract Documents.
4. The Contractor may authorize, in writing, a material or equipment supplier to deal directly with the Construction Manager or with the Owner with regard to a submittal. These dealings shall be limited to Contract interpretations to clarify and expedite the work.

1.03 CATEGORIES OF SUBMITTALS

A. General:
   1. Submittals fall into three general categories:
      1) **Action Submittals** require review and response by the Construction Manager before the Contractor proceeds with incorporating the equipment, materials, or procedure addressed in a submittal into the work. Review comments for Action Submittals, and the subsequent actions of the Contractor based on the review comments, shall conform to review action requirements specified in this Section.
      2) **Informational Submittals** are examined to verify that the information has been furnished as specified. If the information has not been furnished as specified, the submittal will be returned marked "Make Corrections Noted" and any deficiencies will be noted. If the information has been furnished as specified, the submittal will be returned marked "Receipt Acknowledged."
      3) **Closeout Submittals** consist of documentation that is not available for review at the time Action Submittals are submitted for review or documentation that is typically generated or furnished following incorporation of the equipment, materials, or procedure into the work. Closeout submittals include spare-parts inventory listing, spare parts, extra stock materials, special tools and other materials or components that are furnished separate from the installed and completed work. Closeout Submittals require review and response by the Engineer. Closeout Submittal requirements are not satisfied until they have been reviewed and returned marked "no exceptions taken" or "make corrections noted."
   2. At the beginning of the work, the Construction Manager will furnish the Contractor lists of those submittals specified in the Project Manual. Two separate lists will be provided: submittals for review and comment and product data (submittals) for information only.

B. Submittals for Review and Comment:
   1. All submittals, except where specified to be submitted as product data for information only, shall be submitted by the Contractor to the Construction Manager for review and comment.

C. Submittals (Product Data) for Information Only:
   1. Where specified, the Contractor shall furnish submittals (Product Data) to the Construction Manager for information only. Submittal requirements for operation and maintenance (O&M), which are included in this category, are specified in Section 01 78 23.

1.04 TRANSMITTAL PROCEDURE

A. General:
   1. Unless otherwise specified, submittals regarding material and equipment shall be accompanied by Transmittal Form 01 33 00-A specified in Section 01 99 90. Submittals for O&M manuals, information, and data shall be accompanied by Transmittal Form 01 78 23-A specified in Section 01 99 90. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents

common to more than one piece of equipment shall be identified with all the appropriate equipment numbers. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

2. A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: "XXX," where "XXX" is the sequential number assigned by the Contractor. Resubmittals shall have the following format: "XXX-Y," where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of submittal 25.

B. Deviation from Contract:

1. If the Contractor proposes to provide material, equipment, or method of work which deviates from the Project Manual, it shall indicate so under "deviations" on the transmittal form accompanying the submittal copies.

C. Submittal Completeness:

1. Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

1.05 REVIEW PROCEDURE

A. General:

1. Submittals are specified for those features and characteristics of materials, equipment, and methods of operation which can be selected based on the Contractor's judgment of their conformance to the specified requirements. Other features and characteristics are specified in a manner which enables the Contractor to determine acceptable options without submittals. The review procedure is based on the Contractor's guarantee that all features and characteristics not requiring submittals conform as specified. Review shall not extend to means, methods, techniques, sequences or procedures of construction, or to verifying quantities, dimensions, weights or gages, or fabrication processes (except where specifically indicated or required by the Project Manual) or to safety precautions or programs incident thereto. Review of a separate item, as such, will not indicate approval of the assembly in which the item functions.
2. When the Contract Documents require a submittal, the Contractor shall submit the specified information as follows:
    a. One electronic copy in PDF format of all submitted information shall be transmitted with submittals for review and comment.
    b. Unless otherwise specified, one electronic copy in PDF format of all submitted information shall be transmitted with submittals (Product Data) for information only.

B. Submittals for Review and Comment:

1. Unless otherwise specified, within 10 working days after receipt of a submittal for review and comment, the Construction Manager shall review the submittal indicating one of the following actions:

a. If the review indicates that the material, equipment or work method complies with the Project Manual, submittal copies will be marked "No Exceptions Taken." In this event, the Contractor may begin to implement the work method or incorporate the material or equipment covered by the submittal.

b. If the review indicates limited corrections are required, copies will be marked "Make Corrections Noted." The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.

c. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "Amend and Resubmit." Except at its own risk, the Contractor shall not undertake work covered by this submittal until it has been revised, resubmitted and returned marked either "No Exceptions Taken" or "Make Corrections Noted."

d. If the review indicates that the material, equipment, or work method does not comply with the Project Manual, copies of the submittal will be marked "Rejected – See Remarks." Submittals with deviations which have not been identified clearly may be rejected. Except at its own risk, the Contractor shall not undertake the work covered by such submittals until a new submittal is made and returned marked either "No Exceptions Taken" or "Make Corrections Noted."

C. Submittals (Product Data) for Information Only:

1. Such information is not subject to submittal review procedures and shall be provided as part of the work under this Contract and its acceptability determined under normal inspection procedures.

1.06 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS:

A. General:

1. Review of Contract Drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide shall not relieve the Contractor of its responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Construction Manager or the Owner, or by any officer or employee thereof, and the Contractor shall have no claim under the Contract on account of the failure, or partial failure, of the method of work, material, or equipment so reviewed. A mark of "No Exceptions Taken" or "Make Corrections Noted" shall mean that the Owner has no objection to the Contractor, upon its own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

END OF SECTION

SECTION 01 35 14

ARCHAEOLOGICAL FINDS

PART 1 GENERAL

1.01 SUMMARY

A. It is the intent of this Section to provide for the preservation and protection of such material of an archaeological or paleontological nature as may be of scientific or historical value, to provide for expeditious protection, removal, or investigation of such material, and to provide the Contractor such compensation or relief as may be appropriate for unforeseen work or for work stoppage directed by the Construction Manager under the provisions of this Section.

B. The Contractor will not be required to furnish labor, materials, or equipment not normally required in the course of work executed under other Sections of these Contract Documents. Should the need for such labor, materials, or equipment arise, it shall be considered as extra work in accordance with the General Conditions.

1.02 DEFINITIONS

A. Archaeological finds are defined as evidence of human occupation or use of an area within the Contract limits prior to the year 1840. Such evidence may consist of skeletons, stone, or other utensils, or evidence of habitations or structures.

B. Paleontological finds are defined as evidence of prehistoric plant or animal life such as skeletons, bones, fossils, or casts and other evidence such as pictographs.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 FINDS

A. Should finds, as defined above, be made within the Contract limits, the Contractor shall immediately stop work in the vicinity of the find and notify the Construction Manager. Work in other areas may continue without interruption.

B. The Construction Manager may order work stopped in other areas if, in its opinion, the find is more extensive than may appear from uncovered material.

3.02 PROTECTION OF FINDS

A. Cover, fence, or otherwise protect all finds, as directed by the Construction Manager, until notice to resume work is given by the Construction Manager.

B. Covering will normally be done by covering the find with plastic film held in place by earth, rocks, or other weights placed outside the find. Should additional backfilling be necessary for safety or to prevent caving, place backfill material loosely over the plastic film. Sheet or shore only as directed by the Construction Manager.

C. Divert surface runoff away from find by ditching or such other means as the Engineer may direct.

D. Place temporary fence to prevent unauthorized access, when directed by the Construction Manager.

E. Dewater finds made below the water table only as directed by the Construction Manager.

3.03 REMOVAL OF FINDS

A. All finds are the property of the Owner. Do not remove or disturb finds without the Owner's written authorization.

B. Should the Owner elect to have a find removed, provide such equipment, labor and material as the Construction Manager may direct to permit the safe removal of the find. Remove finds as directed by the Construction Manager and under the Construction Manager's immediate supervision.

C. Provide transportation, as directed by the Construction Manager, for delivery to such individuals, institutions, or other places as the Owner may find desirable, expedient, or required by law.

3.04 EXTENSION OF TIME OF COMPLETION

A. Should the completion of the work of this Contract be delayed, in the Construction Manager's opinion, beyond the required time of completion because of a stop-work order issued by the Construction Manager under the provisions of this Section, the time of completion will be appropriately extended by change order.

END OF SECTION

SECTION 01 35 29

HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES

PART 1 GENERAL

1.01 SAFETY AND HEALTH REGULATIONS

A. The Contractor shall comply with Safety and Health Regulations for Construction, promulgated by the Secretary of Labor under Section 107 of the Contract Work Hours and Safety Standards Act, as set forth in Title 29, Code of Federal Regulations. Copies of these regulations may be obtained from Labor Building, 14th and Constitution Avenue N.W., Washington, DC 20013.

B. The Contractor shall also comply with the provisions of the Federal Occupational Safety and Health Act, as amended.

END OF SECTION

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SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

PART 1 GENERAL

1.01 SITE MAINTENANCE

A. The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

1.02 TEMPORARY DAMS

A. Except in time of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as they are no longer necessary.

1.03 AIR POLLUTION CONTROL

A. The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. It shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water in amounts which result in mud on public streets is not acceptable as a substitute for sweeping or other methods.

1.04 NOISE CONTROL

A. Outdoor noise occurring during the course of construction at a temporary construction site which is generated by blasting, excavation, generators or heavy equipment (including, but not limited to, backhoes, tractors, concrete trucks, dump trucks, jackhammers and air compressors) shall only be allowed between the hours of six o'clock (6:00) A.M. through eight o'clock (8:00) P.M. Monday through Saturday, unless expanded hours of operation are specifically allowed by action of the City Council, after a public comment meeting and, in that event, under such terms, conditions and limitations as set forth in the Council's approval. (City of Prescott Ordinance 4053, 11-14-2000).

END OF SECTION

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SECTION 01 45 20

EQUIPMENT AND SYSTEM PERFORMANCE AND OPERATIONAL TESTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section contains requirements for the Contractor's performance in documenting testing work required under this Contract. In addition, this Section contains requirements for the Contractor's performance during installed performance testing of all mechanical, electrical, instrumentation, and heating, ventilation and air conditioning (HVAC) equipment and systems, including structures for watertight construction, provided under this Contract. This Section supplements, but does not supersede, specific testing requirements found elsewhere in this Project Manual.

1.02 QUALITY ASSURANCE

A. Quality Assurance:
   1. The Contractor is responsible for Quality Assurance and managing, coordinating and supervising the Contractor's Quality Assurance Program. The Contractor shall have experience on at least five separate projects with managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. The Quality Assurance Program shall include:
      a. A testing plan setting forth the sequence in which all testing work required under this Project Manual will be implemented.
      b. A documentation program to record the results of all equipment and system tests.
      c. An installed performance testing program for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this Contract.
      d. A calibration program for all instruments, meters, monitors, gauges, and thermometers installed under this Contract.
      e. A calibration program for all instruments, gauges, meters, and thermometers used for determining the performance of equipment and systems installed under this Contract.
      f. A testing schedule conforming to the requirements specified in paragraph 2.02.
   2. For the purposes of this Section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The Contractor shall coordinate the activities of all subcontractors and suppliers to implement the requirements of this Section.

B. Calibration:
   1. All test equipment (gauges, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this Contract shall be calibrated to within ±2% of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance Specifications will fall between 60 and 85% of full scale. Pressure gauges shall be calibrated in accordance with American National Standards Institute/American Society of Mechanical Engineers

(ANSI/ASME) B40.1. Thermometers shall be calibrated in accordance with American Society for Testing and Materials (ASTM) E77 and shall be furnished with a certified calibration curve.

2. Liquid flow meters and all meters installed in pipelines with diameters greater than 2 inches shall be calibrated in situ per American Water Works Association (AWWA) Manual M6 standards for the type of meter installed. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated in situ using the pitot tube velocity averaging method. Flow-meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow-metering systems shall be performed over a range of not less than 10% to at least 75% of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within ±2 %.

C. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ASME B40.1	Gauges Pressure Indicating Dial Type—Elastic Element
ASTM E77	Method for Verification and Calibration of Liquid-in-Glass Thermometers
AWWA M6	Water Meters – Selection, Installation, Testing and Maintenance

1.03 SUBMITTALS

A. Submittal material, to be submitted in accordance with Section 01 33 00, shall consist of the following:

1. A complete description of the Contractor's plan for documenting the results from the test program in conformance with the requirements of paragraph 2.02, including:
   a. Proposed plan for documenting the calibration of all test instruments.
   b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems.
   c. Sample forms for documenting the results of field pressure and performance tests.

2. The credentials and certification of the testing laboratory proposed by the Contractor for calibration of all test equipment.
3. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers.
4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the Contractor for the systematic testing of all equipment and systems installed under this Contract.
5. A schedule and subsequent updates, presenting the Contractor's plan for testing the equipment and systems installed under this contract.
6. A schedule establishing the expected time period (calendar dates) when the Contractor plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place.
7. A summary of the Contractor's qualifications, showing conformance to paragraph 1.02 requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. The Contractor shall prepare test plans and documentation plans as specified in the following paragraphs. The Construction Manager will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

2.02 DOCUMENTATION

A. Documentation Plans:
   1. The Contractor shall develop a record-keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.
   2. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test and signature spaces for the Construction Manager's witness and the Contractor. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:
      a. Metallurgical tests.
      b. Factory performance tests.
      c. Field calibration tests[1].
      d. Field pressure tests[1].
      e. Field performance tests[1].
      f. Field operational tests[1].
   3. Section 01 99 90 contains samples showing the format and level of detail required for the documentation forms. The Contractor is advised that these are samples only

[1]Each of these tests is required even though not specifically noted in detailed Specification Section.

and are not specific to this Project nor to any item of equipment or system to be installed under this Contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this Contract. Acceptable documentation forms for all systems and items of equipment shall be produced for review by the Construction Manager as a condition precedent to the Contractor's receipt of progress payments in excess of 50% of the Contract amount. Once the Construction Manager has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce sufficient forms, at its expense, to provide documentation of all testing work to be conducted as a part of this Contract.

B. Test Plans:
   1. The Contractor shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this Contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors' and manufacturers' representatives to be present and expected test duration. As a minimum, the test plans shall include the following features:
      a. Step-by-step proving procedure for all control and electrical circuits by imposing low-voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device.
      b. Calibration of all analysis instruments and control sensors.
      c. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.
      d. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual.
   2. Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.
   3. As a condition precedent to receiving progress payments in excess of 75% of the Contract amount, or in any event, progress payments due to the Contractor 8 weeks in advance of the date the Contractor wishes to begin any testing work (whichever occurs earliest in the project schedule), the Contractor shall have submitted all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this Contract. Once the Construction Manager has reviewed and taken no exception to the Contractor's test plans, the Contractor shall reproduce the plans in sufficient number for the Contractor's purposes and an additional ten copies for delivery to the Construction Manager. No test work shall begin until the Contractor has delivered the specified number of final test plans to the Construction Manager.

C. Testing Schedule:
   1. The Contractor shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Contractor's construction schedule specified in Section 01 32 16. The schedule shall show the contemplated start date, duration of

the test and completion of each test. The test schedule shall be submitted no later than 4 weeks in advance of the date testing is to begin. The Construction Manager will not witness any testing work for the purpose of acceptance until the Contractor has submitted a schedule to which the Construction Manager takes no exception. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of this project manual.

2.03 SYSTEM AND EQUIPMENT PERFORMANCE TESTS

A. Each item of mechanical, electrical, instrumentation, and HVAC equipment installed under this Contract shall be tested to demonstrate compliance with the performance requirements of this project manual. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this Contract shall be tested in accordance with the requirements of this project manual.

2.04 OPERATIONAL TESTS

A. Once all equipment and systems have been tested individually, the Contractor shall fill all systems with the intended process fluids. After filling operations have been completed, the Contractor shall operate all systems for a continuous period of not less than 5 continuous days, simulating actual operating conditions to the greatest extent possible. The Contractor shall install temporary connections, bulkheads and make other provisions to recirculate process fluids or otherwise simulate anticipated operating conditions. During the operational testing period, the Contractor and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the Construction Manager.

2.05 PRODUCT DATA

A. Product data, to be provided in accordance with Section 01 33 00, shall be the original and three copies of all records produced during the testing program.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall organize teams made up of qualified representatives of equipment suppliers, subcontractors, the Contractor's independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this Contract. The objective of the testing program shall be to demonstrate, to the Construction Manager's complete satisfaction, that the structures, systems, and equipment constructed and installed under this Contract meet all performance requirements and the facility is ready for the commissioning process to commence. In addition, the testing program shall produce baseline operating conditions for the Owner to use in a preventive maintenance program.

3.02 CALIBRATION OF FIXED INSTRUMENTS

A. Calibration of analysis instruments, sensors, gauges, and meters installed under this Contract shall proceed on a system-by-system basis. No equipment or system performance acceptance tests shall be performed until instruments, gauges, and meters

to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Construction Manager.

B. All analysis instruments, sensors, gauges, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gauges, and meters installed under this Contract shall be subject to recalibration as a condition precedent to commissioning under the provisions of Section 01 91 00.

3.03 PERFORMANCE TESTS

A. General:
   1. Performance tests shall consist of the following:
      a. Pressure and/or leakage tests.
      b. Electrical testing as specified in Division 26.
      c. Wiring and piping, individual component, loop, loop commissioning and tuning testing as described in Division 40.
      d. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.
      e. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual.
   2. In general, performance tests for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the Construction Manager after receipt of a written request, complete with justification of the need for the change in sequence.

B. Pressure and Leakage Tests:
   1. Pressure and leakage tests shall be conducted in accordance with applicable portions of Division 40. All acceptance tests shall be witnessed by the Construction Manager. Evidence of successful completion of the pressure and leakage tests shall be the Construction Manager's signature on the test forms prepared by the Contractor.

C. Functional Checkout:
   1. Prior to energization (in the case of electrical systems and equipment), all circuits shall be rung out and tested for continuity and shielding in accordance with the procedures required in Division 26.

D. Component Calibration and Loop Testing:
   1. Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested in accordance with the procedures required in Division 40.

E. Electrical Resistance:
   1. Electrical resistance testing shall be in accordance with Division 26.

F. Preoperational Tests:
   1. Preoperational tests shall include the following:
      a. Alignment of equipment using reverse dial indicator method.
      b. Pre-operation lubrication.
      c. Tests per the manufacturer's recommendations for prestart preparation and preoperational check-out procedures.

G. Functional Tests:
   1. General: Once all affected equipment has been subjected to the required preoperational check-out procedures and the Construction Manager has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these Specifications. Potable water shall be employed as the test medium. The equipment shall be operated a sufficient period of time to determine machine-operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the Owner. Disposal methods for test media shall be subject to review by the Construction Manager. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the Owner to enter in a preventive maintenance system.
      a. Test results shall be within the tolerances set forth in the detailed Specification Sections of this Project Manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the Construction Manager and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the Construction Manager may order the test to be repeated. If the repeat test, using such modified methods or equipment as the Construction Manager may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the Owner. Otherwise, the costs shall be borne by the Contractor. Where the results of any functional test fail to comply with the Contract requirements for such test, then such repeat tests as may be necessary to achieve the Contract requirements shall be made by the Contractor at its expense.
      b. The Contractor shall provide, at no expense to the Owner, all power, fuel, compressed air supplies, water, and chemicals, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.
   2. Retesting: If under test, any portion of the work should fail to fulfill the Contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of

the work as are affected thereby, shall, unless otherwise directed by the Construction Manager, be repeated within reasonable time and in accordance with the specified conditions. The Contractor shall pay to the Owner all reasonable expenses incurred by the Owner, including the costs of the Construction Manager, as a result of repeating such tests.

3. Post-test Inspection: Once functional testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Construction Manager. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the Construction Manager at no cost to the Owner.

3.04 OPERATIONAL TESTS

A. The Contractor shall provide system operation testing. After completion of all performance testing and certification by the Construction Manager that all equipment complies with the requirements of the Specifications, the Contractor shall fill all process units and process systems, except those employing oil, air, or chemicals, with potable water. All oil, air, and chemical systems shall be filled with the specified fluid.

B. Upon completion of the filling operations, the Contractor shall circulate water through the completed facility for a period of not less than 48 hours, during which all parts of the system shall be operated as a complete facility at various loading conditions, as directed by the Construction Manager. The operational testing period shall commence after this initial period of variable operation. The operational testing period shall be not less than 5 continuous days. Should the operational testing period be halted for any reason related to the facilities constructed or the equipment furnished under this Contract, or the Contractor's temporary testing systems, the operational testing program shall be repeated until the specified continuous period has been accomplished without interruption. All process units shall be brought to full operating conditions, including temperature, pressure, and flow.

C. As-built documents of facilities involved shall be accepted and ready for turnover to the Owner at the time of operational testing.

END OF SECTION

SECTION 01 51 00

TEMPORARY UTILITIES

PART 1 GENERAL

1.01 FENCING

A. When the existing fencing is removed per the Contract documents, the Contractor shall provide temporary fencing around the construction site before any construction work, excavation or other site preparation begins. The temporary fencing shall prevent access of the general public to any construction areas/sites. Placement of any fencing needs to respect the surrounding area and acknowledge the presence of: local environmental conditions, access or pathways, stairs, trees or vegetation, weather, equipment, etc. When fencing is required, it will surround the entire construction activity and be kept in place throughout the costruction activity and not removed until the need has ceased and the area made safe. The Contractor shall completely remove all temporary fencing when its use is no longer required.

B. Dependent upon the need for protection, construction fencing can be 48" or 60" high. The fence posts need to be suitable for carrying an impact load and each fence post is to be capped for safety purposes. It is not acceptable to place "construction tape" or hazard cones around excavations, construction areas, etc. A more rigid method of protection is required. For minor construction, maintenance or repair jobs that pose low risk not exceeding four hour's in duration, mobile barricades etc. may be used as long as they are removed at the end of the shift. Beyond this duration, suitable construction fencing must be used.

1.02 POWER

A. The Contractor shall provide power for construction at the site(s). It shall make arrangements with the electrical utility and with the Owner for power takeoff points, voltage and phasing requirements, transformers and metering, and shall pay the costs and fees arising therefrom. The Contractor shall provide the special connections required for its work.

1.03 TELEPHONE

A. The Contractor shall provide telephone service at the construction site(s). Radio-telephone service is not acceptable as a substitute for telephone service. Full-time cellular service is acceptable.

1.04 SANITARY FACILITIES

A. The Contractor shall provide toilet and washup facilities for its workforce at the site of work. The facilities shall comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

1.05 WATER

A. Potable water will be available to the Contractor per the City of Prescott Supplement to MAG Section 104.1.3 through a fire hydrant meter. The Contractor shall provide the

necessary connections to the water supply and the conveyance facilities required for its work. The Contractor shall maintain the integrity of the existing water systems. If access to the water supply is interrupted for any period during the project, the Contractor shall provide water for construction at the site(s).

B. For conservation reasons, water-flooding of trenches for backfilling purposes using potable water is not allowed.

END OF SECTION

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 GENERAL

1.01 DAMAGE

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work, except in cases of minor damage, that have been satisfactorily repaired and are acceptable to the Construction Manager.

1.02 PIPE

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

PART 2 EQUIPMENT

2.01 PACKAGE AND MARKING

A. All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the Specification reference covering the item.

B. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

2.02 IDENTIFICATION

A. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this Contract. Marker shall be of stainless steel. Location of label will be easily visible.

2.03 SHIPPING

A. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

B. Damage shall be corrected to conform to the requirements of the Contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

2.04 FACTORY-APPLIED COATINGS

A. Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop-applied epoxy prime coating as specified in Section 09 90 00. The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for

field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer as specified in Section 09 90 00-3.03.

2.05 STORAGE

A. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

B. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

2.06 PROTECTION OF EQUIPMENT AFTER INSTALLATION

A. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles; debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum-cleaning, blowers with filters, protective shieldings, and other dust-suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted and the ventilation systems installed.

END OF SECTION

SECTION 01 73 24

DESIGN REQUIREMENTS FOR
NON-STRUCTURAL COMPONENTS AND NON-BUILDING STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Minimum structural requirements for the design, anchorage, and bracing of non-structural components such as architectural/mechanical/heating, ventilation and air conditioning (HVAC)/electrical components, equipment, or systems, and non-building structures such as tanks.

B. The requirements of this section apply to design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or non-building structures.

C. This section applies to non-building structures and non-structural components that are permanently attached to structures as defined below and in American Society of Civil Engineers (ASCE) 7.

D. Design and conform to criteria and design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the Drawings or where the size of attachments, anchorage, or bracing is defined in specific Technical Specification sections.

E. The following non-structural components are exempt from seismic design loading requirements of this section.
   1. Temporary or movable equipment.
   2. Mechanical and electrical components in Seismic Design Categories D, E, or F where all of the following apply:
      a. The component importance factor, I_p, is equal to 1.0;
      b. The component is positively attached to the structure;
      c. Flexible connections are provided between the component and associated ductwork, piping, and conduit;
      d. And either:
         1) The component weighs 400 lbs or less and has a center of mass located 4 ft or less above the adjacent floor level; or
         2) The component weighs 20 lbs or less, or in the case of a distributed system, 5 lb/ft or less.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.
   1. Section 05 05 20 Anchor Bolts.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AAMA	American Architectural Manufacturer's Association
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360	Specification for Structural Steel Buildings
ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASTM C635	Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C636	Installation for Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D1.8	Structural Welding Code – Seismic Supplement
IBC	International Building Code with Local Amendments
NFPA-13	Installation of Sprinkler Systems
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.04 DEFINITIONS

A. Structure: The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.

B. Non-structural Components: Non-structural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist effects of wind, snow, impact, temperature and seismic loads. Non-structural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

C. Non-building Structures: Self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Non-building structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification sections, along with justification(s) for requested deviations to Specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
   4. For structural elements of non-structural components and non-building structures required to be designed per this section, provide Drawings and design calculations stamped by an Arizona licensed professional engineer qualified to perform structural engineering.
   5. List of non-structural components and non-building structures requiring wind and seismic design and anchorage.
   6. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies, including connection hardware, and embedment into concrete.
   7. Shop drawings showing plans, elevations, sections and details of equipment support structures and non-building structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.
   8. Identify interface points with supporting structures or foundations, as well as size, location, and grip of required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Equipment vendor shall design anchor bolts, including embedment into concrete, and submit stamped calculations.
   9. Calculations for supports, bracing, and attachments shall clearly indicate design criteria applied. Coordinate concrete embedment calculations with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level) equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in design calculations.

1.06 QUALITY ASSURANCE

A. Quality Control by Owner:
   1. Special Inspection of non-structural components and non-building structures, and their anchorages shall be performed by the Special Inspector under contract with the Owner and in conformance with International Building Code (IBC) Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner at its sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality-control requirements. Where sampling and testing required conforms to Special Inspection standards, such sampling and testing need not be duplicated.

1.07 SPECIAL SEISMIC CERTIFICATION

A. Special Seismic Certification is certification of equipment and components to not only withstand the effects of earthquakes, but also to function following the design seismic event.

B. Special Seismic Certification is required for the following non-structural components in Seismic Design Categories C through F, which have a component importance factor of I_p=1.5 (referred to as "Designated Seismic Systems" in ASCE 7):
   1. Components required to function for life-safety purposes after an earthquake, including fire-protection sprinkler systems and fire dampers.
   2. Components that contain or convey toxic, hazardous, or explosive substances where the quantity of the material exceeds threshold quantities established by the governing code authority, or the component is attached to a structure classified as a hazardous occupancy.
   3. Components in or attached to a Risk Category IV structure and needed for continued operation.

C. Non-structural components requiring Special Seismic Certification include, but are not limited to, the following:
   1. Fire-protection systems and dampers.
   2. Zone 41 Mingus Pumps 1 through 4 and Jockey Pump.
   3. Check valves on the pump trains.
   4. Air-release valves on the pump trains.

D. Methods for Achieving Special Seismic Certification:
   1. For active components (e.g., equipment with parts that rotate, move mechanically, or are energized during operation), Special Seismic Certification is achieved by the following method, unless the component is listed below as being considered inherently rugged:
      a. Shake table testing (see below for requirements).
   2. For non-active components and active components listed below as being considered inherently rugged, Special Seismic Certification is achieved by one of the following methods:
      a. Analysis demonstrating a complete load path and capacity of components to resist loading, including seismic loading calculated in accordance with design criteria in this section.
      b. Shake table testing (see below for requirements).
      c. Experience data meeting requirements described in ASCE 7, Chapter 13.
   3. The following non-structural components are considered "inherently rugged:"
      a. Gate valves on the pump trains.
      b. Check valves on the pump trains.
      c. Air-release valves on the pump trains.
   4. Shake table testing requirements:
      a. In accordance with ICC-ES AC 156.
      b. Test for a minimum S_{DS} (0.2 second design spectral response) shown in the design criteria in this section.

c. Base testing on a ratio of height of component attachment in structure with respect to base of structure of z/h equal to 1.0.

d. Mount equipment in the shake table test in a similar manner to mounting on the project (e.g., mounting to floor vs wall vs suspended mounting, and rigid vs isolated mountings).

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials in conformance with information shown on the Drawings and in other Technical Specification sections. See individual component and equipment Specifications for additional requirements.

2.02 DESIGN CRITERIA

A. Design Codes:

Design	Code
Buildings/Structures	International Building Code 2018 and ASCE 7-16
Reinforced concrete	ACI 350-06 and ACI 350.3-06 for Concrete Liquid Containing Structures, 318-11 for all other reinforced concrete
Structural Steel	AISC 360-10 and AISC 341-10
Aluminum	Aluminum Design Manual, Latest Edition
Welding	AWS Welding Codes, Latest Edition
Occupational Health and Safety Requirements	OSHA and DOSH

Note: When conflicting requirements occur, the most stringent requirements will govern the design.

B. Design Loads:

1. Design non-structural components and non-building structures for the following minimum loads: (do not apply wind and snow loads to non-structural components and non-building structures that are located inside buildings.)
2. Dead Loads:
   a. Add an additional allowance for piping and conduit when supported and hung from the underside of equipment and platforms.
   b. Typical allowance for piping and conduit: 20 psf.

3. Uniform Live Loads:

Elevated Grating Floors	100 psf
Columns	No column live load reduction allowed
Exitways, Stairs and Landings	100 psf
Equipment Platforms, Walkways/Catwalks (Other Than Exitways)	60 psf
Utility Bridges	75 psf per level

4. Snow Loads:

Code	IBC 2018 and ASCE 7
Risk Category	IV
Ground Snow Load (p_g)	30 psf
Exposure Factor (C_e)	C
Thermal Factor (C_t)	1.0
Importance Factor (I_s)	1.1
Flat Roof Snow Load (p_f)	25 psf
Drifting	Per ASCE 7

5. Wind Loads:

Code	IBC 2018 and ASCE 7-16
Risk Category	IV
Basic Wind Speed (Ultimate, 3-second gust) for Risk Category Shown Above	110 mph
Exposure	C
Topographic Factor (K_{zt})	1.0

Note: Design exterior non-structural components and non-building structures, unless located in a pit or basin, to withstand design wind loads without consideration of shielding effects by other structures.

6. Seismic Loads:

Code	IBC 2018 and ASCE 7-16
Risk Category	IV
0.2 Sec. Mapped Spectral Response, S_S	0.302 g
1.0 Sec. Mapped Spectral Response, S_1	0.088 g
Site Class	B
0.2 Sec. Design Spectral Response, S_{DS}	0.314 g
1.0 Sec. Design Spectral Response, S_{D1}	0.141 g
Importance Factor (I_e)	1.55
Component Importance Factor (I_p)	1.0, except I_p=1.5 for components identified in Section 13.1.3 of ASCE 7-16
Seismic Design Category	B

Notes:

1. *Calculate seismic loads on the basis of governing building code. Include equipment operating loads in structure dead load.*
2. *Check individual members for seismic and full-member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Combine equipment operating loads with seismic loads.*

7. Impact Loads:
    a. Consider impact loads in design of support systems.
    b. Use the following impact load factors unless recommendations of the equipment manufacturer will cause a more severe load case:

Rotating Machinery	20% of moving load
Reciprocating Machinery	50% of moving load
Monorail Hoists:	
• Vertical	25% of lifted load
• Longitudinal	10% of lifted load
Hangers Supporting Floors and Platforms	33% of live and dead load

8. Temperature:
    a. Include effects of temperature in design where non-structural components and non-building structures are exposed to differential climatic conditions. See climatic conditions below for temperature extremes.

C. Load Combinations:
    1. Design non-structural components and non-building structures to withstand load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, ignore the load when evaluating that member.

D. Design Considerations:
    1. Design non-structural components and non-building structures for the following conditions:
    2. Climatic Conditions:

Maximum Design Temperature	105 degrees Fahrenheit
Minimum Design Temperature	-21 degrees Fahrenheit

    3. Foundations:
        a. Extend foundations supporting non-structural components and non-building structures below the frost line, or support on non-frost susceptible structural fill down to the frost line.

Frost Line for Foundations	18 inches

Note: Consult project geotechnical report for allowable soil bearing recommendations at location of structure.

E. Column Base Fixity:
    1. Design column bases as pinned connections. No moments shall be assumed to be transferred to foundations.
    2. Where significant shear loads (greater than 5,000 lbs per anchor bolt) are transferred at column base plates, provide a shear key designed to transfer shear load.

F. Deflection:
   1. Maximum beam deflection as a fraction of span for walkways and platforms: L/240 for total load and L/360 for live load.
   2. Maximum crane load deflection for building elements supporting monorail crane: L/1000.
   3. Maximum total load deflection for equipment support: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments and braces in such a manner that component force is transferred to the lateral force-resisting system of the structure. Base attachment requirements and size and number of braces per calculations submitted by Contractor.

B. Anchorage of equipment is specified to be made by cast-in anchor bolts in concrete elements unless specifically noted otherwise on the Drawings or other Specification sections. Contractor is responsible for remedial work or strengthening (of concrete elements because of superimposed seismic loading) if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to Owner.

C. Provide anchor bolts in accordance with Section 05 05 20. Base size of anchor bolts and embedment on submitted calculations.

D. Submit details of and calculations for anchorages prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. Contractor is responsible for revisions to anchorages and/or strengthening of structural support so that there is no overstress condition, at no additional cost to Owner.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE

A. Operation and maintenance (O&M) instructions shall be provided in accordance with this Section and as required in the Technical Sections of this Project Manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this Contract.

B. O&M instructions must be submitted and accepted before on-site training may start.

1.02 TYPES OF INFORMATION REQUIRED

A. General:
   1. O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. Operating Instructions:
   1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
      a. Safety Precautions: List personnel hazards for equipment and list safety precautions for all operating conditions.
      b. Operator Prestart: Provide requirements to set up and prepare each system for use.
      c. Startup, Shutdown, and Postshutdown Procedures: Provide a control sequence for each of these operations.
      d. Normal Operations: Provide control diagrams with data to explain operation and control of systems and specific equipment.
      e. Emergency Operations: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems, including valve locations and portions of systems controlled.
      f. Operator Service Requirements: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
      g. Environmental Conditions: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. Preventive Maintenance:
   1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

a. Lubrication Data: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 1.02.
    1) A table showing recommended lubricants for specific temperature ranges and applications.
    2) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.
    3) A lubrication schedule showing service interval frequency.
b. Preventive Maintenance Plan and Schedule: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance manhours on a daily, weekly, monthly, and annual basis, including craft requirements by type of craft.

D. Corrective Maintenance:
1. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
    a. Troubleshooting Guides and Diagnostic Techniques: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
    b. Wiring Diagrams and Control Diagrams: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits, including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
    c. Maintenance and Repair Procedures: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
    d. Removal and Replacement Instructions: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.
    e. Spare Parts and Supply Lists: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.
    f. Corrective Maintenance Manhours: Provide manufacturer's projection of corrective maintenance manhours, including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. Appendices:
1. The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

a. Parts Identification: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

b. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or Contract Documents to keep warranties in force.

c. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

d. Testing Equipment and Special Tool Information: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.03 TRANSMITTAL PROCEDURE

A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01 33 00, accompanied by Transmittal Form 01 78 23-A and Equipment Record Forms 01 78 23-B and/or 01 78 23-C, as appropriate, all as specified in Section 01 99 90. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

B. Four (4) copies of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the Project Manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the Project Manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information. Binders shall be heavy, 3-ring style, 3-inch maximum, suitable for bookshelf storage.

C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this Project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

1.04 PAYMENT

A. Acceptable O&M information for the Project must be delivered to the Construction Manager prior to the Project being 65% complete. Progress payments for work in excess of 65% completion will not be made until the specified acceptable O&M information has been delivered to the Construction Manager.

1.05 FIELD CHANGES

A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

END OF SECTION

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance (O&M) of the equipment and systems installed under this Contract.

1.02 QUALITY ASSURANCE

A. Where required by the detailed Specifications, the Contractor shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in O&M of the subject equipment.

1.03 SUBMITTALS

A. The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01 33 00. The material shall be reviewed and accepted by the Construction Manager as a condition precedent to receiving progress payments in excess of 60% of the Contract amount and not less than 3 weeks prior to the provision of training.
   1. Lesson plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
   2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 PRODUCTS

2.01 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this Contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved O&M manuals shall be available at least 10 days prior to the date scheduled for the individual training session.

2.02 LOCATION

A. Training sessions shall take place at a site to be determined by the Owner.

2.03 LESSON PLANS

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual

aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2.04 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training sessions shall cover the following subjects for each item of equipment or system:
   1. Familiarization:
      a. Review catalog, parts lists, drawings, etc. which have been previously provided for the files and O&M manuals.
      b. Check out the installation of the specific equipment items.
      c. Demonstrate the unit and indicate how all parts of the Specifications are met.
      d. Answer questions.
   2. Safety:
      a. Using material previously provided, review safety references.
      b. Discuss proper precautions around equipment.
   3. Operation:
      a. Using material previously provided, review reference literature.
      b. Explain all modes of operation (including emergency).
      c. Check out Owner's personnel on proper use of the equipment.
   4. Preventive Maintenance:
      a. Using material previously provided, review preventive maintenance lists, including:
         1) Reference material.
         2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.
      b. Show how to perform preventative maintenance jobs.
      c. Show Owner's personnel what to look for as indicators of equipment problems.
   5. Corrective Maintenance:
      a. List possible problems.
      b. Discuss repairs--point out special problems.
      c. Open up equipment and demonstrate procedures, where practical.
   6. Parts:
      a. Show how to use previously provided parts list and order parts.
      b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
   7. Local Representatives:
      a. Where to order parts: name, address, telephone.
      b. Service problems:

1) Who to call.
2) How to get emergency help.

8. Operation and Maintenance Manuals:
   a. Review any other material submitted.
   b. Update material, as required.

2.05 VIDEO RECORDING:

A. The Owner reserves the right to retain the services of a commercial video-taping service to record each training session. After taping, the material will be edited and supplemented with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be video-taped and shall make available to the Owner's video-taping contractor such utility services and accommodation as may be required to facilitate the production of the video-tape record.

PART 3 EXECUTION

3.01 SUMMARY

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

B. Acceptable O&M manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video-taping shall take place concurrently with all training sessions.

C. The following services shall be provided for each item of equipment or system as required in individual Specification Sections. Additional services shall be provided, where specifically required in individual Specification Sections.
   1. As a minimum, classroom equipment training for operations personnel will include:
      a. Using slides and drawings, discuss the equipment's specific location in the facility and an operational overview.
      b. Purpose and function of the equipment.
      c. A working knowledge of the operating theory of the equipment.
      d. Startup, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
      e. Identify and discuss safety items and procedures.
      f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
      g. Operator detection, without test instruments, of specific equipment trouble symptoms.
      h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      1) Location of primary element.
      2) Location of instrument readout.
      3) Discuss purpose, basic operation, and information interpretation.
   e. Discuss, demonstrate, and perform standard operating procedures and round checks.
   f. Discuss and perform the preventative maintenance activities.
   g. Discuss and perform start-up and shutdown procedures.
   h. Perform the required equipment exercise procedures.
   i. Perform routine disassembly and assembly of equipment, if applicable.
   j. Identify and review safety items and perform safety procedures, if feasible.
3. Equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Start-up and shutdown procedures.
   d. Normal and major repair procedures.
   e. Equipment inspection and troubleshooting procedures, including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
   f. Routine and long-term calibration procedures.
   g. Safety procedures.
   h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform startup and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform Owner-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01 91 00

COMMISSIONING

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section contains requirements for the Contractor's performance during the commissioning of the structures, equipment and systems constructed and installed during the course of this Contract. All commissioning work, as described in this Section shall be performed by the Contractor.

1.02 QUALITY ASSURANCE

A. Cleanup:
   1. Following completion of the operational testing period, the Contractor shall remove, clean, and replace all permanent and temporary filters and strainers in all pipeline systems; replace all heating, ventilation and air conditioning (HVAC) filters; dewater and clean all sumps; and dewater all process units for final inspection as a condition precedent to commissioning.

B. Commissioning Team:
   1. The Contractor shall assemble a commissioning team under the direction of an individual duly authorized to commit the Contractor's personnel and resources to respond to requests for assistance on the part of the Construction Manager or, through the Construction Manager, the Owner. The commissioning team shall consist of representatives of the Contractor's mechanical, electrical, and instrumentation subcontractors, and others as appropriate. The commissioning team shall be available at the site of the work during normal working hours (8 hours a day, 5 days a week, Saturdays, Sundays, and legal holidays excepted) and shall be available within 2 hours' notice at all other times upon notice by telephone. The commissioning team shall at all times be equipped and ready to provide for emergency repairs, adjustments, and corrections to the equipment and systems installed and modified as a part of this Contract.

1.03 SUBMITTALS

A. The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01 33 00:
   1. Detailed plans for commissioning each process unit and each system constructed or modified as a part of the work performed under this Contract.
   2. The Contractor's plan for providing a commissioning team conforming to the requirements of paragraph 1.02 during the commissioning period. The plan shall be complete with a daytime staffing plan and names, qualifications, and telephone numbers of those assigned to off-hour standby duty.

PART 2 PRODUCTS

2.01 SUMMARY

A. Working with representatives of the Owner and the Construction Manager, the Contractor shall develop and produce a detailed, written plan for the startup and initial operation, under actual operating conditions, of the equipment and systems installed and constructed under this Contract. The document, after acceptance by the Construction Manager, shall serve as the guidance manual for the commissioning process.

PART 3 EXECUTION

3.01 SUMMARY

A. After completion of the equipment and system performance and operational testing, where required, and agreement on the part of the Construction Manager that the systems did meet all test requirements, commissioning will begin. The commissioning period for each modified or new unit process system shall be 30 consecutive uninterrupted days. The Contractor shall remove all temporary piping, bulkheads, controls and other alterations to the permanent systems that may have been needed during the performance and operational testing and shall perform the tasks necessary to make the improvements constructed under this Contract fully operational. The Construction Manager shall confirm in writing the date(s) that the system is ready for commissioning and on which actual commissioning activities commence. Activities conducted prior to such written confirmation shall not constitute commissioning.

B. The Owner's operation and maintenance personnel will be responsible for operation of the systems to be commissioned. The portion of the work to be commissioned shall be fully operational, performing all functions for which it was designed.

C. The Contractor shall be available at all times during commissioning periods to provide immediate assistance in case of failure of any portion of the system being constructed. At the end of the commissioning period and when all corrections required by the Construction Manager to assure a reliable and completely operational facility are complete, the Construction Manager shall issue a completion certificate. Each system shall have been issued a completion certificate as a condition precedent to the final acceptance of the work of this Contract.

D. During the commissioning period, the Owner shall be responsible for all normal operational costs and the Contractor shall bear the costs of all necessary repairs or replacements, including labor and materials, required to keep the portion of the plant being commissioned operational.

END OF SECTION

SECTION 01 99 90

REFERENCE FORMS

PART 1 FORMS

1.01 DESCRIPTION

A. The forms listed below and included in this Section are referenced from other Sections of the Project Manual:

Form No.	Title
01 33 00-A	Submittal Transmittal Form
01 45 20-A	Equipment Test Report Form
01 78 23-A	Operation and Maintenance Transmittal Form
01 78 23-B	Equipment Record Form
01 78 23-C	Equipment Record Form
09 90 00-A	Coating System Inspection Checklist
26 05 00-A	Wire and Cable Resistance Test Data Form
26 05 00-B	Installed Motor Test Data Form
40 61 13-A	Loop Wiring and Insulation Resistance Test Data Form
40 61 13-G	Field Switch Calibration Test Data Form
40 61 13-H	Transmitter Calibration Test Data Form
40 61 13-I	Miscellaneous Instrument Calibration Test Data Form
40 61 13-J	Individual Loop Test Data Form
40 61 13-K	Loop Commissioning Test Data Form
43 05 11-A	Manufacturer's Installation Certification Form
43 05 11-B	Manufacturer's Instruction Certification Form
43 05 11-C	Unit Responsibility Certification Form
43 05 13-A	Rigid Equipment Mount Installation Inspection Checklist
43 05 21-A	Motor Data Form

01 33 00-A. SUBMITTAL TRANSMITTAL FORM

Submittal Transmittal

Submittal Description:	Submittal No:[1]	Spec Section:

	Routing	Sent	Received
Owner:	Contractor/CM		
Project:	CM/Engineer		
	Engineer/CM		
Contractor:	CM/Contractor		

We are sending you:
☐ Attached
☐ Under separate cover via _____
☐ Submittals for review and comment
☐ Product data for information only

Remarks: _____

Item	Copies	Date	Section No.	Description	Review action[a]	Reviewer initials	Review comments attached

[a]*Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected*
Attach additional sheets if necessary.

Contractor

Certify either a or b:

a. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

b. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.	Deviation

Certified by:

Contractor's Signature:

[1]See *Section 01 33 00-1.04. A, Transmittal Procedure.*

01 45 20-A. EQUIPMENT TEST REPORT FORM

NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

City of Sample

Example Water Treatment Plant

Stage IV Expansion Project

ABC Construction Company, Inc., General Contractor
XYZ Engineering, Inc., Construction Manager

Equipment Test Report

- Equipment Name: Sludge Pump 2
- Equipment Number: P25202
- Specification Ref: 11390
- Location: East Sedimentation Basin Gallery

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
A. Preoperational Checklist				
1. Mechanical				
a. Lubrication				
b. Alignment				
c. Anchor bolts				
d. Seal water system operational				
e. Equipment rotates freely				
f. Safety guards				
g. Valves operational				
h. Hopper purge systems operational				
i. Sedimentation tank/hopper clean				
j. O&M manual information complete				
k. Manufacturer's installation certificate complete				
2. Electrical (circuit ring-out and high-pot tests)				
a. Circuits:				
1) Power to MCC 5				
2) Control to HOA				
3) Indicators at MCC:				
a) Red (running)				
b) Green (power)				
c) Amber (auto)				
4) Indicators at local control panel				
b. Wiring labels complete				
c. Nameplates:				
1) MCC				
2) Control station				
3) Control panel				
d. Equipment bumped for rotation				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
3. Piping Systems				
a. Cleaned and flushed:				
1) Suction				
2) Discharge				
b. Pressure tests				
c. Temporary piping screens in place				
4. Instrumentation and Controls				
a. Flowmeter FE2502F calibration				
1) Calibration Report No.				
b. Flow recorder FR2502G calibrated against transmitter				
c. VFD speed indicator calibrated against independent reference				
d. Discharge overpressure shutdown switch calibration				
e. Simulate discharge overpressure Shutdown				
B. Functional Tests				
1. Mechanical				
a. Motor operation temperature satisfactory				
b. Pump operating temperature satisfactory				
c. Unusual noise, etc.?				
d. Pump operation: 75 gpm/50 psig				
(1) Measurement:				
(a) Flow:				
(b) Pressure:				
(c) Test gage number:				
e. Alignment hot				
f. Dowelled in				
g. Remarks:				
2. Electrical				
a. Local switch function:				
1) Runs in HAND				
2) No control power in OFF				
3) Timer control in AUTO				
b. Overpressure protection switch PS2502C functional in both HAND and AUTO				
c. Overpressure protection switch PS2502C set at 75 psig				
d. PLC 2500 set at 24-hour cycle, 25 min ON				
C. Operational Test				
1. 48-hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional				

RECOMMENDED FOR BENEFICIAL OCCUPANCY:

Construction Manager	Date

ACCEPTED FOR BENEFICIAL OCCUPANCY

Owner's Representative	Date

01 78 23-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date:	Submittal No:[2]
To:	Contract No:
	Spec. Section:
	Submittal Description:
Attention:	From:

Checklist	Contractor		Construction Manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start-up, shutdown, and postshutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man-hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks:

Contractor's Signature:

[2] See Section 01 33 00-1.04.A, Transmittal Procedure.

01 78 23-B. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

Lubricants: Recommended:

Alternative:

Misc. Notes:

Recommended Spare Parts					Electrical Nameplate Data			
Part No	Quan	Part Name	Cost		Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	V	Amp	Hz
					Ph	Rpm	Sf	Duty
					Code	Insl. Cl	Des	Type
					NEMA Des	C Amb	Temp Rise	Rating
					Misc.			
					Mechanical Nameplate Data			
					Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	Rpm	Cap	Size
					Tdh	Imp Sz	Belt No.	Cfm
					Psi	Assy No.	Case No.	
					Misc			

01 78 23-C. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

09 90 00-A COATING SYSTEM INSPECTION CHECKLIST

Project Name			
Owner		Coating System Manufacturer (CSM)	
General Contractor (GC)		Coating System Applicator (CSA)	
Area or Structure		Location within Structure	
Coating System (e.g., E-1)		Coating Type (e.g., Epoxy, etc.)	

Coating System Inspection Checklist

Step	Description		Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated.	GC QC			
		CSM QC			
		CSA QC			
5	Completion of Primer Application.	GC QC			
		CSM QC			
		CSA QC			
6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or	GC QC			
		CSM QC			

Coating System Inspection Checklist

Step	Description		Name	Signature	Date
	Terminations.	CSA QC			
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations.	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			
12	Completion of Localized Repairs to Coating System Following Testing.	GC QC			
		CSM QC			
		CSA QC			
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

26 05 00-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, °F: _____

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7.	

.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-B. INSTALLED MOTOR TEST DATA FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

				Ambient temp	°F
Resistance:					
Insulation resistance phase-to-ground megohms:					
Phase A		Phase B		Phase C	
Current at Full Load:					
Phase		Current, amps			
Phase		Current, amps			
Phase		Current, amps			
Thermal Overload Device:	Manufacturer/catalog #		Amperes		
Circuit breaker (MCP) setting:					

Motor Nameplate Markings:

Mfr		Mfr Model		Frame		HP	
Volts		Phase		RPM		Service factor**	
Amps		Freq		Ambient temp rating			°C
Time rating				Design letter**			
	(NEMA 1-10.35)				(NEMA MG-1.16)		
Code letter				Insulation class			

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.: _____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	Panel Tie	Field TB	Continuity Resistance[a]		Insulation Resistance[b]			
			Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

NOTES:

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500-volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:

(Attach test form 40 61 13-A)

b. Instrumentation tubing/piping tested:

(Attach test forms 40 61 13-C through I)

c. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:

(Attach test form 40 61 13-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

43 05 11-A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No:	Specification section:
Equipment name:	
Contractor:	
Manufacturer of equipment item:	

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the Project Manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments:

Manufacturer	Contractor
Signature of Authorized Representative	Signature of Authorized Representative
Date	Date

43 05 11-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No:	Specification Section:
Equipment name:	
Contractor:	
Manufacturer of equipment item:	

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)	
Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	

Maintenance Check List (check appropriate spaces)	
Described normal oil changes (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described greasing frequency	
Others:	

Manufacturer	Signature of Contractor Representative Date
Signature of Authorized Representative	
Date	Signature of Authorized Representative Date

43 05 11-C. UNIT RESPONSIBILITY CERTIFICATION FORM

ZONE 41 TANK, PUMP STATION, AND WATER MAIN PROJECT

CERTIFICATE OF UNIT RESPONSIBILITY

FOR SPECIFICATION SECTION _____

_____

[SECTION TITLE]

In accordance with Section 43 05 11-1.02 Unit Responsibility of the Contract Documents, the undersigned manufacturer of driven equipment ("manufacturer") accepts unit responsibility for all components of equipment furnished to the Project under specification Section_____ , and for related equipment manufactured under Sections_____, _____, and _____ .

We have reviewed the requirements for Sections 43 05 11 and 43 23 03 (where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this Specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this Specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility.

Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification sections _____, _____, and _____. Our obligation to warranty all equipment provided by us shall remain unaffected.

Notary Public	Name of Corporation
Commission expiration date	Address
Seal:	By:
	Duly Authorized Official
	Legal Title of Official
	Date

43 05 13-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

CITY OF PRESCOTT, ZONE 41 (MINGUS) PUMP STATION, TANK AND PIPELINE

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 3: Equipment Leveling		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 6: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 7: Epoxy Grout Installation		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 8: Completion of Full and Proper Cure of Epoxy Grout		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

Step 9: Completion of Localized Repair of Grout Voids		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

Step 10: Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

43 05 21-A. MOTOR DATA FORM

Equipment Name: _____ Equipment No(s): _____

Project Site Location: _____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	°C

Time rating:		Design Letter:	
	(NEMA MG1-10.35)		(NEMA MG-1.16)
KVA Code Letter:		Insulation Class:	

The following information is required for explosion-proof motors only:

A. Approved by UL for installation in Class _____, Div _____, Group _____
B. UL frame temperature code ____ (NEC Tables 500-8B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _____

(Section 43 05 21-2.04 Motor Efficiency)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:		°C (NEMA MG1-12.41,42)			
Space Heater included?	☐ Yes	☐ No	If Yes:	Watts	Volts
Type of motor winding over-temperature protection, if specified:					

Provide information on other motor features specified:

_____

SECTION 02 41 13

DEMOLITION AND SALVAGE

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes materials and equipment to be salvaged and returned to the Owner or demolished and removed from the site as trash by the Contractor.

1.02 SCOPE OF WORK

A. Furnish all labor, material, equipment, and incidentals required to demolish, modify, or alter existing facilities as shown or specified and as required for the installation of new mechanical equipment, piping, architectural features and appurtenances. Existing piping and equipment shall be removed and dismantled as necessary for the performance of structural, architectural, and piping alterations in accordance with the requirements herein specified.

B. Coordinate with the subcontractor and Owner for all materials required to be turned over to Owner.

1.03 EXISTING CONDITIONS

A. Contractor shall visit the site and inspect the nature and condition of all facilities to be demolished, partially demolished, modified, or altered in any way prior to submittal of its Bid. No increase in cost or extension of Contract time will be considered for failure to know the conditions of the site and structures.

1.04 SALVAGE

A. Any items specifically indicated to be reused or designated to be salvaged for Owner's own purposes shall be carefully removed and be relocated to designated storage areas on the project site. Contractor shall protect salvaged equipment and materials from weather, staining, construction damage, theft, and vandalism. Arrange storage to facilitate inspection by Construction Manager.

B. The Contractor shall notify the Construction Manager 15 days prior to commencement of demolition work in an area. The Owner shall then tag equipment, piping, valves, control devices, electrical, etc. with a color-code system to designate the location for salvaged items to be stored.

C. The Contractor shall provide four colors of wire tags similar to EMED Co., Inc., LMT70 with a quantity of 2,000 for each color.

1.05 DEMOLITION AND DISPOSAL

A. All other materials removed under the demolition work, including dismantled equipment and materials, piping, pumps, fittings, valves, machinery, gates, concrete equipment pads, miscellaneous and structural metals, masonry, and other construction debris shall become the property of the Contractor and be removed from the site as trash. Trash and

debris shall be disposed of legally, off the site, by Contractor. Upon removal from site, Contractor shall have the rights of salvage of materials.

1.06 PROTECTION OF EXISTING FACILITIES

A. The Contractor shall diligently protect existing structures and property of the Owner while proceeding with work of this Section and the entire Contract. All damage shall be repaired at once to the satisfaction of the Owner. All such repairs shall be at the expense of the Contractor, and no claims for additional payment will be accepted.

B. When removing materials or portions of existing structures and when making openings in walls and partitions, the Contractor shall provide barriers, dust screens, and other protective devices so as not to damage the structures beyond the limits necessary for the new work, nor to damage the structures or contents by falling or flying debris nor to transfer any heavy shocks and vibrations to structures to remain. Swinging weights shall not be used to demolish structures.

PART 2 PRODUCTS

2.01 REPAIR AND RESTORATION

A. The Contractor shall alter or rework existing structures as shown and specified. Generally, when items of equipment and piping are removed, the areas and surfaces from which items were removed shall be left with a neat appearance and finish compatible with surrounding areas, colors, and surfaces. The Contractor shall do all painting, sanding, grouting, sacking, resurfacing, and other work as necessary to comply with the above requirements. Prior to structural modifications, all surfaces shall be subject to inspection by the Construction Manager. Colors shall match existing colors as closely as possible. For replacement or repair of restoration of work removed, comply with the specifications for the type of work to be done.

2.02 PENETRATIONS

A. Where holes in existing masonry or concrete are required to be sealed, unless otherwise specified, they shall be sealed with cement mortar or concrete. The sides of the openings shall be provided with keyed joints and shall be suitably roughened to furnish a good bond and make a watertight joint. All loose or unsound material adjacent to the opening shall be removed and, if necessary, replaced with new material. The method of placing the mortar seal shall provide a suitable means of releasing entrapped air.

2.03 MODIFICATIONS OF EXISTING STRUCTURES

A. Where only a portion of the existing structure is to be removed, the existing concrete shall be sawed to neat lines as shown on the Plans or as established by the Construction Manager. Reinforcing steel shall be removed to a depth of 2 inches from the finished surface. Anchor bolts for equipment and structural steel removed shall be cut off 1 inch below the concrete surface. Surface shall be finished as specified in Division 3.

B. When connections are to be made to existing concrete structures, the existing reinforcing steel shall be exposed to a depth of 12 inches and all bars spliced to the new reinforcing steel.

2.04 PIPING MODIFICATIONS

A. Where necessary or required for the purpose of making piping connections, cut existing pipelines and provide suitable plugs, bulkheads, or other means to hold back the flow of water or other liquids, all as required in the performance of the work under this Contract. The remaining open ends of all piping, valves, fittings, and appurtenances that are removed shall be plugged with standard pipe plugs or closed with flanges so that there will be no leakage through the closure.

PART 3 EXECUTION

3.01 CONTROL OF HAZARDOUS AND NUISANCE CONDITIONS

A. All demolition, salvage, and renovation work shall be conducted in a manner which will protect the environment, promote public health and safety, and preclude nuisance conditions, in strict conformance with the requirements of Sections 01 35 29 and 01 11 80. In addition, Contractor shall enforce the following safety requirements:
   1. No fires will be permitted on-site.
   2. Post "No Smoking" signs in all interior spaces and in hazardous or confined spaces where dismantling operations are to be carried on. Strictly enforce "No Smoking" restrictions among all personnel employed on the work.

3.02 DEMOLITION OF EXISTING STRUCTURES

A. The work sequence for removing existing structures shall be in accordance with Section 01 12 16 and the General Conditions of the Contract Documents.

B. Structures that are in the way of new construction shall be removed completely, regardless if they are above or below existing or proposed ground or grade. This work may be done in any manner selected by the Contractor, and reviewed by the Construction Manager, that does not endanger adjacent structures and property. The use of explosives will not be permitted for any purposes.

C. Structures not in the way of proposed construction, but designated to be demolished or removed, shall be removed to a point 3 feet below existing or proposed grade, whichever is lower. That portion that will remain below grade shall be cleaned of rubble and debris, including exposed reinforcing steel, backfilled with Type C material in accordance with Division 31 and graded in accordance with the site grading plan.

D. Structural steel members shall be cut into sections of such weight and size as will permit convenient handling, hauling, and storage. Concrete to be demolished and removed shall be broken into pieces not greater than 24 inches in any dimension by methods reviewed by the Construction Manager.

3.03 GRADING AND BACKFILL

A. All excavation made in connection with this item and all openings below permanent ground caused by the removal of a structure shall be backfilled with suitable material and graded to match the proposed grading plan. That portion of the backfill which will support any portion of a roadbed, driveway, or structure shall be backfilled and compacted in accordance with applicable Sections for earthwork and paving.

3.04 WEATHER PROTECTION

A. Removal of windows in exterior walls or other elements providing weather protection shall not be started until temporary weatherproof enclosures are in place or can be put in place immediately after such removal.

3.05 EXISTING TREES

A. Extreme care should be taken when working around existing trees. No excavation or compaction shall take place within the tree drip line except with prior permission of the Owner or where the tree is shown for removal on the Drawings.

3.06 ITEMS TO BE SALVAGED AND RETURNED TO OWNER

A. Contractor shall request the Construction Manager to identify all items to be salvaged prior to the start of the work. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner. Salvaged items shall include:

Item Description	Equipment ID	Drawing Number
Soft Starts at Existing Zone 41 (Mingus) Pump Station	N/A	N/A
Light Fixtures at Existing Zone 41 (Mingus) Pump Station	N/A	N/A

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.
   1. Footings.
   2. Slabs-on-grade.
   3. Pipe Supports

B. This Specification Section is intended to specify concrete shown and detailed on the structural drawings. This Section includes foundations, building slab-on-grades, and pipe supports.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated, if requested.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mix water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Shop drawings are required. Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement.

D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials.

E. Material Certificates: Certificates only required if requested. Signed by manufacturers certifying that each of the following items complies with requirements:
   1. Cementitious materials and aggregates.

2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing materials.
5. Vapor retarders.
6. Joint-filler strips.
7. Repair materials.

F. Floor surface flatness and levelness measurements to determine compliance with specified tolerances. Measurement is only required if Owner or Architect deem the tolerances are not being met.

G. Pre-construction meeting minutes, if meeting is held.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel reinforcement to prevent **BENDING** and damage.

PART 2 PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.
   2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      a. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.

B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

B. Dowel Plate Assembly: Diamond Shaped Load Plate:
   1. 1/4-inch and 3/8-inch saw cut from hot rolled steel plate meeting ASTM A 36. 3/4-inch saw cut from cold rolled steel plate for acceptable tolerances meeting ASTM 108-03 Grade 1018.
   2. Pocket Former: High density plastic with internal collapsible fins and spacer that hold diamond shaped load plate in correct position and creates a void to its vertical faces. This void, in addition to its tapered shape, shall allow for differential movement and shall prevent horizontal stress accumulation at joint, thus reducing likelihood of random cracking.
   3. Manufacturer: PNA Construction Technologies, www.pna-inc.com; 1-800-542-0214.

4. Other manufacturer are acceptable if the construction joint doweling requirements of ACI-360 are met.

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I/II or II.
   1. Fly Ash: ASTM C 618, Class C or F.

B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
   1. Class: 3M.
   2. Nominal Maximum Aggregate Size: 1 inch.
   3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3-mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3 mm).

C. Water: Potable and complying with ASTM C 94.

2.5 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride. Any of the following mixtures may be used for mix designs.

B. Water-Reducing Admixture: ASTM C 494, Type A.

C. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

E. Air-Entraining Admixture: ASTM C 260.

2.6 SUBBASE (BELOW SLAB)

A. See Division 07 for vapor retarder requirement.

B. Aggregate Base Course (ABC): Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 8, with 100 percent passing a 1/2-inch (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

2.7 FLOOR AND SLAB TREATMENTS

A. Penetrating Liquid Floor Treatment: Apply to floors indicated as sealed concrete. Chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Penetrating Liquid Floor Treatment:
      a. Ashford Formula; Curecrete Chemical Co., Inc.
      b. Euco Diamond Hard; Euclid Chemical Co.
      c. Seal Hard; L&M Construction Chemicals, Inc.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 22 percent solids.

2.9 RELATED MATERIALS

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.10 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

2.11 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
   1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
   2. See Structural Notes for mix requirements.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
   1. Fly Ash: 35 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use corrosion inhibiting admixtures in concrete where indicated.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116 and furnish batch ticket information.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   1. Class A, 1/8 inch, for all exposed to public view concrete surfaces.
   2. Class C, 1/2 inch, for all other surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
   1. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Do not chamfer exterior corners and edges of permanently exposed concrete. Chamfer edges where indicated on the Drawings.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor bolts, accurately located, to elevations required. Comply with AISC "Code of Standard Practice for Steel Buildings and Bridges" Section 7.5.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 VAPOR RETARDERS

A. See Division 07 for vapor retarder installation, if vapor retarder is required.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints per details on Drawings. Continue reinforcement across construction joints, unless otherwise indicated. Dowel plates are not required when reinforcing is present.
   2. Provide dowel plates in slab-on-grades for unreinforced concrete.
   3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
   3. Provide contraction joints in slab-on-grade at a maximum spacing on 12'-6" on center each way, unless noted otherwise on plans.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, exterior slab locations, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Dowel Plate Assembly:
   1. Install at formed construction joints and mark center point for spacing of each Diamond Dowel® pocket former on top form. Use installation template. Insert correct tube, if needed, based on slab depth. Insert Diamond Dowel® pocket former into installation template. Nail Diamond Dowel® pocket former and remove installation template. Place and finish first slab. Use internal vibration to consolidate concrete around diamond shaped load plate pocket former per industry guidelines. Strip forms and bend nails flush with joint face.
   2. Insert Diamond Dowel® load plate into slot created by pocket former. Center corner of plate in middle of label and push straight through label into pocket former. Do not hammer or use excessive force to insert diamond shaped load plate. Insert diamond shaped load plate within two weeks of concrete placement. Place and finish second slab. Use internal vibration to consolidate concrete around Diamond Dowel® plate per industry guidelines

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
   1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
   2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

E. Deposit and consolidate concrete for floor slab in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
   5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

G. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height.
   1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.
   1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
   2. Finish surfaces to the following tolerances, according to ASTM E 1155 for a randomly trafficked floor surface:
      a. Specified overall values of flatness, F(F) 35; and levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17; for slabs-on-grade. Values are relative to the surface being measured.

E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness for trowel finish floors.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.

B. Equipment Bases and Foundations if applicable: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.11 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floor slabs, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    b. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.12 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
    1. Remove curing compounds (if non-dissipating product was used), sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
    2. Do not apply to concrete that is less than seven days old.
    3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner.
    4. Moist cure concrete for 7 days.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
    1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one-part Portland cement to two and one-half parts fine aggregate passing a No. 16 (1.2-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, pop-outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least ¾-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
   7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: A qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:
1. Steel reinforcement placement.
2. Anchor bolts.
3. Verification of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 80 deg F and above, and one test for each composite sample.
4. Compression Test Specimens: ASTM C 31.
   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
5. Compressive-Strength Tests: ASTM C 39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days. Test specimens at 28 days may be removed from testing if 7-day test exceeds 28-day strength.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
6. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

8. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing if requested by Architect to determine adequacy of floor flatness and levelness.

END OF SECTION

SECTION 03 60 00

GROUTING

PART 1 GENERAL

A. Section includes: Grout for column base plates, other structural supports, equipment bases, reinforcing bar dowels, surface repair, grout toppings, patching of fresh concrete, and uses other than masonry. Grout for masonry is specified in Section 04 22 00. Adhesive anchor bolt grouting is specified in Section 05 05 20. Topping concrete over precast elements and clarifier topping concrete is specified in Section 03 30 00.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00.
   2. Section 04 22 00.
   3. Section 05 05 20.

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm Cube Specimens)
ASTM C230	Flow Table for Use in Tests of Hydraulic Cement
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C939	Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts

Reference	Title
ASTM E329	Agencies Engaged in Construction Inspection, Testing, or Special Inspection
COE CRD-C611	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Non-shrink Grout
IBC	International Building Code

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00.
   2. A copy of this Specification section with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Complete product literature, including mixing, handling and placement instructions for the following: cementitious non-shrink grout, epoxy grout, adhesive for reinforcing bar dowel grouting, concrete repair mortar, and prepackaged cement grout products to be used on the project.
   5. Mix design for cement grout that is not prepackaged, including product data for aggregates and cement in accordance with Section 03 30 00.
   6. Current International Code Council (ICC) Evaluation Service reports for adhesives used for reinforcing dowels.
   7. Installer certification in accordance with American Concrete Institute/Concrete Reinforcing Steel Institute (ACI/CRSI) Adhesive Anchor Installer Certification Program for installers of horizonal or upwardly inclined reinforcing bar dowels grouted using adhesive.
   8. Certified test results verifying the compressive strength, shrinkage and expansion requirements specified herein.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Owner will provide the services of a qualified Special.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
      a. The Special Inspector shall furnish a report to the Engineer, Owner's Representative and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used

conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Quality Control by Contractor
   1. Provide the services of an independent testing laboratory which complies with the requirements of American Society for Testing and Materials (ASTM) E329 if a product other than those listed below is proposed and test data are not available from the supplier to demonstrate equivalence to the specified grout. The testing laboratory shall sample and test the proposed grout materials. Costs of testing laboratory services shall be borne by the Contractor.

C. Certifications
   1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.

D. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications.
   1. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at 7 days and any other time period as appropriate.
   2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at 7 days, 28 days, and any additional time period as appropriate.

E. Manufacturer Qualifications
   1. Manufacturer shall have a minimum of 5 years' experience producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least 5 years each.
   2. When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least 5 years of experience in field applications of the products required.

PART 2 PRODUCTS

2.01 CEMENTITIOUS NON-SHRINK GROUT

A. The grout material shall be an approved, ready-to-use mixture requiring only water for use at the jobsite. The 2-inch cubes shall have a minimum compressive strength of 3,000-psi at 7 days and 7,000-psi at 28 days.

B. Cementitious non-shrink non-metallic aggregate grout shall be:
   1. BASF, Masterflow 928.
   2. Euclid Chemical Company, Hi-Flow Grout.
   3. Five Star Products, Inc., Five Star Grout.

4. Sika Corporation, SikaGrout 212.
5. Approved equal.

C. Non-shrink grout shall conform to CRD-C 621 and ASTM C1107, Grade B or C when tested at a maximum fluid consistency of 30 seconds per ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes.

D. Fluid grout shall pass through the flow cone, with continuous flow, 1 hour after mixing.

2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING:

A. Epoxy grout shall be a pourable, non-shrink, 100% solids system.

B. Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Epoxy grout shall be:
   1. BASF, Masterflow 648.
   2. Euclid Chemical Company, E3-G.
   3. Sika Corporation, Sikadur 42.
   4. Approved equal.

C. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
   1. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per °F when tested in accordance with ASTM C531.
   2. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140°F in accordance with ASTM C1181.
   3. Minimum 7-day compressive strength shall be 14,000-psi when tested in accordance with ASTM C579
   4. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70°F.
   5. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.

2.03 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Adhesive for setting dowels in concrete shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report. Adhesive shall be:
   1. Hilti, HIT-RE 500v3,
   2. Simpson Strong Tie, SET XP,
   3. Approved Equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

B. Adhesive for setting dowels in concrete masonry shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report or International Association of Plumbing and Mechanical Officials (IAPMO) Report. Adhesive shall be:

1. Hilti, HIT-HY 70.
2. Simpson Strong Tie, SET XP.
3. Approved.

2.04 CONCRETE REPAIR MORTAR

A. Horizontal Applications: Repair mortars shall be:
   1. BASF, MasterEmaco S 466CI.
   2. Sika Corporation, SikaTop 111 Plus.
   3. Approved equal.

B. Vertical and Overhead Applications: Repair mortars shall be:
   1. BASF, MasterEmaco 1500HCR Vertical Overhead.
   2. Sika Corporation, SikaTop 123 Plus.
   3. Approved equal.

2.05 CEMENT GROUT

A. Cement grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this section.
   1. Minimum Compressive Strength: 4,500-psi at 28 days.
   2. Maximum Water Cement Ratio: 0.42 by weight.
   3. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
   4. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
   5. Air Content: 5 percent (plus or minus 1 percent).
   6. Minimum Cement Content: 564 pounds per cubic yard.
   7. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed 4 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

3.02 CEMENTITIOUS NONSHRINK GROUT

A. Non-shrink, cementitious, nonmetallic aggregate grout shall be used for column base plates, structural-bearing plates, and all locations where the general term “non-shrink grout” is indicated on the Drawings. Use of this grout to support the bearing surfaces of machinery shall be as specified in Section 43 05 13 or as detailed on the Drawings for specific locations or pieces of equipment. If guidance is not provided in locations noted above, use of non-shrink grout for equipment mounting shall be limited to equipment less than 25 horsepower or 750 pounds. Grout shall be placed and cured in accordance with the manufacturer's instructions.

B. Non-shrink cementitious grout shall not be used as a surface patch or topping. Non-shrink cementitious grout must be used in confined applications only.

3.03 EPOXY GROUT FOR EQUIPMENT MOUNTING

A. Prepare concrete surfaces of equipment pads as indicated in details on the Drawings and as required by the epoxy grout manufacturer. Epoxy grout for equipment mounting shall be placed and cured in accordance with the requirements of Section 43 05 13, details on the Drawings, and in conformance with manufacturer's recommendations.

3.04 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Follow manufacturer's instructions.

3.05 CONCRETE REPAIR MORTAR

A. Concrete repair materials and procedures shall be submitted for review to the Owner's Representative and shall be accepted prior to commencement of the repair work.

B. Follow all manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation and curing. Add aggregate as required per manufacturer's recommendations. Any deviations from the manufacturer's instructions shall be submitted for review to the Owner's Representative and shall be accepted prior to commencement of the work.

3.06 CEMENT GROUT

A. Cement grout shall be used for grout toppings less than 4 inches thick and for patching of fresh concrete.

B. Grouting shall comply with temperature and weather limitations in Section 03 30 00.

C. Cure grout in accordance with grout manufacturer's instructions for prepackaged grout and Section 03 30 00 for non-prepackaged cement grout.

END OF SECTION

SECTION 04 20 00

UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Mortar and grout.
   3. Steel reinforcing bars.
   4. Masonry joint reinforcement.
   5. Ties and anchors.
   6. Embedded flashing.
   7. Miscellaneous masonry accessories.

B. Related Sections:
   1. Division 5 Section "Metal Fabrications" for furnishing steel lintels for unit masonry.
   2. Division 7 Section "Sheet Metal Flashing and Trim" for exposed sheet metal.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
   2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:
   1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

C. Samples for Verification: For sandblast-finish concrete masonry units.

1.6 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include data on material properties and material test reports substantiating compliance with requirements.
      b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.
   5. Reinforcing bars.
   6. Joint reinforcement.
   7. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109 for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockups for typical exterior wall in sizes approximately 48 inches long by 48 inches high by full thickness, using specified masonry units.
      a. Include a sealant-filled joint at least 16 inches long in exterior wall. Protect accepted mockups from the elements with weather-resistant membrane.
   2. Clean one-half of exposed faces of panels with masonry cleaner indicated.
   3. Protect approved mockup panels from the elements with weather-resistant membrane.
   4. Approval of mockup panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
      a. Approval of mockup panels does not constitute approval of deviations from the Contract Documents contained in mockup panels unless such deviations are specifically approved by Architect in writing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

C. Provide all units from a single manufacturer.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent.
   1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) ACM Chemistries; RainBloc.
         2) BASF Aktiengesellschaft; Rheopel Plus.
         3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

C. CMUs: ASTM C 90.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
   2. Density Classification: Medium weight.
   3. Size (Width x Height x Length): Manufactured to dimensions 3/8 inch less than nominal dimensions.
      a. CMU: 8" x 8" x 16" units.
      b. Cap: 2” x 8” x 16” units.
   4. Pattern and Texture: Superlite or Yavapai Block Standard CMU block with Split-Face finish.

2.3 MASONRY LINTELS

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than ¼-inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

E. Aggregate for Grout: ASTM C 404.

F. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Euclid Chemical Company (The); Accelguard 80.
      b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
      c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ACM Chemistries; RainBloc for Mortar.
      b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
      c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

H. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615 or ASTM A 996, Grade 60 (#5 and larger) and Grade 40 (#4 and smaller).

B. Masonry Joint Reinforcement, General: ASTM A 951.
   1. Interior Walls: Hot-dip galvanized, carbon steel.
   2. Exterior Walls: Hot-dip galvanized, carbon steel.
   3. Wire Size for Side Rods: 0.148-inch diameter.
   4. Wire Size for Cross Rods: 0.148-inch diameter.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
   1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
   2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008, Commercial Steel, with ASTM A 153, Class B coating.
   3. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of and an amplitude of 0.06 to 0.10 inch made from 0.030-inch- thick, steel sheet, galvanized after fabrication.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
   2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch- diameter, hot-dip galvanized steel.

2.7 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of dimensions indicated.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
      b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
      c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
      d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.9 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Diedrich Technologies, Inc.
      b. EaCo Chem, Inc.
      c. ProSoCo, Inc.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For all masonry, use Type S.

D. Grout for Unit Masonry: Comply with ASTM C 476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
   3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
1. Mix units from several pallets or cubes as they are placed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:
1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or ½-inch total.

B. Lines and Levels:
1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c.
   2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
   1. Provide an open space not less than ½-inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:
   1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
   2. Install preformed control-joint gaskets designed to fit standard sash block.
   3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
   4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.9 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 24 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches.

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Level 2 special inspections according to the "International Building Code."
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
   2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
   3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
6. Clean stone trim to comply with stone supplier's written instructions.

3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 05 05 14

HOT-DIP GALVANIZING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Hot-dip galvanizing of steel materials.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 09 90 00 Painting and Coating.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A780	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B6	Zinc
ASTM D6386	Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM E536	Test Methods for Chemical Analysis of Zinc and Zinc Alloys
DOD-P-21035A	Paint, High Zinc Dust Content, Galvanizing Repair

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedure: Section 01 33 00.
   2. A copy of this Specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will

signify compliance on the part of the Contractor with the Specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. Coating applicator's Certificate of Compliance that the hot-dip galvanized coating meets or exceeds the specified requirements of ASTM A123 or A153, as applicable.
5. Evidence that the galvanized coating applicator is a member of the American Galvanizing Association.

1.05 QUALITY ASSURANCE

A. Hot-dip galvanized coating applicator shall be a member of the American Galvanizing Association.

PART 2 PRODUCTS

2.01 MATERIALS

A. Zinc used for galvanizing shall conform to ASTM B6, and shall be at least equal to the grade designated as Prime Western.

B. Maximum amount of aluminum added to a galvanizing bath shall not exceed 0.01 percent.

C. Hot-Dip Galvanized Coating: Conform to ASTM A123 and A153, as applicable.

D. Repair: Zinc dust-zinc oxide coating conforming to DOD-P-21035A and containing 95 percent zinc in the dry film. Acceptable product is ZRC Cold Galvanizing Compound by ZRC Worldwide, or approved equal.

2.02 FABRICATION REQUIREMENTS

A. Fabrication practices for products to be galvanized: In accordance with applicable portions of ASTM A143, A384 and A385. Avoid fabrication techniques that could cause steel distortion or embrittlement.

B. Coordinate with steel detailer to provide vent and drain holes of sufficient size and quantity to achieve specified galvanized coating.

PART 3 EXECUTION

3.01 PREPARATION

A. Casting surfaces to be galvanized shall be sand-blasted or ground smooth. When a smooth cast is required, castings shall be tumbled and all high spots ground flush. Castings shall be normalized to prevent cracking. Malleable iron shall be safeguarded against embrittlement by pre-annealing.

B. Steel work shall be precleaned utilizing a caustic bath, acid pickle and flux or shall be blast-cleaned and fluxed to obtain an acceptable surface for quality hot-dip galvanizing.

3.02 APPLICATION

A. Steel Members, Fabrications, and Assemblies: Hot-dip galvanize after fabrication in accordance with ASTM A123.

B. Steel Bolts, Screws, Nuts, Washers and Hardware Components: Hot-dip galvanize in accordance with ASTM A153.

3.03 COATING REQUIREMENTS

A. Hot-dip Coating Thickness: Conform to ASTM A123 or ASTM A153, as applicable.

3.04 TESTING

A. Chemical analysis for impurities in the bath shall be made in conformity with ASTM E536.

B. Test Requirements and Methods: In accordance with ASTM A123 or ASTMA153, as applicable.

3.05 GALVANIZED SURFACES TO BE PAINTED

A. Where galvanized surfaces are specified to be painted in Section 09 90 00 or elsewhere in the Project Manual, conform to ASTM D6386.

3.06 REPAIR OF DEFECTIVE GALVANIZED COATING

A. Where zinc coating has been damaged after installation, clean substrate surface and repair with zinc dust-zinc oxide coating in accordance with ASTM A780. Apply zinc dust-zinc oxide coating in accordance with manufacturer's recommendation. Apply multiple coats to achieve a minimum film thickness of 8 mils.

B. Remove items not physically damaged, but which have insufficient or deteriorating zinc coatings, and items damaged in shipment or prior to installation, from the project site for repair by the hot-dip zinc-coating method.

END OF SECTION

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SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Pipe handrails.

B. Miscellaneous metal fabrications.

C. Thrust Supports.

1.2 RELATED WORK

A. Section 03 30 00 Cast-in-place Concrete

B. Section 09 91 00 Painting

C. Structural General Notes: Where conflict exists between this Section and the Structural General Notes, the Structural General notes shall govern.

1.3 QUALITY ASSURANCE

A. Subcontractor qualifications: Welders shall have passed the AWS code qualification tests and shall have been successfully employed in the welding trade for one year.

1.4 REFERENCES

A. ASTM A36 Structural steel

B. ASTM A53 Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated.

C. ASTM A307 Carbon Steel Externally Threaded Standard Fasteners.

D. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

E. ASTM A501 Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

F. AWS The Welding Handbook.

G. ASTM A992 Structural Steel Shapes.

1.5 SUBMITTALS

A. Submit the following to Architect in accordance with Section 01300. Designate all welds with standard AWS symbols.
   1. Manufacturer's Literature: Material description and application or installation instructions for products.

2. Shop Drawings: Layout and detail of each miscellaneous metal item shown and specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel pipe: ASTM A501 or A53, in sizes shown on the Drawings.

B. Steel tubes: ASTM A500, in sizes shown on the Drawings.

C. Machine bolts and anchor bolts: ASTM A307.

D. Welding rods: AWS A5.0 E70 series.

E. Shop primer: Tnemec 10-99.

F. Galvanized Primer: FS TT-P-641F

2.2 FABRICATION

A. Fabricate all steel items in accordance with the Drawings and the approved shop drawings.

B. Fabricate and assemble all items in the shop and, if necessary, mark to ensure proper installation at the project site. Disassemble for shipment only to the extent required by shipping limitations.

C. Ease all exposed edges of steel shapes.

D. Join all parts with hairline contact, flush and smooth with adjacent surfaces, using concealed welds and fasteners where possible. Where exposed fastenings are unavoidable, countersink screws and bolts. Grind exposed weld areas smooth to match and blend with finished surfaces.

E. Use hot-rolled steel bars, except where cold-rolled or cold finished are shown or specified.

F. Weld in accordance with the recommendations of the AWS.

G. Shop cleaning: Thoroughly clean all steel to be encased in concrete.

2.3 PRIMING AND PROTECTIVE COATING

A. Clean all ferrous metal in accordance with applicable requirements of SSPC-SP1 (Solvent Cleaning) followed by cleaning with applicable requirements of SSPC-SP2 (Hand Tool Cleaning).

B. Apply specified primer to all ferrous metal surfaces by brush or spray to a dry film thickness of 2 mils.

C. Galvanize products as shown or specified in accordance with ASTM A 123, A 385 and A 386 as applicable.

D. Paint galvanized surfaces with one coat of specified primer, by brush or spray application.

E. Paint miscellaneous metal work which is to be in contact with but not fully embedded in concrete or masonry with a heavy coat of bituminous paint; also coat dissimilar metals which are, or will be, in contact with one another with such paint. Coating shall not extend onto surfaces which will be exposed.

PART 3 - EXECUTION

3.1 RAILINGS

A. Provide railings of design and dimensions shown, located where shown or required for safety. Fabricate with flush welded joints and fittings for bends, wall returns, cap tees, and crosses.

B. Furnish galvanized steel sleeves to receive rail standards where installed in concrete or masonry. Set standards in sleeves with lead, or approved quick-setting, non-shrinking cement. Anchor railings to supporting structure by welding wherever possible, and by bolting elsewhere as approved. Support wall handrails with malleable iron brackets. At terminations return ends of railings to walls.

3.2 MISCELLANEOUS FRAMES AND SUPPORTS

A. Furnish miscellaneous metal angles, plates, and assemblies shown on the Drawings with anchors, bolts, and accessories required. This would include but not necessarily be limited to the following:
   1. Embedment plates.

3.3 INSTALLATION

A. Install all material plumb and level. Anchor securely in place.

B. Field welding: Conform to AWS Standards for arc and gas welding in building construction. Close all joints exposed to weather with continuous 1/8” weather welds. Grind smooth all exposed welds without reducing weld strength or required size. Remove unsatisfactory welds by chipping or arc air method.

C. Field painting: Spot prime all abrasions, bolts, and field welds with same paint as shop coat.

END OF SECTION

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SECTION 05 05 20

ANCHOR BOLTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bolts and all-thread rods used to attach structural elements and equipment to concrete and concrete masonry. Included are cast-in-place and post-installed anchors (adhesive systems and wedge-type expansion anchors), nuts and washers.

B. Cast-in-place and post-installed anchors shall be Type 316 stainless steel unless noted otherwise.

1.01 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 03 30 00 Cast-In-Place Concrete
   3. Section 03 60 00 Grouting
   4. Section 43 05 13 Rigid Equipment Mounts

1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High-Pressure Service and Other Special-Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A563	Carbon and Alloy Steel Nuts
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
ASTM F844	Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength
IBC	International Building Code with Local Amendments

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Specification section with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements.
   3. Check-marks shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Anchor bolt placement plans.
   5. Anchor bolt, nut, and washer material information, including material certifications.
   6. Record copy of design calculations and details showing the required diameter, length, embedment, edge distance, confinement, anchor reinforcement, anchor bolt sleeves, connection redesign, and other conditions, stamped and signed by a Professional Engineer currently registered in the state of Arizona. Calculations shall comply with the provisions of American Concrete Institute (ACI) 318, Appendix D. Base anchor capacity determination on cracked concrete condition and compressive strength of new concrete per Section 03 30 00. Assume compressive strength of existing concrete is 3,000 pounds per square inch (psi) unless otherwise noted.
   7. Product Data:
      a. International Code Council (ICC) Evaluation Service Reports for post-installed adhesive type anchors and expansion (wedge-type) anchors when allowed. Products shall be ICC approved for use in cracked concrete in high seismic areas (Seismic Design Category D, E and F).
      b. Product data indicating load capacity charts/calculations.
      c. Chemical resistance.
      d. Temperature limitations.
      e. Manufacturers' written installation instructions.
   8. Installer certification for horizontal or upwardly inclined adhesive anchors in accordance with American Concrete Institute/Concrete Reinforcing Steel Institute (ACI/CRSI) Adhesive Anchor Installer Certification Program.

1.04 QUALITY ASSURANCE

A. Quality Assurance by Owner:
   1. Special inspection of anchor bolts shall be performed by the Special Inspector under contract with the Owner and in accordance with International Building Code (IBC) Chapter 17.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.

3. The Special Inspector shall furnish a report to the Engineer, Owner's Representative, and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Certifications

1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

PART 2 PRODUCTS

2.01 GENERAL

A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 1/4-inch. Minimum anchor bolt diameter shall be 1/2-inch. Anchor bolts for equipment mounting and vibration isolation systems shall be provided as specified in Section 43 05 13.

B. Tapered washers shall be provided where mating surface is not square with the nut.

C. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings. Substitution of post-installed anchors will not be permitted unless specifically requested by the Contractor and approved by the Engineer.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Anchor bolts for equipment shall be designed by the equipment manufacturer to include equipment operational loads combined with seismic and wind forces when applicable. Design criteria provided in Section 01 73 24.

B. Design anchor bolts for support and bracing of non-structural components and non-building structures for loading specified in Section 01 73 24.

2.03 MATERIALS

A. Anchor bolt materials shall be as specified in the following table:

Material	Specification
Stainless Steel Anchor Bolts	ASTM A193 or A320, Type 316
Stainless Steel Threaded Rods	ASTM F593, Type 316
Stainless Steel Nuts	ASTM A194 Heavy Hex Nuts, Type 316 ASTM F594 Heavy Hex Nuts at Adhesive Anchors, Type 316
Stainless Steel Washers	Type 316 to Match Bolt Material
Carbon Steel Anchor Bolts	ASTM F1554, Grade 36, Hot-Dip Galvanized
High-Strength Carbon Steel Anchor Bolts	ASTM F1554, Grade 55, Weldable per Supplementary Requirement S1, Hot-Dip Galvanized
Carbon Steel Nuts and Washers	ASTM A563 and F844, Heavy Hex, Hot-Dip Galvanized
Concrete Adhesive Anchors	Hilti "HIT-RE 500v3," Simpson Strong-Tie "SET-XP," or Approved Equal, with Type 316 Stainless Steel Threaded Rods

Material	Specification
Concrete Masonry Adhesive Anchors	Hilti "HIT-HY 70," Simpson Strong-Tie “SET-XP,” or Approved Equal, with Type 316 Stainless Steel Threaded Rods
Concrete Masonry Expansion (Wedge) Anchors*	Hilti "KWIK BOLT 3," or Approved Equal, Type 316 Stainless Steel
Concrete Expansion (Wedge) Anchors *	Hilti “KWIK BOLT TZ,” or Approved Equal, Type 316 Stainless Steel

**Post-installed anchors shall always be an adhesive type anchor system except where noted otherwise or when Contractor makes a request for a specific application and Engineer approves.*

2.04 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:
   1. Suitable for potable water supply.
   2. Formulated to resist washout.
   3. Acceptable manufacturers are Bostik, Saf-T-Eze, or equal.

2.05 ANCHOR BOLT SLEEVES

A. Provide anchor bolt sleeves as shown on Design Drawings and as required by equipment manufacturer’s design.
   1. Provide high-density, polyethylene, plastic sleeves of single-unit construction with deformed sidewalls such that the concrete and grout lock in place.
   2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
   3. Acceptable manufacturers are Contec, Wilson, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings.

B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where specified, shall be in accordance with Section 03 60 00.

C. The threaded end of anchor bolts and all-thread rods shall be long enough to project through the entire depth of the nut and, if too long, shall be cut off at 1/2-inch beyond top of nut and ground smooth.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

B. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3.03 ADHESIVE ANCHOR BOLTS

A. Note that adhesive anchors shall not be substituted for cast-in-place anchor bolts unless the adhesive anchors have been specified or shown on the Drawings, or approval has been obtained from the Engineer that substitution of adhesive anchors is acceptable for the specific use and location. Use of adhesive anchors shall be subject to the following conditions:
   1. Limit to locations where intermittent or continuous exposure to the following is extremely unlikely:
      a. Acid concentrations higher than 10 percent.
      b. Chlorine gas.
      c. Machine or diesel oils
   2. Limit to applications where exposure to the following is extremely unlikely:
      a. Fire.
      b. Concrete or rod temperature above 120 degrees Fahrenheit (°F).
   3. Overhead applications (such as pipe supports) shall not be allowed unless approved by the Engineer and installation is by an installer specially certified for overhead applications.
   4. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.
   5. Anchor diameter and material shall be per Contract Documents or equipment manufacturer's specifications. Anchor shall be threaded or deformed the full length of embedment and shall be free of rust, scale, grease, and oils.
   6. Embedment depth shall be as specified or as required by the equipment manufacturer.
   7. Follow the anchor-system manufacturer's installation instructions.
   8. Holes shall have rough surfaces created by using a hammer drill with carbide bit. Core-drilled holes are not allowed.
   9. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation. Follow additional requirements of the adhesive manufacturer.
   10. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer's instructions. Anchors shall not be placed in concrete when the temperature is below 25°F.
   11. Anchors shall be left undisturbed and unloaded for full adhesive curing period, which is based on temperature of the concrete.

3.04 EXPANSION ANCHORS

A. Expansion (wedge type) anchors shall not be substituted for cast-in-place anchor bolts or adhesive anchors unless approved by the Engineer for a specific application. Use of expansion anchors shall be subject to conditions 4 through 9 as specified above for adhesive anchors. Expansion anchors shall not be used in a submerged condition or in mounting of equipment subject to vibration or cyclic motion.

3.05 REINFORCING STEEL CONFLICTS WITH POST-INSTALLED ANCHOR INSTALLATION

A. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction and provide beveled washer to match angle of anchor. Drill shall not be slanted more than 10 degrees.

B. Where slanting the drill does not resolve the conflict, notify the Owner's Representative and resolve the conflict to the satisfaction of the Owner's Representative in consultation with the Engineer.

C. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.

D. The costs of determining and executing the resolution shall be borne by the Contractor. The determination and execution of the resolution shall not result in additional cost to the Owner.

E. Reinforcing steel in masonry shall not be damaged.

F. In order to avoid or resolve a conflict, locate embedded reinforcing steel using non-destructive methods and/or redesign the attachment.
   1. Redesign shall be done by the Contractor's Professional Engineer currently registered in the State of Arizona.
   2. Calculations and details for redesign shall be submitted.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. Rough carpentry includes carpentry work not specified as part of other Sections and generally not exposed, unless otherwise specified.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.
   1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Lumber Standards: Furnish lumber manufactured to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

B. Inspection Agencies: Inspection agencies and the abbreviations used to reference them with lumber grades and species include the following:
   1. WCLIB - West Coast Lumber Inspection Bureau.
   2. WWPA - Western Wood Products Association.

C. Grade Stamps: Provide lumber with each piece factory-marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
   1. For exposed lumber furnish pieces with grade stamps applied to ends or back of each piece; or omit grade stamps entirely and provide certificates of grade compliance issued by inspection agency.

D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.
   1. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 MISCELLANEOUS LUMBER

A. General: Provide lumber for support or attachment of other construction including rooftop equipment curbs and support bases, bucks, nailers, blocking, furring, and similar members.

B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.

C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.

D. Grade: "Standard" grade light-framing-size lumber of any species or board-size lumber as required. "No. 3 Common" or "Standard" grade boards per WCLIB or WWPA rules or "No. 2 Boards" per SPIB rules.

2.3 CONSTRUCTION PANELS FOR BACKING

A. Plywood Backing Panels: For mounting electrical or telephone equipment, provide plywood panels with grade designation, APA C-D PLUGGED EXPOSURE 1, in thickness indicated, or, if not otherwise indicated, not less than 15/32 inch.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of AISI Type 304 stainless steel.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Power Driven Fasteners: National Evaluation Report NER-272.

D. Wood Screws: ANME B18.6.1.

E. Lag Bolts: ASME B18.32.1

F. Bolts: Steel bolts complying with ASTM A 307 Grade A with ASTM A 563 hex nuts and, where indicated, flat washers.

2.5 PRESERVATIVE WOOD TREATMENT BY PRESSURE PROCESS

A. General: Where lumber or plywood is indicated as preservative-treated wood or is specified herein to be treated, comply with applicable requirements of AWPA Standards C2 (Lumber) and C9 (Plywood). Mark each treated item with the AWPB or SPIB Quality Mark Requirements.

B. For interior uses, after treatment, kiln-dry lumber and plywood to a maximum moisture content, respectively, of 19 percent and 15 percent. Treat indicated items and the following:
   1. Wood nailers, blocking and similar members in connection with roofing, flashing, vapor barriers and waterproofing.

2. Wood furring, stripping, and similar concealed members in contact with concrete.

C. Pressure-treat wood members in contact with the ground or fresh water with water-borne preservatives to a minimum retention of 0.40 pcf.

D. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces to comply with AWPA M4. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of rough carpentry construction and that are too small to use in fabricating rough carpentry with minimum joints or optimum joint arrangement.

B. Set rough carpentry to required levels and lines, with members plumb and true to line and cut and fitted.

C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of nailers, blocking, grounds, and similar supports to allow attachment of other construction.

D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.

E. Countersink nail heads on exposed carpentry work and fill holes.

F. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

END OF SECTION

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SECTION 06 17 53

SHOP FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Fabrication and erection of shop fabricated wood roof trusses.

1.2 RELATED WORK

A. Section 06 10 00 Rough carpentry

1.3 SUBMITTALS

A. Submit engineered shop drawings and calculations to Owner. Manufacturer shall furnish design drawings bearing seal and registration number of a civil or structural engineer licensed in state where trusses are to be installed. Drawings shall be approved by Architect prior to fabrication.

B. Truss design drawings shall include as minimum information:
   1. Span, depth or slope and spacing of trusses.
   2. Required bearing width.
   3. Design loads, as applicable for all members.
   4. Adjustment to lumber and plate design loads for condition of use.
   5. Reactive forces, their points of occurrence and direction.
   6. Lumber size, species and grade for each member.
   7. Location of any required continuous later bracing.
   8. Calculated deflection ratio and/or maximum deflection for live and total load.
   9. Maximum axial compressive forces in truss members.
   10. Location of joints.
   11. Specifications for connectors/plates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber:
   1. Lumber used for truss members shall be in accordance with published Values of lumber rules writing agencies approved by board of review of American Lumber Standards Committee. Lumber shall be identified by Grade mark of a lumber inspection bureau or agency approved by that Board and shall be as shown on design drawings.
   2. Moisture content of lumber shall be no less than 7 percent nor greater than 19 percent at time of fabrication.
   3. Adjustment of values for duration of load or conditions of use shall be in accordance with National Design Specifications for Wood Construction (NDS).

4. Fire retardant treated lumber, if applicable, shall meet specifications of truss design and ANSI/TPI 1-1995, par 9.1.5 and shall be re-dried after treatment in accordance with AWPA Standard C20. Allowable values must be adjusted in accordance with NDS par 2.3.6. Lumber treater shall supply certificate of compliance.

B. Metal Connector Plates:
   1. Metal connector plates shall be manufactured by ALPINE/LUMBERMATE/CLARY (or equal) and shall be not less than .036 inches in thickness (20 gage) and shall meet or exceed ASTM A653-94 grade 37 and shall be hot dipped galvanized according to ASTM A653-94, coating designation G60. Working stresses in steel are to be applied to effective ratios for plates as determined by test in accordance with Appendix E and F of ANSI/TPI 1-1995.
   2. In highly corrosive environments, special applied coatings or stainless steel may be required.
   3. At the request of Architect, supplier shall furnish a certified record that materials comply with steel specifications.

2.2 TRUSS FABRICATION

A. Truss Fabrication;
   1. Trusses shall be fabricated in a properly equipped manufacturing facility of a permanent nature. Trusses shall be manufactured by experienced workmen, using precision cutting, jigging and pressing equipment meeting requirements of ANSI/TPI 1-1995, Section 4. Truss members shall be accurately cut to length angle and true to line to assure proper fitting joints within tolerances set forth in ANSI/TPI 1-1995, Section 4, and proper fit with other work.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all prefabricated wood trusses in strict accordance with Drawings and manufacturer's instructions.
   1. Truss delivery shall be scheduled reasonably near the scheduled time of erection.
   2. Trusses shall be handled during fabrication, delivery and at job site so as not to be subjected to excessive bending.
   3. Trusses shall be unloaded on smooth ground to avoid lateral strain. Trusses shall be protected from damage that might result from on-site activities and environmental conditions. Prevent toppling when banding is removed.
   4. Upon arrival and during the unloading process, trusses shall be inspected for damage.
   5. Handle during installation in accordance with Handling, Installing and Bracing Wood Trusses (HIB-91), TPI, and ANSI/TPI 1-1995. Installation shall be consistent with good workmanship and good building practices and shall be responsibility of Truss Installer.
   6. Apparent damage to trusses, if any, shall be reported to Manufacturer prior to installation.
   7. Trusses shall be set and secured level and plumb, and in correct location. Trusses shall be held in correct alignment until specified permanent bracing is installed.

8. Cutting and altering of trusses is not permitted.
9. Concentrated loads shall not be placed atop trusses until all specified bracing has been installed and decking is permanently nailed in place. Specifically avoid stacking full bundles of decking or other heavy materials onto unsheathed trusses.
10. Erection bracing is always required. Professional advice should always be sought to prevent toppling or "dominoing" (cascading collapse) of trusses during installation.
11. The Contractor is responsible for obtaining and furnishing the materials used for installation and permanent bracing.

END OF SECTION

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SECTION 07 21 00

THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Glass-fiber blanket insulation.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product test reports.

C. Research / evaluation reports.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CertainTeed Corporation.
   2. Johns Manville.
   3. Owens Corning.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
   1. Provide insulation in attic on top of ceiling, in thickness required to achieve R-30 Value.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

END OF SECTION

SECTION 07 61 13

STANDING SEAM SHEET METAL ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Prefinished, prefabricated structural standing seam roof system, with mechanically seamed side lap.
   2. Coordination with installation of roofing substructure.
   3. Coordinated flashings, counterflashings, and accessories.
   4. Clips, fasteners, closures and sealants as necessary to meet design criteria and ensure weathertight installation.

B. Related Work:
   1. Refer to Division 06 Section "Rough Carpentry."

1.3 SUBMITTALS

A. Product Data: Manufacturer's specifications, standard detail drawings and installation instructions.

B. Shop Drawings: Show layouts of panels on roofs, details of edge conditions, joints, corners, panel profiles, supports, anchorages, trim, flashings, closures, and special details. Distinguish between factory and field assembly work.

C. Samples for Verification Purposes:
   1. Submit 2 samples, 12" long x full width panel, in the profile, style, finish color and panel material specified.

D. Certification: Submit manufacturer's certification that materials meet specification requirements.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Ten years minimum experience in fabrication of metal standing seam roofs.

B. Installer Qualifications:
   1. Installers and supervisors shall be trained and approved by roof manufacturer.
   2. Three years minimum experience in application of metal standing seam roofs.
   3. Minimum of 5 satisfactory roofs on similar type of project.

C. Preinstallation Roofing Conference: Approximately 2 weeks prior to scheduled commencement of roof system installation and associated work, meet at Project Site with Installer, installer of each component of associated work, installers of deck or substrate construction to receive roofing work, and other work that must precede or follow Work of this Section--including mechanical work, Architect, Owner, roofing system manufacturer's representative, and other representatives directly concerned with work performance.
   1. Review foreseeable methods and procedures related to Work of this Section, including, but not necessarily limited to, the following:
      a. Review metal panel system requirements: Drawings, specifications, and other contract documents.
      b. Review required submittals, both complete and incomplete.
      c. Review and finalize construction schedule related to metal panel work and verify availability of materials, Installer personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Contractor shall record discussions of conference, including decisions and agreements or disagreements reached, and furnish a copy for each attendee. If substantial disagreements exist at the conclusion of the conference, determine how disagreements will be resolved and set a date for reconvening the conference.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect products and accessories from damage and discoloration during transit and at Project site. Store sheets and components in dry storage area to prevent condensation.

B. Do not overload roof structure with stored materials. Do not permit material storage or traffic on completed roof surfaces.

1.6 WARRANTY

A. Finish Warranty: Furnish panel manufacturer's written warranty covering failure of the factory-applied exterior finish on metal roof panels within the warranty period. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.
   1. Warranty period for factory-applied finishes on roof panels is 20 years after the date of Substantial Completion.

B. Submit written warranty signed by applicator for 2 years from the date of substantial completion of building covering repairs required to maintain roof and flashings in watertight condition.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturer: Subject to compliance with requirements, provide prefinished metal roof panels by one of the following:
   1. Basis-of-Design product is Metal Sales "Magna-Loc 180."

2. Similar products by the following are acceptable, providing they comply with this Specification:
   a. AEP Span.
   b. ATAS International, Inc.
   c. Morin Corporation.

B. Substitutions: Refer to Specification Division 00 Section "Instructions to Bidders" for substitution request procedures.

2.2 STANDING SEAM ROOF SYSTEM

A. Provide standing seam metal roof system meeting the following physical characteristics:
   1. Profile: Flat panel, 16 inches wide with 2-inch rib height, factory-applied sealant.
   2. Seam: Mechanically seamed, 180 degrees.
   3. Texture: Smooth.
   4. Clip Type: Utility, fixed, 2-1/8 inches tall.
   5. Thickness: Panels shall meet design loads as indicated on Structural Drawings, but not less than 22 gauge (0.030 inches).
   6. Fastening System: Concealed.
   7. Finish: Fluoropolymer coating as specified below.

2.3 SHEET MATERIALS

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755.
   1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653, G90 coating designation; structural quality.

2.4 METAL FINISHES

A. General: Apply coatings either before or after forming and fabricating panels, as required by coating process and as required for maximum coating performance capability. Protect coating either by application of strippable film or by packing plastic film or other suitable material between panels in a manner to properly protect the finish. Furnish air-drying spray finish in matching color for touch-up.
   1. Color: Standard color, to be selected.

B. Fluoropolymer Coating: Manufacturer's standard two-coat, thermo-cured, premium 70 percent "Kynar 500 / Hylar 5000" coating consisting of an 0.2 mil primer and a nominal 0.8-0.9 mils top coat for a total minimum dry film thickness of 1.0-1.1 mils and 30 percent reflective gloss when tested in accordance with ASTM D 523.
   1. Durability: Provide coating that has been field tested under normal range of weathering conditions for minimum of 20 years without significant peel, blister, flake, chip, crack, or check in finish; without chalking in excess of No. 8 in accordance with ASTM D 659; and without fading in excess of 5 NBS units.

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets, self-locking bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.
   1. Use aluminum, corrosion-resistant steel, or stainless steel fasteners for exterior application and galvanized or cadmium-plated fasteners for interior applications.
   2. Provide exposed fasteners with heads matching color of roof panel by means of plastic caps or factory-applied coating.
   3. Provide metal-backed neoprene washers under heads of exposed fasteners bearing on weather side of panels.
   4. Locate and space exposed fasteners in true vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of neoprene washer.

B. Rosin Paper ("Slip Sheet"): Wood fiber paper, 4-6 lbs./sq., sized with wood rosin.

C. Accessories: Except as indicated as work of another specification section, provide components required for a complete roof panel system, including trim, fascias, flashings, fillers, closure strips, and similar items. Match materials and finishes of panels.
   1. Closure Strips: Provide closures to match roof panel profile, of same material as roof. Provide closures where indicated or necessary to ensure weathertight construction.
   2. Sealing Tape: Pressure-sensitive 100 percent solids polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
   3. Joint Sealant: One-part elastomeric polyurethane, polysulfide, or silicone rubber sealant as recommended by the roof manufacturer.
   4. Gutters:
      a. Shall be of same material and finish as roof panel; similar to Magna-Loc Box Gutter.
      b. All gutter joints, end caps, drop sections and connected scuppers shall have soldered connections. Solder shall conform to ASTM B-32.
      c. All solder flux remaining on the joints shall be washed off with soap and baking soda solution.
   5. Downspouts: Formed from same material and finish as roof panels. Fabricate in 10-foot-long sections, complete with formed elbows and offsets. (Similar to Magna-Loc 6 x 4-inch Downspout with 95-degree elbow.)
   6. Snow Guards. Provide snow guards on all eaves to prevent the sliding of snow from roof. Guards to be finished to match roofing as specified above.
   7. Other standard brackets, straps and supports as required for installation of roofing system and accessories.

D. Bituminous Coating: Cold-applied asphalt mastic, SSPC paint 12, compounded for 15 mil dry film thickness per coat.

E. Underlayment:
   1. Felt Underlayment: ASTM D 266, Type II (No. 30) asphalt-saturated organic felts.

F. Flashing:
   1. Flashing, closure accessories and decorative trims shall be of the same metal panel as for the standing seam system. Attachment shall be concealed where possible.

2. All edges to be hemmed 1/2-inch minimum, with fastening devices not to exceed 16 inches on center. See Detail Drawings.

2.6 PANEL FABRICATION

A. General: Fabricate and finish panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as required to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and dimensional requirements and with structural requirements.

B. Apply bituminous coating or other permanent separation materials on concealed panel surfaces where panels would otherwise be in direct contact with substrate materials that are noncompatible or could result in corrosion or deterioration of either material or finishes.

C. Fabricate panel joints with captive gaskets or separator strips, which provide a tight seal and prevent metal-to-metal contact in a manner that will minimize noise from movements within panel system.

D. Form and fabricate sheets, seams, strips, clips, valleys, ridges, edge treatments, integral flashings, and other components of the metal roof to the profiles, patterns, and drainage arrangements indicated on Drawings to provide permanent leakproof construction with no oil canning or panel distortion.
   1. Fabricate exposed items of prefinished sheet metal in color to match standing seam metal roof.
   2. Hem exposed edges on underside 3/8-inch to 1/2-inch miter and seam corners.
   3. Provide for thermal expansion and contraction of the Work.
   4. Seal joints to achieve leakproof construction per manufacturer's detail.
   5. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.
   6. Unless otherwise shown on Drawings or specified herein, panels shall be full length.
   7. Fabricate flashings and accessories in longest practical lengths.
   8. Metal panels shall be factory formed. Field formed panels are not acceptable.

PART 3 - EXECUTION

3.1 UNDERLAYMENT

A. Prior to installing roof system install felt underlayment continuous over entire roof surface. Unless recommended otherwise, cover all surfaces of underlayment with one ply of rosin paper "slip sheet" prior to installing roofing.
   1. Apply underlayment in shingle fashion to shed water, and with lapped joints of not less than 2 inches.

3.2 INSPECTION

A. Prior to beginning Work of this Section, inspect the installed work of other trades and verify that such Work is complete to the point of acceptance. Report all discrepancies to the Architect. Do not proceed with this Work until corrections are made. Installation of roofing materials will be construed as acceptance of substrate conditions.

3.3 PANEL INSTALLATION

A. General: Comply with manufacturers' instructions and recommendations for installation, as applicable to project conditions and supporting substrates. Anchor panels and other components of the work Securely in place, with provisions for thermal and structural movement.
   1. Installation of roofing system shall be plumb, straight and true. Seams shall be equal distance from corners, meet at hips and ridges; and be acceptable to the Architect, in accordance with the design concept.

B. Accessories: Install components required for a complete roof panel system, including trim, fascias, clips, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

C. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

E. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

F. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
   1. Provide elbows at base of downspouts to direct water away from building.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of panel systems. Provide types of gaskets, sealants, and fillers indicted or, if not otherwise indicated, types recommended by panel manufacturer.

H. Installation Tolerances: Shim and align panel units within installed tolerance of 1/4 inch in 20'-0" on level/plumb/slope and location/line as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.4 WEATHERTIGHTNESS INSPECTION

A. The metal roof manufacturer shall provide inspection by their approved technical inspectors to approve the metal roof system installation drawings and inspect the installation of the metal roof system at the following stages of installation:
   1. Initial inspection prior to installation of roof panels. The purpose of this inspection is to review the final approved installation drawings, verify substrate installation, review installation procedures, and agree upon the scheduling of the intermediate inspections.
   2. Intermediate inspections will include the review of the installed product in compliance with the final approved installation drawings and manufacturer's installation procedures.
   3. Final inspection at the completion of all metal roof system work.

B. The metal roof component manufacturer's inspector shall provide written and photographic reports. The manufacturer-approved installer shall make all necessary corrections, additions, or remedial actions to resolve any issues identified in the reports.

C. The metal roof component manufacturer's inspector shall have the authority to have roof work corrected, as required, to insure proper installation and weathertightness of the metal roof system, in accordance with the manufacturer's specifications.

3.5 CLEANING AND PROTECTION

A. Damaged Units: Replace panels and other components of the work that have been damaged or have deteriorated beyond successful repair by means of finish touch-up or similar minor repair procedures.

B. Cleaning: Remove temporary protective coverings (if any) as soon as each panel is installed. Upon completion of panel installation, clean finished surfaces as recommended by panel manufacturer, and maintain in a clean condition during construction.

END OF SECTION

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SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.

B. Provide joint sealants for interior applications that have been produced and installed to establish and maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

1.3 SUBMITTALS

A. Product Data and Color Chart: From manufacturers for each joint sealant product required.
   1. Certification by joint sealant manufacturer that materials provided for this Section are 100 percent asbestos-free.

B. Samples: For initial selection purposes in form of manufacturer's standard bead samples, consisting of strips of actual products showing full range of colors available, for each product exposed to view.

1.4 QUALITY CONTROL

A. Sealants for Work of this Section shall be obtained from a single manufacturer for each different product required, to ensure that materials which come in contact with one another will be compatible. Installer shall supply a letter from the manufacturer certifying the compatibility of all sealants with one another, and with all construction materials with which they will come in contact on the Project.

1.5 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
   2. When joint substrates are wet.

B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.

C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.6 SEQUENCING AND SCHEDULING

A. Sequence installation of joint sealants to occur not less than 21 nor more than 30 days after completion of waterproofing, unless otherwise indicated.

1.7 WARRANTY

A. Provide a 3-year warranty, in writing and signed jointly by the installer and sealant manufacturer, agreeing to replace any or all joints failing within the warranty period at not cost to the Owner, labor and material inclusive.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, joint fillers, 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.

B. Colors: Provide color of exposed joint sealants to comply with the following:
   1. Provide selections made by Architect from manufacturer's full range of standard and custom colors for products of type indicated.

2.2 ELASTOMERIC JOINT SEALANTS

A. Materials listed below are manufactured by Tremco and establish the standard desired for this Project. Similar materials manufactured by the following are also acceptable:
   1. Dow Corning.
   2. Sonneborn
   3. Sika Corp.
   4. Pecora Corp.
   5. Vulkem.
   6. General Electric Company.

B. Polyurethane sealants, multi-component. These sealants shall comply with ASTM C 920:
   1. Sealant #1: Type M, Grade NS, Class 50, Use NT, M, A and O; capable of 50 percent extension and compression movement. (Dymeric 240 FC)
   2. Sealant #2: Type M, Grade P, Class 25, Use T, M, A and O. (THC - 900/901)

C. Silicone Sealants, one-part, complying with ASTM C 920:
   1. Sealant #3: Type S, Grade NS, Class 25, Use NT, M, G, A and O; capable of 50 percent extension and compression movement. (Spectrem 2 or Spectrem 3) (Note: Use Spectrem 4 if tintable sealant is desired).
   2. Sealant #4: Type S, Grade NS, Class 25, Use NT, M, G, A and O; capable of 100 percent extension and 50 percent compression movement. (Spectrem 1)

3. Sealant #5: Mildew-resistant, formulated with fungicide, Type S, Grade NS, Class 25, Use NT, A and O. (Tremsil 200). Color: White.

D. Sealant #6: Acrylic latex sealant, one-part, complying with ASTM C 834. (Acrylic Latex 834 Caulk)

E. Sealant #7: Acoustical sealant (ASTM D 217). (Tremco Acoustical Sealant)

2.3 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Plastic Foam Joint Fillers: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
   1. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
      a. Horizontal Application: ITP "HBR" or approved equal.
      b. Vertical Application: ITP closed-cell or soft-type backer rod or approved equal.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces and formulated to promote optimum adhesion of sealants with joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
   3. Remove laitance and form release agents from concrete.
   4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealant manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

D. Remove sealant and prepare joints in existing exterior locations as directed by representative of sealant manufacturer specified in this work.

3.3 INSTALLATION OF TYPICAL JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
   1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
      a. Do not leave gaps between ends of joint fillers.
      b. Do not stretch, twist, puncture, or tear joint fillers.
      c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.
   2. Install bond breaker tape between sealants where backer rods are not used between sealants and joint fillers or back of joints.

D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.

E. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
   1. Provide concave joint configuration per Figure 8A in ASTM C 1193, unless otherwise indicated.
   2. Provide flush joint configuration, per Figure 8B in ASTM C 1193, where indicated.
      a. Use masking tape to protect adjacent surfaces of recessed tooled joints.
   3. Provide recessed joint configuration, per Figure 8C in ASTM C 1193, of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

B. Clean excess adhesive from exposed surfaces of neoprene compression seal with solvent cleaner as recommended by manufacturer.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

3.6 SCHEDULES, TYPICAL SEALANTS

A. Exterior Locations:
   1. Joints which are bordered by glass: Sealant #3. (Spectrem 2)
   2. Joints which are bordered by plastic: Sealant #4.
   3. Horizontal joints in sidewalks, decks, concrete floors, and driveways: Sealant #2.
      a. At walk expansion joints.
      b. Where walks abut structural slabs or stoops.
      c. Where walks abut exterior wall of buildings.
      d. Where exposed interior concrete slabs abut vertical surfaces.
      e. Where sealant is shown on the Drawings for concrete slabs.
   4. All other exterior joints: Sealant #1.
      a. Around perimeters of frames where door, window and louver frames abut concrete, masonry or other building materials (interior and exterior).
      b. Sills and thresholds.
      c. At miscellaneous locations where sealant is shown on Drawings.

B. Interior Locations:
   1. Expansion and control joints: Sealant #1.
   2. Interior wet area and around plumbing fixtures: Sealant #5.
   3. Interior static dry joints as required to dress appearance: Sealant #6.
   4. Where required for sound control: Sealant #6 or #7.
   5. Where required for smoke partitions: Sealant #6.

C. General:
   1. Joints in construction between interior and exterior spaces and other designated or required locations to provide effective barrier against passage of elements: Sealant #1.
   2. Specialty perimeters where required for appearance or weather tightness: Sealants #1, #3 or #4.

END OF SECTION

SECTION 08 13 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Steel doors.
   2. Steel door frames.

1.3 SUBMITTALS

A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, and finishes.

B. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

1.4 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hot-Rolled Steel Sheet: ASTM A 1011, Commercial Steel (CS), Type B

B. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Metallic-Coated Steel Sheets: ASTM A 653, Commercial Steel (CS), Type B, with an A40 (galvannealed) coating.
   1. For exterior installations.

D. Frame Anchors: ASTM A 591, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

E. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.2 DOORS

A. General: Provide doors of sizes, thicknesses, and designs indicated.

B. Exterior Doors: Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
   1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless) (0.053-inch / 16 ga. thick).

2.3 FRAMES

A. General: Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.

B. Frames of 0.067-inch- (14 ga.) thick steel sheet for:
   1. Level 3 steel doors, unless otherwise indicated.
   2. Wood doors, unless otherwise indicated.

C. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.

D. Supports and Anchors: Fabricated from not less than 0.042-inch- (18 ga.) thick, electrolytic zinc-coated or metallic-coated steel sheet.

E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153, Class C or D as applicable.

2.4 FABRICATION

A. General: Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, and frames from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053-inch- (16 ga.) thick, metallic-coated steel channels with channel webs placed even with top and bottom edges.

C. Core Construction: Vertical steel stiffeners.

D. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.

E. Single-Acting, Door-Edge Profile: Square edge, unless beveled edge is indicated.

F. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

G. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

H. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

I. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.

J. Frame Construction: Fabricate frames to shape shown.
   1. Fabricate frames with mitered and continuously welded corners and seamless face joints (knock-down frames not acceptable).

K. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

L. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

2.5 FINISHES

A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install steel doors, frames, and accessories according to ANSI A250.8, manufacturer's data, and as specified.

B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   1. Place frames before construction of enclosing walls and ceilings.
   2. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
   3. Apply bituminous coating to backs of frames that are filled with grout or sound-deadening material.

C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.

3.2 ADJUSTING AND CLEANING

A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.

B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

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.

B. See Paragraph 1.2.C "Related Sections" below.

1.2 SUMMARY

A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.

B. This Section includes the following:
1. Hinges.
2. Key control system.
3. Lock cylinders and keys.
4. Lock and latch sets.
5. Bolts.
6. Closers.
7. Miscellaneous door control devices.
8. Door trim units.
9. Protection plates.
10. Weatherstripping for exterior doors.
11. Seals
12. Thresholds
13. Power Supplies

C. Related Sections: The following Sections contain requirements that relate to this Section:
1. Division 8 Section "Hollow Metal Doors and Frames" for hollow metal frame profiles affecting hardware applications and factory prefitting and premachining of doors for door hardware.

D. Products furnished but not installed under this Section include:
1. Power Supplies installed by Division 26

1.3 HARDWARE RESPONSIBILITIES

A. Door hardware supplier's responsibilities shall be as follows:
1. Submittals: Submit through Contractor required product data, final hardware schedule, separate keying schedule, and samples as specified in this Section, unless otherwise indicated.

2. Construction Schedule: Inform Contractor promptly of estimated times and dates that will be required to process submittals, to furnish templates, to deliver hardware, and to perform other work associated with furnishing door hardware for purposes of including this data in construction schedule. Comply with this schedule.
3. Coordination and Templates: Assist Contractor as required to coordinate hardware with other work in respect to both fabrication and installation. Furnish Contractor with templates and deliver hardware to proper locations.
4. Product Handling: Package, identify, deliver, and inventory door hardware specified in this Section.
5. Discrepancies: Based on requirements indicated in Contract Documents in effect at time of door hardware selection, furnish types, finishes, and quantities of door hardware, including fasteners, and Owner's maintenance tools required to comply with specified requirements and as needed to install and maintain hardware. Furnish or replace any items of door hardware resulting from shortages and incorrect items at no cost to the Owner or Contractor. Obtain signed receipts from Contractor for all delivered materials.

B. Contractor's responsibilities shall be as follows:
1. Submittals: Coordinate and process submittals for door hardware in same manner as submittals for other work.
2. Construction Schedule: Cooperate with door hardware supplier in establishing scheduled dates for submittals and delivery of templates and door hardware. Incorporate in construction schedule the times and dates related to furnishing hardware by door hardware supplier.
3. Coordination: Coordinate door hardware with other Work. Furnish hardware supplier or manufacturer with shop drawings of other work where required or requested. Verify completeness and suitability of hardware with supplier.
4. Product Handling: Provide secure lock-up for hardware delivered to the site. Inventory hardware jointly with representative of hardware supplier and issue signed receipts for all delivered materials.
5. Installation Information: The general types and approximate quantities of hardware required for this Project are indicated at the end of this Section in order to establish Contractor's costs for installation and other work not included in allowance.
6. No adjustments in Contract sum will be made for costs other than those covered by the allowances for subsequent increases or decreases in quantity of one or more hardware types that do not exceed 5 percent.

1.4 SUBMITTALS

A. Product Data: Include manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

B. Final Hardware Schedule: Coordinate with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations or every item required for each door or opening. Include the following information:
a. Type, style, function, size, and finish of each hardware item.
b. Name and manufacturer of each item.
c. Fastenings and other pertinent information.

d. Location of each hardware set cross referenced to indications on Drawings both on floor plans and in door and frame schedule.
e. Explanation of all abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for hardware.
g. Door and frame sizes and materials.
h. Keying information.

2. Submittal Sequence: Submit the schedule in a DHI vertical format where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.
3. Submittal Sequence: Submit final schedule along with essential product data in order to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit final schedule after samples, product data, coordination with shop drawings of other work, delivery schedules, and similar information has been completed and accepted.
4. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

C. Templates: For doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain each type of hardware (latch and lock sets, hinges, closers, etc,) from a single manufacturer.

B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for the Project and that employs an experienced architectural hardware consultant (AHC) who is available to Contracting Officer and Contractor, at reasonable times during the course of the Work, for consultation.
1. Require supplier to meet with Contracting Officer to finalize keying requirements and to obtain final instructions in writing.

C. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.

B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.

C. Inventory door hardware jointly with representatives of hardware supplier and hardware installed until each is satisfied that count is correct.

D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).

E. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.7 MAINTENANCE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
   1. Butts and Hinges:
      a. Stanley Hardware, Div. Stanley Works (ST)
      b. Hager Hinge Co.
      c. Bommer
   2. Key Control System:
      a. Schlage (SG)
      b. Approved Equal
   3. Locksets:
      a. Schlage (SG)
      b. Approved Equal
   4. Cylinders and Locks:
      a. Sargent (SG)
      b. Approved Equal
   5. Closers:
      a. Stanley K2 (ST)
      b. Sargent
      c. LCN
   6. Door Trim Units:
      a. Trimco (TR)
      b. Rockwood
      c. Hager

7. Kick, Mop, and Armor Plates:
    a. Trimco (TR)
    b. Rockwood
    c. Hager
8. Door Stripping and Seals:
    a. Pemko Manufacturing Co., Inc. (PE)
    b. National Guard Products, Inc.
    c. Reese
9. Thresholds:
    a. Pemko Manufacturing Co., Inc. (PE)
    b. National Guard Products, Inc.
    c. Reese

2.2 SCHEDULED HARDWARE

A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" and the end of this Section. Products are identified by using hardware designation numbers of the following:
    1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.
    2. BHMA designations used elsewhere in this Section or in schedules to describe hardware items or to define quality or function are derived from the following standards. Provide products complying with these standards and requirements specified elsewhere in this Section.
        a. Butts and Hinges: BHMA A156.1.
        b. Bored and Preassembled Locks and Latches: BHMA A156.2.
        c. Door Controls - Closers: BHMA A156.4.
        d. Architectural Door Trim: BHMA A156.6.
        e. Template Hinge Dimensions: BHMA A156.7.
        f. Mortise Locks and Latches: BHMA A156.13.
        g. Closer Holder Release Devices: BHMA A156.15.
        h. Auxiliary Hardware: BHMA A156.16.
        i. Materials and Finishes: BHMA A156.18.

2.3 MATERIALS AND FABRICATION

A. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.

B. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

C. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

D. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are use as a mean of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.4 HINGES, BUTTS, AND PIVOTS

A. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

B. Screws: Provide and install manufacturer provided screws complying with the following requirements:
   1. For metal doors and frames install machine screws into drilled and tapped holes.
   2. For wood doors and frames install wood screws.
   3. For fire-rated wood doors install #12 x 1-1/4-inch (32-mm), threaded-to-the-head steel wood screws or as otherwise required by NFPA-80.
   4. Finish screw heads to match surface of hinges or pivots.

C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   1. Out-Swing Exterior Doors: Non-removable pins.
   2. Out-Swing Corridor Doors with Locks: Non-removable pins.
   3. Interior Doors: Nonrising pins.
   4. Tips: Flat button and matching plug, finished to match leaves.

D. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges per door leaf for doors 90 inches (2250 mm) or less in height and one additional hinge for each 30 inches (750 mm) of additional height.
   1. Fire-Rated Doors: Not less than 3 hinges per door leaf for doors 90 inches or less in height with same rule for additional hinges.

2.5 LOCK CYLINDERS AND KEYING

A. Existing System: Grandmasterkey the locks to the Owner's existing system, per the Owner's instructions. Final keying will be established by the Owner. Conduct keying meeting prior to ordering of locksets to coordinate keying system to tie-in with Owner standardized systems and components.

B. Equip all Locksets and cylinders with construction keying.
   1. Furnish final keys to owner prior to building occupancy.
   2. Upon Substantial Completion owner to use permanent keys in all lock cylinders to void construction keys.

C. All permanent keys provided for these locks shall be sent direct to the Owner via certified mail, signature required, prior to building occupancy for safekeeping.

D. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.

E. Provide Bump Resistant Cylinders where noted (BR).

F. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks. Furnish Sargent Conventional Cylinders and Cores, 6 Pin, Standard keyway to match owners existing system.
   1. Permanently inscribe each key with number of lock that identifies cylinder manufacturer's key symbol, and notation "DO NOT DUPLICATE."

G. Key Material: Provide keys of nickel silver only.

H. Key Quantity: Furnish.
   1. 3 change keys for each lock
   2. 1 extra blank for each lock.
   3. 10 each Construction Keys
   4. 2 each Master Keys
   5. 1 each Grand Master Key

2.6 KEY CONTROL SYSTEM

A. Provide a two tag key control box, wall mounted, equal to 50 percent greater than quantity of locks for this project to allow for expansion of the system.

2.7 LOCKS, LATCHES, AND BOLTS

A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.
   1. Provide curved lip strikes for locks with 2-piece, antifriction latchbolts as recommended by manufacturer.
   2. Provide extended lips for locks used on frames where required to avoid damage to frame, wall or trim.
   3. Provide recess type top strikes for bolts locking into head frames, unless otherwise specified.
   4. Provide lipped strikes where required for proper functionality, for top bolts in frame headers.
   5. Provide dust-proof strikes for foot bolts
   6. Provide roller type strikes where recommended by manufacturer or the latch and lock units.
   7. Lever trim shall not be removable when spindle is broken on secure side of door.

B. Lock Throw: Comply with UL requirements for throw of bolts and latch bolts on rated fire openings. Where required, provide 3/4-inch minimum throw of latch.

C. Tactile Warning: Tactile Levers shall be provided as a warning at all doors where hazards may exist.

2.8 CLOSERS AND DOOR CONTROL DEVICES

A. Size of Units: Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit depending on size of door, exposure to weather, and anticipated frequency of use.
   1. Where parallel arms are indicated for closers, provide:
      a. Closer sized to meet the manufacturer's recommendations.
      b. Extra Duty Arms

B. Access-Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped, provide adjustable units complying with ANSI A117.1, provisions for door opening force and delayed action closing.

C. Combination Door Closers and Holders: Except where noted otherwise, provide units designed to hold door in open position under normal usage and to release and close door automatically under fire conditions. Incorporate an integral electromagnetic holder mechanism designed for use with UL listed fire detectors, provided with normally closed switching contacts.
   1. Provide integral smoke detector device in combination door closers and holders complying with UL 228.

D. Provide grey resilient parts for exposed bumpers.

2.9 DOOR TRIM UNITS

A. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.

B. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.

C. Protection plates not more than 2 inches (50 mm) less than door width on push side at single doors and pairs with mullions and not more than 1 inch (25 mm) less than door width on push side at pairs without mullions and where mop plates are indicated on pull side, by height indicated.
   1. Metal Plates: Stainless Steel, .050 inch (U.S. 18 gauge) (1.3 mm).

2.10 WEATHERSTRIPPING, SEALS AND INTUMESCENTS

A. General: Provide continuous weatherstripping on exterior doors and smoke, light, or sound seals on interior doors where indicated or schedule. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

B. Provide intumescent seals as required by the door and frame manufacturers tested assembly requirements for labeled opening assemblies as needed.

C. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.

D. Weatherstripping at Jambs and Heads: Provide bumper-type resilient insert and metal retainer strips, surface applied and of following metal, finish, and resilient bumper material:
   1. Extruded aluminum with natural anodized finish, 0.062-inch (1.6 mm) minimum thickness of main walls and flanges with silicon seal.

E. Weatherstripping at Door Bottoms: Provide design and size shown in sets

2.11 THRESHOLDS

A. General: Except as otherwise indicated, provide standard metal threshold unit of type, size, and provide as shown or scheduled.

B. Exterior Hinged or Pivoted Doors: Provide units not less than 4 inches (100 mm) wide, formed to accommodate change in floor elevation where indicated, fabricated to accommodate door hardware and to fit door frames, and as follows:
   1. Seal thresholds as noted in part 3 of this specification section.

2.12 HARDWARE FINISHES

A. Match items to the manufacturer's standard color and texture finish for the latch and lock sets (or push-pull units if no latch or lock sets).

B. Provide finishes that match those established by BHMA or, if none established, match the Architect's sample.

C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

D. Provide protective lacquer coating on all exposed hardware finishes of brass, bronze, and aluminum, except as otherwise indicated. The suffix "NL" is used with standard finish designations to indicate "no lacquer."

E. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

F. The designations used in schedules and elsewhere to indicate hardware finishes are the industry-recognized standard commercial finishes, except as otherwise noted.
   1. Rust-Resistant Finish: For iron and steel base metal required for exterior work and in areas shown as "High Humidity" areas (and also when designed with the suffix-RR), provide 0.2-mil (0.005-mm) thick copper coating on base metal before applying brass, bronze, nickel, or chromium plated finishes.

G. Closer finishes listed in the hardware sets are for the closer covers. Closer bodies and arms are to be painted to match.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Contracting Officer.
   1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
   2. "Recommended Locations for Builders Hardware for Custom Steel Doors and Frames" by the Door and Hardware Institute.
   3. "Recommended Locations for Builders Hardware for Wood Doors" by the Door and Hardware Institute.

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or applications or surface protection with finishing work specified in the Division 09 painting Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Set thresholds and raindrips, for exterior doors, in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 07 Section "Joint Sealants."
   1. Seal Thresholds four sides

F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
   1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

B. Clean adjacent surfaces by hardware installation.

C. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.

D. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer, accompanied by representatives of the manufacturers of latchsets and locksets and of door control devices, and of other major hardware suppliers, shall return to the Project to perform the following work:
   1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
   2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
   3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
   4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.3 HARDWARE SCHEDULE

A. General: Provide hardware for each door to comply with requirements of Section "Door Hardware," hardware set numbers indicated in door schedule, and in the following schedule of hardware sets.
   1. Hardware sets indicate quantity, item, manufacturer and product designation, size, and finish or color, as applicable.
   2. All Fire Rated Doors shall have Door Closers and Smoke Seals.

HARDWARE SETS

EXTERIOR DOORS

SET #1 –Doors 101B, 101C

3	Hinges	FBB168 4.5 X 4.5 NRP	630 ST
1	Lockset	C0-100 70 KP RHO BD	626 SG
1	Permanent Core Keyed to System		626 BEST
1	Latch Guard	KLP-110 Handed	630 DON-JO
1	Closer	QDC120 Ho/Spring Stop	689 ST
1	Kickplate	8400 10” x 34” B3E CSK	630 IVES
1	Weatherstrip	303AS 36” X 84”	Clear PE
1	Threshold	171A 5” X 36” X ½”	Alum PE
1	Raindrip	346C – 40”	Clear PE
1	Sweep	315CN – 36”	Clear PE

SET #2 –Door 101A, 102A

8	Hinges (6 hinges at 102A)	FBB168 4.5 X 4.5 NRP	630 STANLEY
2	Rim Exit	99EO – 36”	626 VON DUPRIN
1	Trim	CO 100-993R-70KP RHO	626 SCHLAGE
1	Mullion	KR 4954-120	600 VON DUPRIN
1	Thumb Turn Cylinder	1E6A4C140RP	626 BEST
1	Rim Cylinder	12E 72 S2 RP3	626 BEST
2	Permanent Cores Keyed to System		BEST
2	Closers	QDC120 HO/Spring Stop	689 STANLEY
2	Kickplate	8400 10” X 34” B3E CSK	630 IVES
1	Threshold	270A 4” X 72” X ¼”	Alum PEMKO
1	Weatherstrip	303AS 72” X Varies	Clear PEMKO
1	Mullion Seal	5110 - 120”	Black PEMKO
2	Sweep	315CN - 36”	Clear PEMKO
1	Raindrip	346C – 76”	Clear PEMKO

INTERIOR DOORS

SET #3 – Door 102B

3	Hinges	FBB168 4.5 X 4.5	626 STANLEY
1	Storeroom	9K3 7D 15D S3	626 BEST
1	Permanent Core Keyed System		BEST
3	Silencers		Grey IVES

SECTION 08 81 00

GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Types of glazing included:
   1. Heat-treated (tempered) float glass.

1.3 DEFINITIONS

A. Manufacturer is used in this Section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.

B. Normal thermal movement results from the following maximum change (range) in ambient and surface temperatures acting on glass-framing members and glazing components. Base engineering calculation on materials' actual surface temperatures due to both solar heat gain and nighttime sky heat loss.
   1. Temperature Change (Range): 120 F deg, ambient; 180 F deg, material surfaces.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples for Verification Purposes: 12-inch square samples of each type of glass indicated except for clear monolithic glass products, and 12-inch long samples of each color required (except black) for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative in color of the adjoining framing system.

C. Glass fabricator shall submit copy of his glass manufacturer's certification for insulating products.

D. Product Certificates: Signed by glazing materials manufacturers certifying that their products comply with specified requirements.

E. Maintenance Data: For glass and other glazing materials to include in Operating and Maintenance Manual specified in Division 01.

1.6 QUALITY ASSURANCE

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. GANA Publications: "GANA Glazing Manual."
   2. IGMA Publications: SIGMA TM-3000 "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use" and TB-3001 "Sloped Glazing Guidelines."

B. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.
   1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.

C. Glass Fabricator Qualifications: Fabricator of insulating units shall be certified by glass manufacturer.

D. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.

E. Single-Source Responsibility for Glass: Obtain glass from one source for each product indicated below:
   1. Primary glass of each (ASTM C 1036) type and class indicated.
   2. Heat-treated glass of each (ASTM C 1048) condition indicated.
   3. Insulating glass of each construction indicated.

F. Single-Source Responsibility for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
   1. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator's recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing materials manufacturer or when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Install liquid sealants at ambient and substrate temperatures above 40 deg F.

1.9 WARRANTY

A. General: Warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

B. Manufacturer's Warranty on Insulating Glass: Submit written warranty signed by manufacturer of insulating glass agreeing to furnish replacements for insulating glass units that deteriorate as defined in "Definitions" article, f.o.b. point of manufacture, freight allowed Project site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, protecting, and maintaining practices contrary to glass manufacturer's published instructions.
   1. Warranty Period: Manufacturer's standard but not less than 10 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide products of one of the following manufacturers:
   1. Manufacturers of Clear Float Glass:
      a. Guardian Industries Corp.
      b. PPG Industries, Inc.
      c. AFG Industries, Inc.
      d. Viracon, Inc.

2.2 PRIMARY FLOAT GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I (transparent glass, flat), Class as indicated below, and Quality q3 (glazing select).
   1. Class 1 (clear) unless otherwise indicated.

2.3 TYPICAL INTERIOR GLASS

A. Tempered Glass: ASTM C 1048, Kind FT (fully tempered, Condition A (uncoated), Type I (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
   1. Clear Glass: Class 1 (clear).
   2. Thickness: 1/4 inch.
   3. Provide safety glass permanently marked with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.

2.4 ELASTOMERIC GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:
   1. Compatibility: Select glazing sealants and tapes of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturer's recommendations for selecting glazing sealants that are suitable for applications indicated and conditions existing at time of installation.
   3. Colors of Exposed Glazing Sealants: Provide selections made by Architect from manufacturer's full range for products of type indicated.

B. Elastomeric Glazing Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that comply with ASTM C 920 requirements indicated below:
   1. Two-Part Polysulfide Glazing Sealant: Type M; Grade NS; Class 25; Uses NT, M, G, A, and, as applicable to uses indicated, O.
   2. One-Part Acid-Curing Silicone Glazing Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to uses indicated, O.
   3. One-Part Non-Acid-Curing Silicone Glazing Sealant: Type S; Grade NS, Class 25; Uses NT, G, A, and, as applicable to uses indicated, O; and complying with the following requirements for modulus and additional joint movement capability.
      a. Medium Modulus: Tensile strength of not less than 45 nor more than 75 psi at 100 percent elongation when tested per ASTM D 412 after 14 days at 77 deg F and 50 percent relative humidity.
      b. Additional capability, when tested per ASTM C 719 for adhesion and cohesion under maximum cyclic movement, to withstand the following percentage increase and decrease of joint width, as measured at time of application, and remain in compliance with other requirements of ASTM C 920: 50 percent.

2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tape: Closed-cell, PVC foam tape; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
   1. Type 1, for glazing applications in which tape acts as the primary sealant.
   2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.6 GLAZING GASKETS

A. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock strips, complying with ASTM C 542, black.

B. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
   1. EPDM, ASTM C 864.
   2. Silicone, ASTM C 1115.
   3. Thermoplastic polyolefin rubber, ASTM C 1115.
   4. Any material indicated above.

C. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
   1. EPDM.
   2. Silicone.
   3. Thermoplastic polyolefin rubber.
   4. Any material indicated above.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.8 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.

B. Grind smooth and polish exposed glass edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine glass framing, with glazier present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
   2. Presence and functioning of weep system.
   3. Minimum required face or edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions as indicated on Drawings provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass from edge damage during handling and installation. Remove damaged glass from Project site and legally dispose of off site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass sizes larger than 50 united inches (length plus height) as follows:
   1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.
   2. Provide 3-mm (1/8-inch) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each lite is installed.

F. Apply heel bead of elastomeric sealant, if required.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 LOCK-STRIP GASKET GLAZING

A. Comply with ASTM C 716 and gasket manufacturer's printed recommendations. Provide supplementary wet seal and weep system, unless otherwise indicated.

3.8 PROTECTION AND CLEANING

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkali deposits, or stains; remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than 4 days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION

SECTION 09 21 16

GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Interior gypsum wallboard.

1.3 SUBMITTALS

A. Texture samples 12" x 12".

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

B. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

1.5 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 and with gypsum board manufacturer's recommendations.

B. Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40 deg F. For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F for 48 hours prior to application and continuously after until dry. Do not exceed 95 deg F when using temporary heat sources.

C. Ventilation: Ventilate building spaces, as required, for drying joint treatment materials. Avoid drafts during hot dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Gypsum Board and Related Products:
    a. BPB America, Inc.
    b. G-P Gypsum
    c. National Gypsum Co.
    d. PABCO Gypsum
    e. USG Corporation.

2.2 GYPSUM BOARD PRODUCTS

A. General: Provide gypsum board of types indicated in maximum lengths available to minimize end-to-end butt joints. Products comply with ASTM C 1396 requirements.
    1. Thickness: Provide gypsum board in 5/8-inch thickness to comply with ASTM C 840 for application system and support spacing indicated.

B. Gypsum Wallboard:
    1. Type: Type X.
    2. Edges: Tapered.
    3. Thickness: 5/8 inch unless shown otherwise.

C. Water-Resistant Gypsum Backing Board:
    1. Type: Regular, unless shown otherwise.
    2. Thickness: 5/8 inch, unless shown otherwise.

2.3 TRIM ACCESSORIES

A. Accessories for Interior Installation: Corner beads, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:
    1. Material: Formed metal, plastic, or metal combined with paper, with metal complying with the following requirement:
        a. Sheet steel zinc-coated by hot-dip process.
        b. Sheet steel coated with zinc by hot-dip or electrolytic processes, or with aluminum or rolled zinc.
    2. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:
        a. Cornerbead on outside corners, unless otherwise indicated.
        b. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim unless otherwise indicated.
        c. L-bead with face flange only; face flange formed to receive joint compound. Use L-bead where indicated.
        d. U-bead with face and back flanges; face flange formed to be left without application of joint compound. Use U-bead where indicated.
        e. One-piece control joint formed with V-shaped slot, with removable strip covering slot opening.

2.4 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

B. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.
   1. Use pressure-sensitive or staple-attached open-weave glass-fiber reinforcing tape with compatible joint compound where recommended by manufacturer of gypsum board and joint treatment materials for application indicated.

C. Drying-Type Joint Compounds for Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
   1. Ready-Mixed Formulation: Factory-mixed product.
   2. Job-Mixed Formulation: Powder product for mixing with water at Project site.
   3. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.
   4. Topping compound formulated for fill (second) and finish (third) coats.
   5. All-purpose compound formulated for both taping and topping compounds.

2.5 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.

B. Spot Grout: ASTM C 475, setting-type joint compound recommended for spot grouting hollow metal door frames.

C. Steel drill screws complying with ASTM C 1002 for the following applications:
   1. Fastening gypsum board to steel members less than 0.03 inch thick.
   2. Fastening gypsum board to gypsum board.

D. Steel drill screws complying with ASTM C 954 for fastening gypsum board to steel members from 0.033 to 0.112 inch thick.

2.6 TEXTURE FINISH PRODUCTS

A. Primer: Of type recommended by texture finish manufacturer.

B. Aggregate Finish: Factory-packaged proprietary drying-type powder product formulated with aggregate for mixing with water at Project site for spray application to produce texture indicated below:
   1. Light Skip Trowel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840 and GA-216.

B. Install ceiling board panels across framing to minimize the number of abutting end joints and avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install wall/partition board panels to minimize the number of abutting end joints or avoid them entirely. Stagger abutting end joints not less than one framing member in alternate courses of board.

D. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

E. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Position adjoining panels so that tapered edges abut tapered edges, and field-cut edges abut field-cut edges and ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions. Avoid joints at corners of framed openings where possible.

F. Attach gypsum panels to steel studs so that the leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. Attach gypsum panels to framing provided at openings and cutouts.

H. Spot grout hollow metal door frames for solid core wood doors, hollow metal doors, and doors over 32 inches wide. Apply spot grout at each jamb anchor clip and immediately insert gypsum panels into frames.

I. Form control joints and expansion joints at locations indicated and as detailed, with space between edges of adjoining gypsum panels, as well as supporting framing behind gypsum panels.

J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chase walls that are braced internally.
   1. Except where concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
   2. Fit gypsum panels around ducts, pipes, and conduits.
   3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4-to-1/2-inch-wide joints to install sealant.

K. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 1/4-inch-to-1/2-inch-wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

L. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.

3.3 GYPSUM BOARD APPLICATION METHODS

A. Single-Layer Application: Install gypsum wallboard panels as follows:
   1. On ceilings, apply gypsum panels prior to wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated, and provide panel lengths that will minimize end joints.
   3. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless parallel application is required for fire-resistive-rated assemblies. Use maximum-length panels to minimize end joints.
   4. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Single-Layer Fastening Methods: Apply gypsum panels to supports as follows:
   1. Fasten with screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.

B. Install corner beads at external corners.

C. Install edge trim where edge of gypsum panels would otherwise be exposed or semiexposed. Provide edge trim type with face flange formed to receive joint compound except where other types are indicated.
   1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
   2. Install L-bead where edge trims can only be installed after gypsum panels are installed.
   3. Install U-bead where indicated.
   4. Install aluminum edge trim and other accessories where indicated.

D. Install control joints at locations indicated, and where not indicated according to ASTM C 840, and in locations approved by Architect for visual effect.

E. Install H-molding in exterior gypsum board assemblies where control joints are indicated. Install on cut or ends of gypsum panels, not on tapered edges.

3.5 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim, and control joints; penetrations; fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration and levels of gypsum board finish indicated.

B. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.

C. Apply joint tape over gypsum board joints except those with trim accessories having concealed face flanges not requiring taping to prevent cracks from developing in joint treatment at flange edges.

D. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.
   1. Level 1 for ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistive-rated assemblies and sound-rated assemblies.
   2. Level 2 where water-resistant gypsum backing board panels form substrates for tile, and where indicated.
   3. Level 4 for gypsum board surfaces unless otherwise indicated.

E. For level 4 gypsum board finish, embed tape in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration. Use the following joint compound combination:
   1. Embedding and First Coat: Ready-mixed, drying-type, all-purpose or taping compound.
   2. Fill (Second) Coat: Ready-mixed, drying-type, all-purpose or topping compound.
   3. Finish (Third) Coat: Ready-mixed, drying-type, all-purpose or topping compound.

F. Where level 2 gypsum board finish is indicated, apply joint compound specified for first coat in addition to embedding coat.

G. Where level 1 gypsum board finish is indicated, apply joint compound specified for embedding coat.

3.6 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes according to texture finish manufacturer's instructions. Apply primer only to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish to gypsum panels and other surfaces indicated to receive texture finish according to texture finish manufacturer's directions. Using powered spray equipment acceptable to texture finish manufacturer, produce a uniform texture matching approved field samples and free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray as recommended by texture finish manufacturer to prevent damage.

3.7 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner suitable to Installer, that ensures gypsum board assemblies remain without damage or deterioration at time of Substantial Completion.

END OF SECTION

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SECTION 09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section specifies coating systems, surface preparations, and application requirements for coating systems of equipment, conduit, piping and ductwork. All other painting is in Section 09 91 00.

B. Definitions:
   1. Specific coating terminology used in this section is in accordance with definitions contained in American Society for Testing and Materials (ASTM) D16, ASTM D3960, and the following definitions.
      a. Definitions:
         1) Abrasive: Material used for blast-cleaning, such as sand, grit or shot.
         2) Abrasive Blast-Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.
         3) Anchor Pattern: Profile or texture of prepared surface(s).
         4) ANSI: American National Standards Institute.
         5) Coating/Paint/Lining Thickness: The total thickness of primer, intermediate and/or finish coats.
         6) Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this section.
         7) Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer.
         8) Dew Point: Temperature of a given air/water vapor mixture at which condensation starts.
         9) Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001-inch). Use this definition as opposed to existing definition.
         10) Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.
         11) Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
         12) Holiday: A discontinuity, skip, or void in coating or coating system film that exposes the substrate.
         13) ICRI: International Concrete Repair Institute.
         14) Laitance: A layer of weak, non-durable concrete containing cement fines that is brought to the surface through bleed water because of concrete finishing and/or over-finishing.
         15) Mil: 0.001-inch.
         16) NACE: National Association of Corrosion Engineers.

17) Overspray: Dry spray, particularly such paint that failed to strike the intended surface.

18) Pinhole: A small-diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.

19) Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.

20) Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.

21) Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.

22) Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.

23) Spreading Rate: Area covered by a unit volume of paint at a specific thickness.

24) SSPC: The Society for Protective Coatings.

25) Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.

26) Touch-Up Painting: The application of paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

27) TPC: Technical Practice Committee.

28) Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter (g/l) or pounds per gallon (lb/gal).

29) Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application. WFT is measured in mils or thousandths of an inch (0.001-inch).

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that

date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI B74.18	Grading of Certain Abrasive Grain on Coated Abrasive Material
ASTM D16	Standard Terminology for Paint, Related Coatings, Materials, and Applications
ASTM D2200 (SSPC-VIS1)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ICRI 03732	Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
NACE Standards	January 1988 Edition of the National Association of Corrosion Engineers, TPC.
NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
NAPF 500-03-04	Abrasive Blast Cleaning for Ductile Iron Pipe
NAPF 500-03-05	Abrasive Blast Cleaning for Cast Ductile Iron Fittings
SSPC	Paint Application Specification No. 1.
SSPC-PA Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC SP1	Solvent Cleaning
SSPC SP2	Hand Tool Cleaning
SSPC SP3	Power Tool Cleaning
SSPC SP5	White Metal Blast Cleaning
SSPC SP6	Commercial Blast Cleaning
SSPC SP7	Brush-Off Blast Cleaning
SSPC SP10	Near-White Blast Cleaning
SSPC SP11	Power Tool Cleaning to Bare Metal
SSPC SP13	Surface Preparation of Concrete

B. Standardization:

1. Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.
2. The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for consideration of CSMs other than those specified in this Section will be considered, provided the following minimum conditions are met. Such requests are not a substitution for submittals after the alternative CSMs have been considered and accepted.
    a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total DFT.
    b. The proposed coating system shall use coatings of the same generic type as that specified, including curing agent type.

c. Requests for consideration of products from CSMs other than those specified in this Section shall include information listed in paragraph 1.04, demonstrating that the proposed CSM's product is equal to the specified coating system.

d. The Contractor and the proposed alternative CSM shall provide a list of references for the proposed product where the coating of the same generic type has been applied. The reference list shall include the project name, city, state, owner, phone number of owner; coating system reference and number from this Section 09 90 00; type of facility in which it was used; generic type; and year coating was applied.

C. Quality-Control Requirements:

1. The Contractor is responsible for the workmanship and quality of the coating system installation. Inspections by the Construction Manager will not relieve or limit the Contractor's responsibilities.
2. The Contractor's methods shall conform to requirements of this Specification and the standards referenced in this Section. Changes in the coating system installation requirements will be allowed only with the written acceptance of the Construction Manager before work commences.
3. Only personnel who are approved by the CSM specifically for this Contract shall be allowed to perform the coating system installation specified in this section.
4. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.
5. For repairs, the Contractor shall provide the same products, or products recommended by the CSM, as used for the original coating.
6. The Contractor shall identify the points of access for inspection by the Owner or the Construction Manager. The Contractor shall provide ventilation, ingress and egress, and other means necessary for the Construction Manager's personnel to access safely the work areas.
7. The Contractor shall conduct the work so that the coating system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Coating system work that does not conform to the specifications or is otherwise not acceptable shall be corrected as specified.
8. The Contractor shall complete the Coating System Inspection Checklist, Form 09 90 00-A, included in Section 01 99 90, for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System Inspection Checklist. For each portion of the work, install the coating system and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System Inspection Checklist, the Contractor shall sign the checklist, indicating that the work has been installed and inspected as specified.
9. The Contractor shall provide written daily reports that present, in summary form, test data, work progress, surfaces covered, ambient conditions, quality-control inspection test findings, and other information pertinent to the coating system installation.

D. Inspection at Hold Points:

1. The Contractor shall conduct inspections at hold points during the coating system installation and record the results from those inspections on Form 09 90 00-A. The

Contractor shall coordinate such hold points with the Construction Manager such that the Construction Manager may observe Contractor's inspections on a scheduled basis. The Contractor shall provide the Construction Manager a minimum of 2 hours of notice prior to conducting Hold Point Inspections. The hold points shall be as follows:

a. Environment and Site Conditions: Prior to commencing an activity associated with coating system installation, the Contractor shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. The acceptability of the weather and/or environmental conditions within the structure shall be determined by the requirements specified by the CSM of the coating system being used.

b. Conditions Prior to Surface Preparation: Prior to commencing surface preparation, the Contractor shall observe, record, and confirm that oil, grease, and/or soluble salts have been eliminated from the surface.

c. Monitoring of Surface Preparation: Spot-checking of degree of cleanliness, surface profile, and surface pH testing, where applicable. In addition, the compressed air used for surface preparation or blow-down cleaning shall be checked to confirm it is free from oil and moisture.

d. Post Surface Preparation: Upon completion of the surface preparation, the Contractor shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09 90 00 and in the CSM's written instructions.

e. Monitoring of Coatings Application: The Contractor shall inspect, measure, and record the WFT and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.

f. Post Application Inspection: The Contractor shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness and other problems as may be observed.

g. Post Cure Evaluation: The Contractor shall measure and inspect the overall DFT. The Contractor shall conduct a DFT survey, as well as perform adhesion-testing, holiday-detection, or cure-testing as required based on the type of project and the specific requirements in this Section 09 90 00 and/or in the CSM's written instructions.

h. Follow-up to Corrective Actions and Final Inspection: The Contractor shall measure and reinspect corrective coating work performed to repair defects identified at prior hold points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

1.03 DELIVERY AND STORAGE

A. General:

1. Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label.
2. Labels on material containers shall show the following information:
   a. Name or title of product.
   b. CSM's batch number.

c. CSM's name.
d. Generic type of material.
e. Application and mixing instructions.
f. Hazardous material identification label.
g. Shelf life expiration date.

3. Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the CSM's recommendations. Flammable materials shall be stored in accordance with state and local requirements.
4. Containers shall be clearly marked, indicating personnel safety hazards associated with the use of or exposure to the materials.
5. Material Safety Data Sheets (MSDS) for each material shall be provided to the Construction Manager.
6. The Contractor shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.

1.04 SUBMITTALS:

A. General:
1. Provide in accordance with Section 01 33 00:
a. A copy of this Specification Section, with addendum updates included, and referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for requested deviations to the Specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
b. CSM's current printed recommendations and product data sheets for coating systems including:
1) VOC data.
2) Surface preparation recommendations.
3) Primer type, where required.
4) Maximum dry and wet-mil thickness per coat.
5) Minimum and maximum curing time between coats, including atmospheric conditions for each.
6) Curing time before submergence in liquid.
7) Thinner to be used with each coating.

8) Ventilation requirements.
9) Minimum atmospheric conditions during which the paint shall be applied.
10) Allowable application methods.
11) Maximum allowable moisture content.
12) Maximum shelf life.

c. MSDS for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.
d. List of cleaning and thinner solutions allowed by the CSMs.
e. Storage requirements including temperature, humidity, and ventilation for coating system materials as recommended by the CSMs.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. The following list specifies the material requirements for coating systems. Coating systems are categorized by generic name followed by an identifying abbreviation. If an abbreviation has a suffix number, it is for identifying subgroups within the coating system.

Material Requirements for Coating Systems

Coating System	CSM	First Coat(s)		Finish Coat(s)
Epoxy Coatings				
E-1	PPG PMC	Amerlock 2/400 Series		Amerlock 2/400 Series
	Carboline	Carboguard 890		Carboguard 890
	International Paint/ICI*	Devran 224 HS		Devran 224
	Sherwin Williams	Macropoxy 646		Macropoxy 646
	Tnemec	Series V69		Series V69
Epoxy Polyurethane				
		Primer Coat(s)	Intermediate Coat(s)	
EU-1	PPG PMC	Amercoat	Amercoat 385	Amercoat 450H
	Carboline	Carbozinc 859	Carboguard 890	Carbothane 134 VOC
	International Paint/ICI	Cathacoat 313	Devran 233 or 224HS	Devthane 379
	Sherwin Williams	Zinc Clad IV	Macropoxy 646	Hi Solids Polyurethane
	Tnemec	Series 90-97	Series V69	Series 1075
Miscellaneous				
M-1	Carboline	Carbowrap Priming Paste		Tape A, B, or C (temp. dependent)
	Denso	Denso Paste		Densyl Tape
	Trenton	Waxtape Primer		#1 Wax Tape

**See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.*

2.02 PRODUCT DATA

A. General:
   1. Submit reports specified in paragraph 1.02 when the work is underway.
   2. Submit the Coating System Inspection Checklists, using Form 09 90 00-A, included in Section 01 99 90, for the coating work.

PART 3 EXECUTION

3.01 COATINGS

A. General:
   1. Coating products shall not be used until the Construction Manager has inspected the materials.
   2. Erect and maintain protective enclosures as stipulated per SSPC Guide 6, Guide for Containing Debris Generated during Paint Removal Operations.

B. Shop and Field Coats:
   1. Shop-Applied Prime Coat: Except as otherwise specified, prime coats may be shop-applied or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum DFT recommended by the CSM. Data sheets identifying the shop primer used shall be provided to the on-site coating application personnel. Adhesion tests shall be performed on the shop primer as specified in paragraph 3.01. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09 90 00 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09 90 00, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.
   2. Field Coats: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified DFT. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until previous coats have been inspected.
   3. Adhesion Confirmation: The Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop-applied primer coat adheres to the substrate, and (2) the specified field coatings adhere to the shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.

C. Application Location Requirements:
   1. Equipment, Non-immersed: Items of equipment, or parts of equipment that are not immersed in service, shall be shop-primed and then finish-coated in the field after installation with the specified or acceptable color. If the shop primer requires top-coating within a specified period, the equipment shall be finish-coated in the shop and then touch-up painted after installation. If equipment removal and reinstallation

is required for the Project, touch-up coating work shall be performed in the field, following installation.

3.02 PREPARATION

A. General:

1. Surface preparations for each type of surface shall be in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the COATSPEC sheets shall take precedence.
2. Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast-cleaning, the abrasive used shall be washed, graded and free from contaminants that might interfere with the adhesion of the coatings. The air used for blast-cleaning shall be sufficiently free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.
3. Where deemed necessary by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before application of a coating. Surface defects identified by the inspector shall be corrected by the Contractor at no additional cost to the Owner.
4. Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces shall be removed or masked prior to surface preparation and painting operations. Following completion of coating, removed items shall be reinstalled. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and painting of equipment and walls and, following painting, shall be replaced and reconnected.

B. Blast-Cleaning:

1. When abrasive blast-cleaning is required to achieve the specified surface preparation the following requirements for blast-cleaning materials and equipment shall be met:
   a. Used or spent blast abrasive shall not be reused on this Project.
   b. The compressed air used for blast-cleaning shall be filtered and shall contain no condensed water and no oil. Moisture traps shall be cleaned at least once every four hours or more frequently as required to prevent moisture from entering the supply air to the abrasive-blasting equipment.
   c. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. These shall be checked on the same frequency as the moisture traps, as defined above.
   d. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles times during this work.
   e. An air dryer or desiccant filter drying unit shall be installed which dries the compressed air prior to blast pot connections. This dryer shall be used and maintained for the duration of surface preparation work.
   f. The abrasive blast nozzles used shall be of the venturi or other high-velocity type supplied with a minimum of 100 psig air pressure and sufficient volume to obtain the blast-cleaning production rates and cleanliness/specified.

g. The Contractor shall provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast-cleaning and inspection of the substrate during surface preparation work.

h. If between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrate's appearance darkens or changes color, recleaning by water-blasting, reblasting and abrasive blast-cleaning shall be required until the specified degree of cleanliness is achieved.

i. The Contractor is responsible for dust control and for protection of mechanical, electrical, and other equipment adjacent to and surrounding the work area.

C. Solvent-Cleaning:

1. Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with SSPC SP-1 Solvent Cleaning and shall be of the emulsifying type, contains no phosphates, is biodegradable, removes no zinc, and is compatible with the specified primer.
2. Clean white cloths and clean fluids shall be used in solvent-cleaning.

D. Metallic Surfaces:

1. Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the SSPC specified for each coating system. See COATSPEC for each coating system in this Section 09 90 00. The profile depth of the surface to be coated shall be in accordance with the COATSPEC requirements in this Section measured by Method C of ASTM D4417. Blast particle size shall be selected by the Contractor to produce the specified surface profile. The solvent in solvent-cleaning operations shall be as recommended by the CSM.
2. Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS1-89 (ASTM D2200), and as described in the COATSPEC for each coating system. If dry abrasive blast-cleaning is selected and to facilitate inspection, the Contractor shall, on the first day of cleaning operations, abrasive blast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2-inches by 11-inches. Panels meeting the requirements of the Specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear non-yellowing finish. One of these panels shall be prepared for each type of abrasive-blasting and shall be used as the comparison standard throughout the Project.
3. Blast-cleaning requirements for steel, ductile iron and stainless steel substrates are as follows:
    a. Steel piping shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) and primed before installation. Ductile iron piping surfaces, including fittings, shall be prepared in accordance with National Association of Pipe Fabricators (NAPF) 500-03, NAPF 500-03-04, and NAPF 500-03-05.
    b. Stainless steel surfaces shall be abrasive blast-cleaned to leave a clean uniform appearance with a minimum surface profile of 1.5 to 2.5 mils that is uniform.
    c. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasive from substrate by vacuum-cleaning prior to coating application.
    d. Care must be taken to prevent contamination of the surface after blasting from workers' fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.

e. Ambient environmental conditions in the enclosure must be constantly monitored and maintained to ensure the degree of cleanliness is held and no “rust back” occurs prior to coating material application.

E. Fiberglass Reinforced Plastic (FRP) Surfaces:

1. Prepare FRP surfaces by sanding to establish uniform surface roughness and to remove gloss from the resin in the FRP. Next, vacuum-clean to remove loose FRP dust, dirt, and other materials. Next, solvent-clean using clean white rags and allow solvent to evaporate completely before application of coating materials.

F. Existing Facilities:

1. Unless otherwise specified, existing coating systems damaged by new construction shall be repaired and coated in accordance with the appropriate system specified for new work.
2. Contractor shall demonstrate that the existing coating is compatible with field-coating by performing the adhesion test specified in paragraph 3.01. Where unacceptable test results are obtained, the Contractor shall follow manufacturer’s written instructions as to the necessity of existing coating removal or the need for a tie coat to provide a satisfactory bond between the existing coating and the specified field coating.

3.03 APPLICATION

A. Workmanship:

1. Coated surfaces shall be free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce an even film of uniform thickness completely coating corners and crevices.
2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. A paper blotter test shall be performed by the Contractor when requested by the Construction Manager to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. The amount of oil and moisture in spray air shall be less than the amount recommended by the CSM. Spray equipment shall be equipped with mechanical agitators, pressure gages, pressure regulators, and spray nozzles of the proper sizes.
3. Each coat of coating material shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.
4. Coating-application method shall be conventional or airless spray, brush or roller, or trowel as recommended by CSM.
5. Allow each coat to cure or dry thoroughly, according to CSM’s printed instructions, prior to recoating.
6. Vary color for each successive coat for coating systems when possible.
7. When coating complex steel shapes, prior to overall coating system application, stripe-coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer coat. This involves applying a separate

coat using brushes or rollers to ensure proper coverage. Stripe-coat via spray application is not permitted.

B. Coating Properties, Mixing and Thinning:
   1. Coatings, when applied, shall provide a satisfactory film and smooth, even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Coating materials shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the coating may be thinned as recommended by the CSM immediately prior to use. The VOC content of the coating as applied shall comply with prevailing air-pollution control regulations. Unless otherwise specified, coatings shall not be reduced more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the CSM.

C. Atmospheric Conditions:
   1. Coatings shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Coatings systems shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10°F of the dew point, forced dehumidification equipment may be used to maintain a temperature of minimum 40°F and 10°F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. These conditions shall be maintained for a period of at least 8 hours, or as recommended by the CSM. Where conditions causing condensation are severe, dehumidification equipment, fans, and/or heaters shall be used inside enclosed areas to maintain the required atmospheric and surface temperature requirements for proper coating application and cure.

D. Not Used.

E. Protection of Coated Surfaces:
   1. Items that have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard. After delivery at the site, and upon permanent erection or installation, shop-coated metalwork shall be recoated or retouched with specified coating when it is necessary to maintain the integrity of the film.

F. Method of Coating Application:
   1. Where two or more coats are required, alternate coats shall contain sufficient compatible color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead, or lead compounds, which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.
   2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, shall be touch-up primed and coated with two coats of the specified coating system to match the color scheduled. Electrical and instrumentation equipment specified in Divisions 26 and 40 shall be coated as specified in paragraph 3.03.

3. Coatings shall not be applied to a surface until it has been prepared as specified. The primer or first coat shall be applied by brush to ferrous surfaces that are not blast-cleaned. Coats for blast-cleaned ferrous surfaces and subsequent coats for nonblast-cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, pinholes and holidays shall be marked, repaired in accordance with CSM's recommendations, and retested before succeeding coats are applied. Unless otherwise specified, coats for concrete and masonry shall be brushed, rolled, or troweled.

G. Film Thickness and Continuity:
   1. WFT of the first coat of the coating system and subsequent coats shall be verified by the Contractor following application of each coat.
   2. The surface area covered per gallon of coating for various types of surfaces shall not exceed those recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers or other pretreatment applications. Coatings shall be applied to the thickness specified, and in accordance with these Specifications. Unless otherwise specified, the average total thickness (dry) of a completed protective coating system on exposed metal surfaces shall be not less than 1.25 mils per coat. The minimum thickness at any point shall not deviate more than 25% from the required average. Unless otherwise specified, no less than two coats shall be applied.
   3. In testing for continuity of coating about welds, projections (such as bolts and nuts), and crevices, the Construction Manager shall determine the minimum conductivity for smooth areas of like coating where the dry-mil thickness has been accepted. This conductivity shall be the minimum required for these rough or irregular areas. Pinholes and holidays shall be recoated to the required coverage.
   4. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified DFT.
   5. For concrete substrates, the Contractor shall apply a complete skim coat of the specified filler/surfacer material over the entire substrate prior to application of the coating system. This material shall be applied such that all open-air voids and bugholes in the concrete substrate are completely filled prior to coating application.

H. Special Requirements:
   1. Before erection, the Contractor shall apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. The final coat shall be applied after erection. Structural friction connections and high-tensile bolts and nuts shall be coated after erection. Areas damaged during erection shall be hand-cleaned or power-tool cleaned and recoated with primer coat prior to the application of subsequent coats. Touch up of surfaces shall be performed after installation. Surfaces to be coated shall be clean and dry at the time of application. Except for those to be filled with grout, the underside of equipment bases and supports that have not been galvanized shall be coated with at least two coats of primer specified for system E-2 prior to setting the equipment in place. Provide coating system terminations at leading edges and transitions to other substrates in accordance with the CSM’s recommendations or detail drawings.

I. Electrical and Instrumentation Equipment and Materials:

1. Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.

a. Finish: Electrical equipment shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventive treatment. Equipment shall be primed, coated with enamel, and baked. Minimum DFT shall be 3 mils.

1) Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.

2) Before final acceptance, the Contractor shall touch up scratches on equipment with identical color coating. Finish shall be smooth, free of runs, and match existing finish. Prior to touching up scratches, Contractor shall fill them with an appropriate filler material approved by the CSM.

b. Color: Exterior color of electrical equipment shall be FS 26463 (ANSI/NSF 61) light grey. Interior shall be painted FS 27880 white. Nonmetallic electrical enclosures and equipment shall be the equipment manufacturer's standard grey color.

1) Exterior color of instrumentation panels and cabinets mounted indoors shall be FS 26463 light grey; unless otherwise specified, exterior color for cabinets mounted outdoors shall be FS 27722, white. Cabinet interiors shall be FS 27880, white.

3.04 CLEANUP

A. General:

1. Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

A. General:

1. Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Surfaces shall be coated in accordance with the COATSPEC to the system thickness specified. Coating systems shall be as specified in paragraph 3.06. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.

2. Coating Specification Sheets included in Table A are included in this paragraph.

Table A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
E-1	Epoxy	Metal	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
M-1	Petrolatum-based mastic or wax-based wrapping tapes	Metal	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
EU-1	Zinc-epoxy polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed.

Note: The coating for the steel, above-ground storage tank shall be per Specification Section 09 97 13.33.

Coating System Specification Sheets (COATSPEC)

A.	**Coating System Identification: E-1**	
1.	Coating Material:	Epoxy
2.	Surface:	Metal
3.	Service Condition:	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
4.	Surface Preparation:	
a.	General:	Shop-primed surfaces to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop-coated areas shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2 to 2.5 mils and spot-primed with the primer specified. Shop epoxy-primed surfaces shall require light abrasive and vacuum-cleaning blasting prior to receiving finish coats.
b.	Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) to achieve a uniform, surface profile of 2- to 2.5-mils.
		Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC SP-1 (Solvent Cleaning). Areas of rust penetration shall be spot-blasted to SSPC SP-10 (Near White Blast) (to achieve the 2 to 2.5 mils surface profile) and spot-primed with the specified primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02.
c.	Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to achieve uniform, minimum surface profile 1 to 1.5 mils.
5.	Application:	Field
a.	General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air-pollution control regulations.
b.	Ferrous Metal:	Prime coats shall be an epoxy primer compatible with the specified finish coats and applied in accordance with the written instructions of the CSM.
c.	Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC SP-1 (Solvent Cleaning).
6.	System Thickness:	10 mils dry film.
7.	Coatings:	
a.	Primer:	One coat at CSM's recommended DFT.
b.	Finish:	One or more coats at CSM's recommended DFT per coat to achieve the specified system thickness.
B.	**Coating System Identification: EU-1**	
1.	Coating Material:	Zinc-Epoxy-Polyurethane System
2.	Surface:	Ferrous Metal
3.	Service Condition:	Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.
4.	Surface Preparation:	
a.	General:	Shop-primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning surfaces in accordance with SSPC SP-2 (Hand Tool Cleaning). Damaged shop-coated areas shall be cleaned in accordance with SSPC SP-3 (Power Tool Cleaning) and recoated with the primer specified.
b.	Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) 2.5 to 3 mil. Ductile-iron surfaces to be coated shall be abrasive blast-cleaned in accordance with paragraph 3.02.
		Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP-11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot-blasted to SSPC SP-10 (Near White Blast) and spot-primed with the specified primer.
c.	Galvanized Metal:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC SP-5 (White Metal Blast Cleaning) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP-11 to achieve a uniform 1 to 1.5 mil profile and spot-primed with the primer specified.

	Nonferrous and galvanized metal shall be prepared in accordance with SSPC SP-7 (Brush-off Blast Cleaning) to impart a 1 to 2 mil profile to the galvanized steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP-3, Power Tool Cleaning to impart a 1 to 1.5 mil profile uniformly to the galvanized steel surfaces.
	For EU-1 over galvanized steel, delete the zinc-rich primer.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air-pollution control regulations.
b. Ferrous Metal:	Prime coats shall be a zinc-rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc-rich. In these cases, only a two-coat system is applied.
6. System Thickness:	3 to 4 mils of zinc-rich primer, one intermediate or primer epoxy coat at 5 to 6 mils and one finish coat of polyurethane at 2 to 3 mils DFT.
7. Coatings:	
a. Primer:	One coat at CSM's recommended DFT.
b. Intermediate:	One coat at CSM's recommended DFT.
c. Finish:	One coat at CSM's recommended DFT per coat to meet the specified system thickness.

C. Coating System Identification: M-1

1. Coating Material:	Petrolatum-based mastic or wax-based wrapping tapes.
2. Surfaces:	Metal
3. Service Condition:	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
4. Surface Preparation:	Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC SP-2 (Hand Tool Cleaning).
5. Application:	All surfaces shall be hand-rubbed or brushed with a priming paste recommended by the CSM. Sharp projections such as threads, irregular contours, or badly pitted areas shall receive a liberal amount of priming paste to ensure maximum protection of metal throughout.
	On irregular shaped surfaces, i.e., nuts, bolts, flanges, valves, etc., the Contractor shall use either of the following systems recommended by the CSM.
	A. Apply recommended mastic by hand in sufficient quantity to build an even contour over entire surface. The Contractor shall pay particular attention to ensure that folds and air pockets within the mastic layer are thoroughly pressed out prior to subsequent application of tape.
	OR:
	B. An extra layer of tape shall be cut and carefully molded around sharp projections, nuts, bolts, etc., before final application of tape, in order to meet specified system thickness.
	Tape shall be spirally wrapped with a 55% overlap and sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand during wrapping. On vertical application, Contractor shall begin at bottom and proceed upward, creating a weatherboard overlap.
6. System Thickness:	Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.
7. Tape:	Number and types of tape wraps shall be in accordance with the CSM's written instructions.

3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

A. General:

1. Specific coating systems, colors, and finishes for rooms, galleries, piping, equipment, and other items that are coated or have other architectural finishes are specified in the following Coating System Schedule. Unless otherwise specified in the Coating System Schedule, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
A. General: All Surfaces not Specified by Area or Structure		
1. Equipment and Metal Appurtenances		
a. Equipment, non-immersed, unless otherwise specified		
1) Indoors	E-1	FS 25051 Blue
2) Outdoors	EU-1	FS 20040 Brown
b. Existing equipment		
1) Not damaged nor modified by work in this Contract	Uncoated	--
2) Damaged, exposed, or modified by work in this Contract		
a) Indoors	E-1 (see paragraph 3.02)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02)	Match existing color
c. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels; indoors and outdoors	See paragraph 3.03	ANSI 61 Grey (outside) FS 27880 White (inside)
d. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified		
1) Indoors	See paragraph 3.03	FS 26306 Grey (outside) FS 27880 White (inside)
2) Outdoors	See paragraph 3.03	FS 27722 White (outside) FS 27880 White (inside)
e. Existing electrical and instrumentation panels		
1) Not damaged by work in this Contract	Uncoated	--
2) Damaged or exposed to outside surfaces by work in this Contract		
a) Indoors	E-1 (see paragraph 3.02)	FS 26306 Grey
b) Outdoors	EU-1 without primer (see paragraph 3.02)	FS 26306 Grey (electrical) FS 27722 White (instrumentation)
2. Conduit, Piping and Ductwork		
a. Ferrous, non-ferrous and galvanized piping, and appurtenant hangers and supports, non-immersed, unless otherwise specified		
1) Indoors – noncorrosive	E-1	FS 25051 Blue
2) Outdoors – noncorrosive	EU-1	FS 20040 Brown
3) Buried piping	M-1 or M-2	Not required
b. Conduit, outlet and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports on coated surfaces, unless otherwise specified		

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
1) Indoors	E-1	Match background color
2) Outdoors	EU-1	Match background color
c. Conduit, outlets and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps and supports on uncoated surfaces, unless otherwise specified		
1) Indoors	E-1	FS 25051 Blue
2) Outdoors	EU-1	FS 20040 Brown
d. Existing conduit, outlet and junction boxes, lighting transformers, lighting communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports		
1) Not damaged nor modified by work in this Contract	Uncoated	--
2) Damaged, exposed, or modified by work in this Contract		
a) Indoors	E-1 (see paragraph 3.02)	Match existing color
b) Outdoors	EU-1 without primer (see paragraph 3.02)	Match existing color
e. Racked conduits and cable trays	Uncoated	--
f. Insulated pipe jacketing	Uncoated	--
g. Exposed ductwork, unless otherwise specified	Uncoated	--
3. Other		
a. Pipe, ductwork, equipment and appurtenances made from fiberglass, plastic, rubber, including flexible-hose, conduit, and plastic-coated tubing, in areas not exposed to view (indoors) (metal hangers and supports are coated with E-1)	Uncoated	--
b. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1	Manufacturer's color

Note: Owner will select color from coating manufacturer's list of EPA-approved colors for potable water.

3.07 INSPECTION AND TESTING BY OWNER

A. General:

1. Inspection by the Owner or others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Inspection by the Owner is in addition to any inspection required to be performed by the Contractor.
2. The Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section 09 90 00. These inspections may include the following:
   a. Inspect materials upon receipt to ensure that are supplied by the CSM.
   b. Inspect to verify that specified storage conditions for the coating system materials, solvents and abrasives are provided.
   c. Inspect and record findings for the degree of cleanliness of substrates.

d. Inspect and record the pH of concrete and metal substrates.
e. Inspect and record substrate profile (anchor pattern)
f. Measure and record ambient air and substrate temperature.
g. Measure and record relative humidity.
h. Check for the presence of substrate moisture in the concrete.
i. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.
j. Inspect, confirm, and record that the "pot life" of coating system materials is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
k. Perform adhesion-testing.
l. Measure and record the thickness of the coating system.
m. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.
n. Perform holiday or continuity testing for coatings that will be immersed or coatings that will be exposed to aggressively corrosive conditions.

3.08 FINAL INSPECTION

A. General
1. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the Specifications.
2. The Construction Manager will subsequently conduct a final inspection with the Contractor to determine the work is in conformance with requirements of the Contract Documents.
3. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

END OF SECTION

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SECTION 09 91 00

PAINTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes surface preparation and field painting of the following:
   1. Exposed exterior items and surfaces.
   2. Exposed interior items and surfaces.
   3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.
   1. Painting includes field painting of exposed, bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
   1. Prefinished items include the following factory-finished components:
      a. Finished mechanical and electrical equipment.
      b. Light fixtures.
      c. Distribution cabinets.
   2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
      a. Furred areas.
      b. Ceiling plenums.
      c. Pipe spaces.
      d. Duct shafts.
   3. Finished metal surfaces include the following:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Chromium plate.
      d. Copper.
      e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:
    a. Valve and damper operators.
    b. Linkages.
    c. Sensing devices.
    d. Motor and fan shafts.
5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.03 DEFINITIONS

A. General: Standard coating terms defined in American Society for Testing and Materials (ASTM) D16 apply to this Section.

1.04 SUBMITTALS

A. Product Data: For each paint system specified.
    1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
    2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
    3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. Samples for Verification: Of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.
    1. Provide samples of each color, defining each separate coat, including primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.
    2. Submit two draw-downs (8-1/2-inch x 11-inch) of each color and finish gloss.

C. At completion of work of this Section, submit manufacturer's or distributor's numbered invoices showing type and quantity of products used on this Project.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
    1. Notify Architect of problems anticipated using the materials specified.

C. Field Samples, Interior: Provide a full-coat benchmark finish sample of each type of coating and substrate required on the Project. Comply with procedures specified in

Painting and Decorating Contractors of America (PDCA) P5. Duplicate finish of approved prepared samples.

1. The Architect will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted. Apply coatings in this room or surface in accordance with the schedule or as specified. After finishes are accepted, this room or surface will be used for evaluation of coating systems of a similar nature.

D. Material Quality: Provide the manufacturer's best-quality, top-of-the-line paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45°F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.07 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90°F. Manufacturer temperature requirements that specify a more stringent temperature range take precedence over this requirement.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95°F. Manufacturer temperature requirements that specify a more stringent temperature range take precedence over this requirement.

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85%, or at temperatures less than 5°F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.08 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.

1. Quantity: Furnish the Owner with 2 gallons of each color or type applied.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide products manufactured by one of the following:
   1. Dunn-Edwards.
   2. Frazee Industries.
   3. Sherwin Williams.

2.02 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
   1. Products specified are manufactured by Dunn-Edwards and establish standards for kind, quality, sheen and function desired for this Project.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
   1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
   2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.02 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and re-prime.

2. Cementitious Materials: Prepare concrete surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
    a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
    b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.
3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
    a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
    b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.03 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules following.
2. Provide finish coats that are compatible with primers used.
3. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.
4. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds,

and exposed fasteners, receive a dry film thickness (DFT) equivalent to that of flat surfaces.

5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
6. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
7. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
8. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
9. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

C. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total DFT of the entire system as recommended by the manufacturer.

D. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

E. Mechanical items to be painted include, but are not limited to, the following:
   1. Piping, pipe hangers, and supports.
   2. Heat exchangers.
   3. Tanks.
   4. Ductwork.
   5. Insulation.
   6. Motors and mechanical equipment.
   7. Accessory items.

F. Electrical items to be painted include, but are not limited to, the following:
   1. Conduit and fittings.
   2. Switchgear.
   3. Panelboards.

G. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

H. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness,

spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

I. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

3.04 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.05 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA Standard P1-09 "Touch-Up Painting and Damage Repair – Financial Responsibility."

3.06 INTERIOR LOCATIONS

A. Gypsum Wallboard, (Typical):		
1 Coat	VNSL00 Vinylastic Select Acrylic Copolymer latex sealer	1.5 mil DFT min.
2 Coats	EVSH40-1 Evershield 100% Acrylic Low Sheen Paint	1.5 mil DFT min. per coat
B. Interior Ferrous Metals:		
1 Coat	BRPR00-1-RO Bloc-Rust Premium Red Oxide Alkyd Emulsion Metal Primer **-OR-** BRPR00-1-WH Bloc-Rust Premium White Alkyd Emulsion Metal Primer	2.0 mil DFT min. 2.0 mil DFT min.
2 Coats	EVSH40-1 Evershield 100% Acrylic Low Sheen Paint	1.5 mil DFT min. per coat
C. Interior Non-Ferrous Metals:		
1 Coat	UGPR00-1 Ultra-Grip Premium Acrylic Multi-Purpose Primer	1.5 mil DFT min.
2 Coats	EVSH40-1 Evershield 100% Acrylic Low Sheen Paint	1.5 mil DFT min. per coat

3.07 COLOR SCHEDULES

A. General: Items not included on the Color Location Schedule, i.e., conduit, pipes, etc., shall be painted to match the surface on which they occur.

B. Paint: Final colors shall be as selected by Architect and Owner.

END OF SECTION

SECTION 09 97 13.33

COATING FOR STEEL WATER STORAGE RESERVOIR

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies coating systems, surface preparations, and application requirements for coating of a steel water reservoir.

B. Definitions:
   1. Specific coating terminology used in this section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions:
      a. Dry Film Thickness (DFT):
         1) The thickness of one fully cured continuous application of coating.
      b. Field Coat:
         1) The application or the completion of application of the coating system after installation of the surface at the site of the work.
      c. Shop Coat:
         1) One or more coats applied in a shop or plant prior to shipment to the site of erection or fabrication, where the field or finishing coat is applied.
      d. Volatile Organic Content:
         1) The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter or pounds per gallon.
      e. Touch-Up Painting:
         1) The application of a paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that

date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D16	Standard Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products
ASTM D2200 (SSPC-Visl-67T)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ASTM D3359	Methods for Measuring Adhesion by Tape Test--Method A
ASTM D3960	Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4417	Field Measurement of Surface Profile of Blast Cleaned Steel
AWWA D102	Painting Steel Water-Storage Tanks
NSF 61	Drinking Water System Components Health Effects
SSPC	Steel Structures Painting Council Specifications, Vol. 2

B. Standardization:
   1. Materials and supplies provided shall be the standard products of manufacturers. Materials in each coating system shall be the products of a single manufacturer.
   2. The standard products of manufacturers other than those specified will be accepted when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for substitutions will be considered, provided the following minimum conditions are met:
      a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required dry film thickness.
      b. The proposed coating system shall use coatings of the same generic type as that specified.
      c. Requests for substitution shall have directions for application and descriptive literature which includes generic type, percent solids by volume, volatile organic content (grams per liter), and information confirming that the substitution is equal to the specified coating system.
      d. The Contractor shall provide a list of references where paint of the same generic type has been applied. The reference list shall give the project name, city, state, owner, phone number of owner, coating system reference and number, and year paint was applied.

C. Inspection:
   1. The Construction Manager will provide, or arrange to have provided, all coating inspections, with the exception of holiday testing. Test equipment provided by the Contractor as specified in paragraph 3.04 Inspection and Checking will be operated by the Construction Manager.
   2. The Construction Manager may perform inspection on all on-site and off-site phases of the surface preparation, abrasive blast cleaning, and application of the coating systems. Specified and optional tank surfaces to have shop-applied primer will be monitored by off-site inspection. The Contractor shall notify the Construction Manager in sufficient time to schedule inspection during shop priming and shall make the shop priming premises open and available to the Construction Manager for inspection. The Contractor shall pay all costs incurred for off-site inspection.

3. If shop work is not scheduled on a continuous basis to facilitate scheduling by the Construction Manager, all costs incurred for multiple trips to the shop shall be borne by the Contractor. Actual costs incurred for off-site inspection will be incorporated into a change order and deducted from progress payments due the Contractor.

1.03 DELIVERY AND STORAGE

A. Materials shall be delivered to the job site in their original, unopened containers. Each container shall bear the manufacturer's name, coating type, batch number, date of manufacture, storage life, and special directions.

B. Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Flammable materials shall be stored in accordance with state and local codes. Materials exceeding storage life recommended by the manufacturer shall be removed from the site.

1.04 SPARE SUPPLIES

A. The Contractor shall provide one unbroken gallon container of each color and type of paint and each type of solvent and thinner required by the specification. These spare paint supplies shall be stored as required in paragraph 1.03 until delivery is requested by the Construction Manager.

PART 2 PRODUCTS

2.01 COATING SYSTEMS

A. General:

B. All materials of a specified coating system, including primer, intermediate, and finish coats, shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the coating manufacturer for the particular coating system.

C. Outside Coating:
   1. Outside coating shall be system AWWA D102 OCS -5 consisting of two coats of epoxy and one coat of polyurethane. Contractor to supply color samples including custom colors for selection by Owner.

D. Inside Coating:
   1. Inside coating shall be system AWWA D102 ICS-2 consisting of 3 coats of epoxy 12 mils DFT. All inside coatings shall be certified in accordance with NSF 61.
   2. Finish Coating:
      a. Intermediate coat shall be contrasting color.
      b. Inside finish coat shall be an epoxy white in color.

2.02 PRODUCT DATA

A. Before materials are delivered to the job site, the Contractor shall provide the following information in accordance with Section 01 33 00:

1. Manufacturer's standard product data and material safety data sheet for each primer and finish coating.

B. List of materials proposed to be used under this section.
    1. Manufacturer's literature and written instructions for surface preparation, mixing, and application of each primer and finish coating.

PART 3 EXECUTION

3.01 COATINGS

A. General:
    1. Coating products shall not be used until the Construction Manager has inspected the materials and the coating manufacturer's technical representative has instructed the Contractor and Construction Manager in the surface preparation, mixing and application of each coating.
    2. At least 14 days prior to the shop or field application of the coating systems on the steel tank, the Contractor shall schedule and arrange a conference with the coating applicator, Construction Manager, tank manufacturer, and the coating manufacturer to coordinate the following:
        a. Tank manufacturer's work schedule for inspection coordination.
        b. Surface preparation prior to abrasive blast cleaning.
        c. Specification compliance of blast abrasives and surface profile.
        d. Schedule of blast cleaning and coating application.
        e. List of equipment for cleaning and coating applications.
        f. Weather limitations for acceptable work.
        g. Inspection facilities and test equipment.

B. Coating Systems:
    1. Field Coats:
        a. Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified dry film thickness. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until all previous coats have been inspected.

3.02 PREPARATION

A. General:
    1. Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed except as specified. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded and free of contaminants which might interfere with the adhesion of the coatings. The Contractor shall examine all surfaces to be coated and shall correct all surface defects before application of any coating.

2. Clean cloths and clean fluids shall be used in solvent cleaning. Cleaning and painting shall be scheduled so that dust and spray from the cleaning process shall not come in contact with wet, newly painted surfaces.
3. The Contractor shall perform an adhesion test in accordance with ASTM D3359 to demonstrate that (1) the shop primer adheres to the substrate, and (2) the specified field coatings adhere to the shop primer. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on all other surfaces shall be considered acceptable. Where unacceptable test results are obtained, the Contractor shall be responsible for removing and reapplying the specified coatings at no expense to the Owner.

B. Metallic Surfaces:
1. Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Steel Structures Painting Council (SSPC). Unless otherwise specified, interior ferrous metal surfaces shall be prepared in accordance with SSPC SP 5 (White Metal Blast Cleaning) and exterior ferrous metal surfaces prepared in accordance with SSPC SP 6 (Commercial Blast Cleaning). The profile depth of the surface to be coated shall be 20 to 25 percent of the coating dry film thickness as measured by Method C of ASTM D4417. Blast particle size shall be selected by the contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the manufacturer.
2. Preparation of metallic surfaces shall be based upon comparison with SSPC-Vis-1-67T (ASTM D2200), and as described herein. To facilitate inspection, the Contractor shall, on the first day of sandblasting operations, sandblast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear nonyellowing finish. One of these panels shall be prepared for each type of sandblasting and shall be used as the comparison standard throughout the project.

C. Abrasive Blast Cleaning:
1. The specified limitations on the application of coatings also applies to blast cleaning. Blast cleaning shall only be done when conditions permit the immediate subsequent application of coating, and only for the area that can be coated with primer or touch-up coating during the same day. Changed humidity or a delay, such as equipment failure, may cause a cleaned surface to color or slightly oxidize from condensation before the coating can be applied. In the event that a surface colors or becomes moist, it shall be blast cleaned again before applying the coating.
2. Abrasive blast cleaning shall comply with the following:
    a. Dry abrasive blast shall be used for cleaning metal surfaces. Sand used for cleaning shall be washed, uniformly graded, dry, and free of contaminants. Sand containing salt or unwashed beach sand shall not be used. When shop blast cleaning with stationary automatic equipment that recycles the blast particles, new abrasives shall be used in the equipment at the beginning of the blast cleaning operations. Use of abrasives that have become contaminated in automatic equipment is prohibited. When shop or field blast cleaning with hand-held nozzles, blast particles shall not be recycled or reused.
    b. After blast cleaning and prior to application of coating, surfaces to be coated shall be dry cleaned by dusting, sweeping, and vacuuming to remove residue from blasting. The blasting and the specified primer or touch-up coating shall be

applied within the period of an 8-hour working day. Coating shall not be applied over damp or moist surfaces. Prior to application of primer or touch-up coating, any blast cleaned surface not coated within the 8-hour period shall be recleaned.

c. The area of the work shall be kept in a clean condition and blasting particles shall not be permitted to accumulate and constitute a nuisance or hazard. The reservoir inlet, outlet, drain, and overflow piping shall be covered, and blasting particles prevented from being blown into the piping.

d. During blast cleaning, caution shall be exercised to prevent damage to adjacent preapplied coatings. Blast cleaning and coating shall be scheduled such that dust, dirt, blast particles, old coatings, rust, mill scale, etc., shall not damage or come in contact with wet or newly coated surfaces. Damaged coatings shall be restored to their specified condition.

3.03 APPLICATION

A. Workmanship:

1. Coated surfaces shall be free from runs, drops, ridges, waves, laps, and brush marks. Coats shall be applied so as to produce an even film of uniform thickness completely coating corners and crevices. Painting shall be done in accordance with the requirements of SSPC Paint Application Specification No. 1.
2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.
3. Each coat of paint shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.

B. Paint Properties, Mixing and Thinning:

1. Paint, when applied, shall provide a satisfactory film and smooth even surface, and glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Paints shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of two or more components shall be mixed in accordance with the manufacturer's instructions. Where necessary to suit the conditions of the surface, temperature, weather and method of application, the paint may be thinned immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, paint shall not be thinned more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the coating manufacturer.

C. Atmospheric Conditions:

1. Paints shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Paint shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. Coatings shall not be applied when the temperature of the surface to be coated is more than 5 degrees F below the air temperature, or when the surface temperature is over 120 degrees F. During painting, and for a period of at least 8 hours after the paint has been applied, the temperature of the surfaces to be painted, the painted surfaces,

and the atmosphere in contact shall be maintained at or above 50 degrees F and at least 10 degrees F above the dew point. Paint, when applied, shall be approximately the same temperature as that of the surface on which it is applied. Fans or heaters shall be used inside enclosed areas where conditions causing condensation exist.

2. If conditions are adverse as noted above, the application of coating shall be delayed or postponed until conditions are favorable. Dew or moisture condensation should be anticipated and if such conditions are prevalent, coating work shall be delayed until midmorning to be certain that the surfaces are dry. The day's coating shall be completed in time to permit the film sufficient drying time prior to damage by climatic conditions. Climatic conditions will be monitored by the Construction Manager to aid in inspection. If a change in climatic conditions damages a coating application, repair of the damaged coatings to their specified condition shall be made at no additional cost to the Owner.

D. Protection of Coated Surfaces:
   1. Items which have been coated shall not be handled, worked on, or otherwise disturbed, until the paint is completely dry and hard. After delivery to the site and permanent erection or installation, shop-coated metalwork shall be repainted or retouched with specified paint when it is necessary to maintain the integrity of the film.

E. Procedures:
   1. General:
      a. Procedures for application of coatings shall comply with the following:
         1) Coating applicator shall conform to the requirements of SSPC PA-1 and follow the recommendations of the coating manufacturer including the selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
         2) Coating applicator shall stir, strain, and keep coating materials at a uniform consistency during application. A different shade or tint shall be used on succeeding coating applications to indicate coverage. Finished surfaces shall be free from defects or blemishes.
         3) If allowed, thinning shall not exceed the maximum allowable amount of thinner per gallon of coating material. Coating materials shall be stirred at all times when adding thinner; flooding the coating material surface with thinner prior to mixing is prohibited. Coating materials shall not be thinned more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.
      b. Blast cleaned surfaces shall be cleaned as specified in paragraph 3.02 Abrasive Blast Cleaning. Ventilator fans shall be used to clean airborne dust to provide good visibility of working area prior to coating applications. Dust shall be removed from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.
         1) Coating applicator shall observe minimum and maximum recoat times between primer and succeeding coating applications to achieve maximum crosslinking of coatings. If the recommended minimum or maximum recoat time is violated, the surface shall be prepared as directed by the coating manufacturer. A second application of the primer or coating shall be applied if the maximum recoat time has been exceeded.

2) Coating systems shall be applied to the specified minimum dry-film thicknesses as measured from above the peaks of the surface profile. Measurement will be in accordance with SSPC PA-2 and will be corrected for the magnetic effect of the surface profile.

3) Primer or touch-up coating shall be applied immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Steel surfaces that have surface colored or become moist prior to coating application shall be recleaned by blast cleaning.

2. Field-Applied Interior Primer and Coating:
   a. Procedures for application of field-applied interior primer and coating shall comply with the following:
      1) Coating applicator shall remove dust from the sandblasted surface and allow ventilator fans to clear airborne dust to provide good visibility of working area. Adequate lights shall be provided.
      2) Dust shall be removed from primer before applying second coat. Total mil thickness shall be verified. Floor shall be coated last.
      3) The coating will be checked with a holiday detector as the work progresses. A final check of the entire coating will be performed when it is complete.
3. Exterior Coating:
   a. Procedures for application of exterior coatings shall comply with the following:
      1) Coating applicator shall remove sandblasted dust. Primer shall be applied with rollers that leave a smooth surface or by spraying. Rollers shall be used when wind causes unacceptable drift. The finish coats shall be sprayed except spraying is not allowed when wind or other weather conditions are unfavorable.
      2) The mil thickness and the dryness of each coat shall be verified before overcoating.
4. Limitations on Coating Applications:
   a. Coatings shall not be applied under the following conditions:
      1) When the air and surface temperature are outside the range recommended by the coating manufacturer.
      2) When the ambient temperature is less than 5 degrees F above the dew point.
      3) When the surfaces are wet or moist.
      4) During rain, snow, fog, or mist.
      5) When it is expected that the air temperature will drop below that recommended by the paint manufacturer or will drop to less than 5 degrees F above the dew point within 8 hours after applying the coating.
      6) Coating applicator shall maintain a thermometer in the shade on the project site and keep informed of the dew point and the humidity from the weather bureau.

F. Cleaning and Coating of Roof Plates and Framing:
   1. Before erection of the roof framing, all sides of the roof framing members and the roof plates that will be in contact with them shall be cleaned and painted with the specified prime coat. After erection, visible scratches and other damaged painted surfaces shall be sandblasted, primer applied to the recleaned areas, then finish coat applied along with other interior surfaces.

G. Underside of Flat Bottom Tanks:
   1. The underside of flat bottom tanks shall not be coated.

H. Cleaning and Coating of Overflow Piping Within Tank:
   1. The interior and exterior of overflow piping within the tank shall be cleaned and coated as specified for the tank interior. This does not apply to the overflow piping that is exterior to the tank.

3.04 INSPECTION

A. Inspection Facilities:
   1. Contractor shall provide the Construction Manager with facilities for inspection consisting of the following:
      a. Safety equipment and devices required during abrasive blast cleaning and coating operations. Helmet with continuous fresh air supply shall be provided for observation during cleaning operations.
      b. Illumination and the manpower to move the lights, whenever required by the Construction Manager. Additional lights and supports shall be sufficient to illuminate all areas to be inspected. The Construction Manager will determine the level of illumination required for inspection purposes.
      c. Temporary ladders and scaffolding as required to provide access to the locations requested by the Construction Manager.

B. Inspection and Checking:
   1. The Construction Manager reserves the right to perform such tests as are required to demonstrate substantial compliance with all phases of the surface preparation, abrasive blast cleaning, and application of the coating systems. Test equipment shall include the following: SSPC surface preparation standards, surface profile comparator, test tape, micrometer, abrasive sieve test, ultraviolet lamp, mirror, certified thickness calibration plates, magnetic-type dry-film thickness gage, nondestructive holiday detector, and nonsudsing-type wetting agent. Equipment will be calibrated by the Construction Manager in the presence of the Contractor to verify its accuracy prior to use. The Contractor shall provide the test equipment.
   2. The Construction Manager shall be notified 5 working days in advance of shop and field operations involving abrasive blast cleaning and coating applications.
   3. The Construction Manager may inspect each coat of primer, touch-up, intermediate, and finish coating to determine thickness and integrity. Each coating application will be checked and deficiencies marked. After observing specified recoat time, additional coating materials shall be applied over area not having the specified minimum dry-film thickness and areas having any holidays or pinholes. After correction of deficiencies, the Construction Manager will reinspect those areas to determine the acceptability of additional coating. Each coating application shall be

100 percent to the satisfaction of the Construction Manager prior to succeeding coating applications.

3.05 WARRANTY

A. A first-anniversary warranty inspection of the interior and exterior surfaces of the tank will be conducted during the eleventh month following final acceptance of the work by the Owner to determine whether any repair work is necessary. Inspection shall comply with Section 5 of AWWA D102 except as specified. The Owner will establish the inspection date and notify the Contractor. The Owner will drain and wash down the tank. The Contractor shall provide lighting and scaffolding for the tank inspection. Where coatings have peeled off, bubbled, or cracked, and any location where rusting is evident shall be considered to be a failure of the coating system. Repairs at failures shall be performed by removing the deteriorated coating; preparing the surface by abrasive blast cleaning and applying the same coating systems as specified in this section. Inspection and repairs and re-disinfection of the tank and VOC testing shall be performed at no cost to the Owner.

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies informational and accident prevention signs.

1.02 OPERATING AND DESIGN REQUIREMENTS

A. General:
   1. Accident prevention signs shall conform as to design with Occupational Safety and Health Administration (OSHA) Section 1910.145 of Subpart J, Part 1910, Chapter XVII, Title 29 of the Code of Federal Regulations. Exit signs shall conform with Section 1910.37(g) of the OSHA Safety and Health Standard for General Industry, Article 10, Section 10.113 of the Uniform Fire Code and, where applicable, with local fire regulations.
   2. In addition to the signs identified on the schedule in Part 3 of this Section, the following shall be provided:
      a. "Caution Automatic Equipment May Start at Any Time" signs shall be provided in accordance with Section 43 05 11-2.07.

B. Design Requirements:
   1. Size:
      a. Sign size shall be as follows:
         1) 14-inch x 20-inch
         2) 10-inch x 14-inch
         3) 7-inch x 10-inch
   2. Type:
      a. The sign type shall be as follows:

Type	Message
I	RESTRICTED AREA – AUTHORIZED PERSONNEL ONLY
III	CAUTION – AUTOMATIC EQUIPMENT MAY START AT ANY TIME
IV	ELECTRICAL ROOM
V	DANGER – 480 VOLTS
VI	STANDBY GENERATOR LOCATED NORTH OF SES

PART 2 PRODUCTS

2.01 GENERAL

A. Sign lettering shall be single-stroke and shall contrast in color with the background. For those messages for which there are international symbols, the international symbols shall be used. Chain-mounted signs shall have lettering on both sides.

2.02 MATERIALS

A. Signs shall be 0.100-inch thick fiberglass with embedded fadeproof legends.

PART 3 EXECUTION

3.01 GENERAL

A. Signs shall be distributed as follows:

Location	Number	Size	Message	Mount
Pump Room Entrance	2	2	I	Wall
Pump Room	2	1	III	Wall
Electrical Room	2	2	IV	Door
All 480-Volt Electrical Equipment: Service Entrance Section (SES), Transfer Switch, Standby Generator, Variable-Frequency Drive, Panelboard, etc.	---	3	V	Door
Electrical SES	1	3	VI	Door

END OF SECTION

SECTION 10 44 00

FIRE-PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Fire extinguishers.
   2. Fire extinguisher mounting brackets.

1.03 SUBMITTALS

A. Product Data: For each type of product specified. For fire extinguisher cabinets, include rough-in dimensions; details showing mounting methods; relationships of box to surrounding construction; door hardware; cabinet type and materials; door construction; panel style; and materials.

1.04 QUALITY ASSURANCE

A. Underwriters Laboratories (UL) Listed Products: Fire extinguishers UL-listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher.

B. Factory Mutual (FM) Listed Products: Fire extinguishers approved by Factory Mutual Research Corporation for type, rating, and classification of extinguisher and carry appropriate FM marking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. J.L. Industries.
   2. Larsen's Manufacturing Co.
   3. Potter-Roemer, Inc.

2.02 FIRE EXTINGUISHERS

A. General: Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by Architect from manufacturer's standard, which comply with requirements of governing authorities.
   1. Fill and service extinguishers to comply with requirements of governing authorities and manufacturer.

2. Abbreviations indicated below identify extinguisher types related to UL classification and rating system and not necessarily to type and amount of extinguishing material contained in extinguisher.

B. Multipurpose Dry-Chemical Type:
   1. Typical: UL-rated 3A-40BC, 5-lb. nominal capacity, in enameled steel container (Similar to J L Industries Cosmic 5E).

2.03 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   1. Color: Red.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red-letter decals applied to mounting surface.
      a. Orientation: Vertical, with arrow pointing down at fire extinguisher unit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items included in this Section in locations with top of cabinet at 5 feet-4 inches above finished floor.
   1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
   2. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer's instructions.
   3. Provide both extinguisher and cabinet where shown on Plans.

B. Install dry-chemical type fire extinguishers on brackets as shown on Plans.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies drains, piping, appurtenances and general requirements for plumbing systems.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
UPC (1988)	Uniform Plumbing Code

PART 2 PRODUCTS

2.01 CLEANOUTS

A. General:

1. Unless otherwise specified, cleanouts shall be the same size as the pipe connected. Cleanouts shall be provided with clamping collars where waterproofing membranes are located in the floor. Cleanouts located inside buildings shall be provided with nickel-bronze alloy covers. Bronze plug with tapered thread shall be provided for cleanouts on pressurized systems. Cleanouts on chemical waste or drain lines shall be of the same material and type of joint as the pipe.

B. Type I Cleanout:

1. Unless otherwise specified, Type I cleanouts shall be Josam series 57000-Z, J. R. Smith series 4020, or equal.

C. Type II Cleanout:
   1. Unless otherwise specified, Type II cleanouts shall be Josam series 57000-Z-12, J. R. Smith series 4140, or equal.

D. Type III Cleanout:
   1. Unless otherwise specified, Type III cleanouts shall be Josam series 58500 (-20), J. R. Smith series 4420, or equal, with cast-iron frame and cover as specified on the drawing details.

E. Type IV Cleanout:
   1. Unless otherwise specified, Type IV cleanouts shall be Josam series 58500(-20), J. R. Smith series 4420, or equal.

F. Type V Cleanout:
   1. Unless otherwise specified, Type V cleanouts shall be Josam series 58890, J. R. Smith series 4472, or equal.

2.02 DRAINS

A. Floor Drains:
   1. General: Floor drains shall be provided with clamping collars where waterproofing membranes are located in the floor.
   2. Type I Floor Drain: Unless otherwise specified, Type I floor drains shall be Josam series 32130, J. R. Smith series 2225, or equal.
   3. Type II, III, and IV Floor Drains: Unless otherwise specified, Type II, III, and IV floor drains shall be Josam series 32120, J. R. Smith series 2220, or equal.
   4. Type V Floor Drain: Unless otherwise specified, Type V floor drains shall be Josam series 30000-A, J. R. Smith series 2010-A, or equal.
   5. Type VI Floor Drain: Unless otherwise specified, Type VI floor drains shall be Josam series 49850 (-31), J. R. Smith series 3066, or equal.

B. Condensate Drains:
   1. Unless otherwise specified, condensate drains shall be as specified for piping system 24 in Section 40 05 01.

2.03 VALVE ACCESS COVERS – NOT USED

2.04 COUPLINGS, NIPPLES AND UNIONS

A. Couplings and nipples shall be of the same material as the pipe on which they are used.

B. Unions 2 inches and smaller shall be ground joint screwed pattern unions. Unions larger than 2 inches shall be flanged. Unions shall be packed with 1/16-inch thick rubber packing. Dielectric unions shall be as specified in Section 40 05 06.16-2.05.

2.05 SINK HOSE BIBBS

A. Sink hose bibbs shall be Acorn No. 8126, Chicago 387-LF, or equal.

2.06 WATER HAMMER ARRESTERS

A. Water hammer arresters shall be Josam, J. R. Smith, Wade, or equal.

2.07 SLEEVES

A. Sleeves shall be 22-gage sheet metal.

2.08 ESCUTCHEONS

A. Escutcheons shall be chrome-plated cold rolled steel or stainless steel.

2.09 PRODUCT DATA

A. Brochures of plumbing equipment, including catalog data and installation information, shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Work shall be in accordance with the Uniform Plumbing Code.
   2. Plumbing shall be provided to avoid obstructions, allow 7.5-foot minimum headroom, and keep openings and passageways clear.
   3. No holes shall be made in structural members.
   4. Torn and pierced waterproofing shall be repaired.
   5. Fixtures, fittings, valves, and copper and brass items shall be wrapped with burlap or building paper. Wrapping shall be removed at completion of the work.

B. Valves and Accessories:
   1. Valves shall be provided upstream of branches, apparatus and fixtures.
   2. Valves on branch lines and at distribution points shall be provided with a 2-inch heavy brass disc, stamped and stenciled with 1/4-inch high letters, stating portion of system controlled by valve. Valve locations shall be shown on Record Drawings. The Contractor shall provide a chart of location and use of main valves.
   3. Adjustable shaft valve boxes shall be provided for underground valves.

C. Dielectric Unions:
   1. Dielectric unions shall be provided at connections between pipe or fittings of different material.

D. Escutcheons:
   1. Escutcheons shall be provided where pipes penetrate finished walls, ceilings or floors. Escutcheons shall be securely mounted, allowing clearance for expansion.

E. Piping:

1. Piping shall be carried in chases or recesses where provided in walls, through floors and partitions, and over ceilings. Unless otherwise specified, piping shall not be run in floor slabs.
2. Pipes shall not be supported by plumbing fixtures or equipment. Changes in pipe size shall be made with reducing fittings. The use of bushings is not acceptable.
3. Where galvanized steel pipe is calked into a cast-iron hub, a soil-pipe adapter shall be provided on the calked end of the steel pipe.
4. Unless otherwise specified, underground piping outside buildings shall have a minimum cover of 24 inches. Piping under buildings shall have a minimum clearance from structure of 12 inches.
5. Hot- and cold-water piping shall be separated by at least 6 inches.

3.02 CLEANING AND FLUSHING

A. Piping and equipment shall be cleaned and flushed in accordance with Section 40 05 01.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies the labor and services necessary to test, adjust, and balance under actual operating conditions air systems' design flow rates. Nothing herein shall be construed as relieving the Contractor of the overall responsibility of this portion of the work.

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEBB	Procedural Standards for Testing Adjusting and Balancing of Environmental Systems
AABC	National Standards for Total System Balance
ASHRAE 70	Standards--Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets

B. Testing Agency:

1. The Contractor shall procure the services of an independent air balancing and testing agency, belonging to the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB), to perform air balancing, testing and adjustment of systems. The Contractor shall submit a copy of the National Project Certification Performance Guaranty, issued to the testing agency by the AABC, as a part of the balancing report.

C. Codes and Standards:
   1. The Contractor shall comply with applicable procedures and standards of the certification sponsoring association:
      a. "National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution-Hydronics Systems," AABC.
      b. "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", NEBB.
      c. "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets," American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).
   2. Calibration and maintenance of instruments and accuracy of measurements shall comply with the requirements of the standards.

1.03 SPECIAL REQUIREMENTS

A. Tests and adjustments shall include the complete testing and balancing of all hydronic systems and heating, ventilating, and air conditioning (HVAC) systems and necessary adjustments to the HVAC equipment to accomplish the specified design flow rates.

B. Should any apparatus, material or work fail to meet the specified requirements in these tests, the Contractor shall make the necessary corrections and retest the apparatus, material, or work at no additional cost to the Owner.

1.04 BALANCING

A. General:
   1. The Contractor shall review plans and Specifications prior to testing and balancing the air systems. The Contractor shall submit a proposed approach and schedule for approval prior to the start of testing and balancing work. Characteristics to be tested and adjusted to conform to the values specified include the following:
      a. Total airflow rates delivered by fans and air-handling units.
      b. Flow rates at all grilles, registers, diffusers, supply and exhaust and return ducts.
      c. Capacity and temperature rise or drop across each heating and cooling coil.
      d. Distribution patterns at air outlets.

B. Air Flow Rate Measurements:
   1. Air flow rates shall be obtained by adjustment of the fan speeds, dampers, or registers. All flow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between the design values specified for clean and dirty filters, with auxiliary systems in operation, and with all doors and windows closed.
   2. Flow rates at grilles, registers, branch ductwork and air distribution patterns shall be tested in strict accordance with ASHRAE Standard-70.

1.05 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each

paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements shall be sufficient cause for rejection of the entire submittal and no further submittal matter will be reviewed.

2. Sample copy of each of the NEBB or AABC report forms.
3. Proposed approach and schedule of testing and balancing work as specified in paragraph 1.04 A.
4. A description of each air system including equipment to be balanced.
5. Preliminary Balancing Report. This report includes field data after initial balance and recommendations for further adjustments if required.

PART 2 PRODUCTS

2.01 BALANCING REPORT

A. Report Data:
   1. The final certified balancing report shall include the following actual field-verified data:
      a. Equipment Data:
         1) Manufacturer and model, size, arrangement, class, location, and equipment number.
         2) Motor horsepower, voltage, phase, and full-load amperage.
         3) Fan cfm, static pressure, rpm, and operating motor brake horsepower.
      b. Duct size, supply or exhaust recorded cfm, velocity, pressure measurements, and location of all measurements.

B. Report Requirements:
   1. Each individual final reporting form must bear the signature of the person who recorded the data and that of the supervisor of the reporting organization.
   2. One certified organization shall perform the testing and balancing services.
   3. All instruments which were used shall be listed and identified including the last date each was calibrated.

C. Final Report:
   1. A Final Report shall be submitted prior to Contractor's request for final inspection. In addition to providing all specified data and information on applicable reporting forms, the report shall include the following:

a. A schedule for testing and balancing parts of the systems which must be delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor. Delayed work shall be completed as early as the proper conditions will allow, after consultation with the Construction Manager.
b. Due to delayed testing, reports shall be submitted after execution of those services.
c. A Total Balance Report shall include the following components:
    1) General information and summary.
    2) Instrument calibration.
    3) Air systems.
    4) Record Drawings with specified and measured flow rates.

2.02 CERTIFICATE OF COMPLETION

A. At completion of testing and balancing, Contractor shall submit a Certificate of Compliance stating that each apparatus, device, outlet, and system has been tested, adjusted, and balanced so that it is operating in conformance with manufacturer's recommendations and with the specified conditions.

2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
    1. The Balancing Report
    2. Documentation to confirm compliance with codes and standards
    3. NEBB or AABC certification

PART 3 EXECUTION

3.01 GENERAL

A. The balancing agency shall conduct the above field tests in the presence of the Construction Manager.

B. Following completion of testing and balancing, the system shall be left in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.02 PERFORMANCE OF WORK

A. Air Systems:
    1. General: Testing, adjusting, and balancing shall be performed after the system installation is complete but prior to acceptance of the Project.
    2. Measurements: The Contractor shall perform the following:
        a. Air flow rates supplied, exhausted, or returned shall be within ± 5% of the design values specified.
        b. Measure static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.

c. Adjust fan speeds and motor drives within drive limitations, for required air volume. Set a speed to provide air volume farthest distance from the fan without excess static pressure. Check draw amps of fans on initial startup. If running amps exceed nameplate, shut off motor immediately, notify Construction Manager, and make necessary drive changes as directed.

d. Air flow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between design values specified for clean and dirty filters, and with auxiliary systems in operation. The deflection pattern of supply outlets shall be adjusted to ensure uniform air distribution throughout the space served.

3. Systems to be balanced. The following building mechanical equipment and associated devices shall be balanced:

Equipment Description	Equipment No.
Electrical Room Air Handling Unit	AHU-1
Pump Station Exhaust Fan No. 1	EF-1
Pump Station Exhaust Fan No. 2	EF-2

3.03 FINAL INSPECTION

A. Following completion of testing and balancing, submit the Draft Balancing Report. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new reports submitted, and new inspection test made.

B. Following acceptance of the reports by the Construction Manager, the Contractor shall permanently mark all damper positions so that they can be restored to their correct position if disturbed at any time. Devices shall not be marked until after final inspection.

END OF SECTION

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SECTION 23 30 00

HVAC AIR DISTRIBUTION

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section specifies plenums, sheet-metal housings, ductwork, equipment connections, reinforcing and other devices required to make the air distribution systems complete and operational.

B. Type:
   1. Ductwork and appurtenances shall be designed and fabricated specifically for the applications described under the conditions specified.

C. Design Criteria and Considerations:
   1. General: Unless otherwise specified, sheet-metal gauge, reinforcing, hanger and support systems, ductwork joint types and other basic design construction details shall be in accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) HVAC Duct Construction Standards. Ductwork shall be fabricated to the configurations and dimensions specified. Dimensions specified indicate net-free area; dimensions shall be increased by the thickness of the lining where internal lining is required.
   2. Low-Pressure Ductwork: Low-pressure ductwork shall convey air with a velocity less than 2,000 fpm and maximum static pressure of 2 inches of water column (w.c.). Low-pressure ductwork shall conform to 2-inch w.c. pressure class.
   3. Medium-Pressure Ductwork: Medium-pressure ductwork, where specified, shall convey air with a velocity greater than 2,000 fpm and a maximum static pressure of 6 inches of w.c. Medium-pressure ductwork shall conform to 6-inch w.c. pressure class.
   4. System Leakage: All joints shall be sealed as required to limit total system leakage to a maximum of 1% of the specified equipment airflows.
   5. Change in Duct Size: Change in duct size shall be made by a uniformly tapering section. The change in direction of the tapering section shall not be more than 1 inch in 5 inches of run, unless otherwise specified.
   6. Bends in Duct: With the exception of mitered bends, all bends in ducts shall have inside radii equal to the duct width or diameter. Double-wall turning vanes shall be provided at all 90-degree mitered bends.
   7. Duct Sleeves: Whenever ducts extend through concrete or masonry walls, floors or ceilings, they shall be provided with a sleeve as specified in paragraph 2.04. Concrete inserts shall be provided before pour to support all ductwork under this Section.
   8. Duct Openings: Access doors or hand holes shall be provided in ducts at locations to reach modulating dampers, fusible links, controllers and any other moveable devices in the ducts. The opening shall be 1-inch less duct size or of adequate size to reach in and maintain these devices. Two-inch diameter nipples with threaded caps shall be welded to the duct where specified or directed by the engineer for balancing the system.
   9. Vibration Isolation Flexible Connections: Flexible connections shall be provided at duct connections to motor-driven air-handling equipment and other locations specified.

Flexible connections shall be Underwriters Laboratory (UL) approved and provided with the necessary angle, straps, bolts, clips, or other fasteners to secure the flexible material to the equipment and ducts. Flexible connections exposed to the weather shall be provided with approved sheet-metal weather covers.

1.02 QUALITY ASSURANCE

A. References:
   1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASHRAE CH 1-89	Handbook - Equipment Volume, Duct Construction
ASHRAE0 CH 33-89	Handbook - Fundamentals Volume, Duct Design
ASTM A167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A525	General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A527/A527M	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM B211	Aluminum and Aluminum Alloy Bar, Rod, and Wire
ASTM B308	Aluminum – Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
SMACNA	HVAC Duct Construction Standards Metal and Flexible
IBC	International Building Code
IMC	International Mechanical Code
UL 181	Factory-made Air Ducts and Connectors

B. Standards:
   1. Ductwork construction, installation, and air system performance shall comply with IMC, American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) CH-1 and CH-33, and Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Duct Construction Standards.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
   2. An 8-1/2-inch by 11-inch manual with detail sheets or catalog data of flexible duct connectors, duct sleeves, duct access doors, turning vanes, volume dampers, supports, hangers, etc.
   3. Shop drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all ductwork, plenums, and all auxiliary work and products of any kind necessary to make the heating, ventilation and air conditioning (HVAC) systems complete and ready for operation. Ductwork shall comply with the following restrictions and conditions:
   1. Ductmate systems shall be used as an option for low-pressure systems only and only in concealed spaces.
   2. Snap-lock seams shall not be permitted.
   3. Where space conditions permit, full-radius turns shall be used at offsets.
   4. Turning vanes shall be provided where tees, bends, and elbows are not 1-1/2 times the width at centerline and in all rectangular elbows.
   5. Ductwork elbows, take offs, and fittings shall be in accordance with the SMACNA and ASHRAE standards for the pressure class and conditions specified.
   6. Visible duct deflection, loss of shape, or unwarranted noise or vibration resulting from faulty or inadequate support, reinforcing, metal gauge, fabrication, or joint spacing shall be corrected at no expense to the Owner.

2.02 MATERIALS

A. Low- and Medium-Pressure Systems:

Component	Material
Duct	Galvanized steel, ASTM A525 and ASTM A527 or aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211
Duct Sleeve	Galvanized steel, 10-gage or aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211
Flexible Duct Connector	Noncombustible, weather and ozone resistant, abrasion-proof woven fiberglass fabric with coating weighing not less than 24 ounces per square yard. Maximum flame spread rating of 25; smoke rating of 50 for all materials including connecting tape, etc. UL 181 approved.
Turning Vanes	Galvanized steel or aluminum to match duct material.
Hangers and Supports, Rivets and Bolts, Reinforcing	Galvanized steel or aluminum, alloy 6061-T6 conforming to ASTM B308 to match duct material.

2.03 JOINTS AND REINFORCING

A. Transverse stiffeners and joints shall be appropriately spaced to maintain duct cross-section integrity in accordance with the pressure class specified and at the prevailing operating velocities. After joints are crimped, they shall be further secured by bottom-punching or riveting. Longitudinal seams shall be Pittsburgh lock and shall be cross-broken outward. Intake, or exhaust, side ducts shall be cross-broken inward. Discharge ducts shall be cross-broken outward. All plenums and casings shall be similarly cross-broken and further reinforced with 1-inch x 1-inch x 1/8-inch angles running diagonally between joints, riveted to the casings.

B. Low-pressure ductwork shall have slip joints. Medium-pressure ductwork shall have flanged or welded joints. Joints shall not interfere with airflow in the ducts. Exterior ducts shall be stiffened, braced, and supported in a manner designed to maintain duct integrity and cross-section under wind and snow loads specified in the appropriate codes or standards for Yavapai County.

C. Interior ducts shall be suitably braced and stiffened at floor and roof penetrations as well as over their unsupported length in a manner designed to maintain duct integrity and limit vibration and noise in accordance with recognized standards of the industry.

D. Ducts over 17 inches in largest dimension shall be cross-broken or beaded on all four sides. In ducts over 72 inches at each transverse joint, 3/8-inch stay rods shall be installed. Spacing between rods or rods on side of duct shall not exceed 48 inches.

2.04 DUCT SLEEVES

A. Sleeve flanges shall not be less than 4 inches wide and shall be installed tight against each side of the barrier. Sleeves shall be 2 inches larger than the duct or external duct insulation. The space between the duct (or insulation) and the sleeve shall be packed with fiberglass or material of original wall. Duct flanges not less than 4 inches wide shall be installed tight against the wall on each side and fastened to the duct sleeves.

2.05 HANGERS AND SUPPORTS

A. General:
   1. Duct support spacing shall be in accordance with the SMACNA standards for the pressure class and conditions specified and prevailing in the system. Supports shall be spaced to prevent visible duct deflection and loss of system integrity. Aluminum ductwork shall be constructed with strength and dimensional stability comparable to conventional steel duct. In the absence of other criteria, aluminum sheet and reinforcing shall have a moment of inertia three times greater than that recommended for steel ductwork. Supports shall be designed in accordance with the International Building Code (IBC).

B. Concealed Ceiling Spaces:
   1. Rectangular ductwork shall be supported with metal strap hanger screwed to the sides and bottom of duct; one strap each side with minimum of two screws in side and one in bottom of each strap.

C. Exposed Areas:
   1. Rectangular ductwork shall be supported with shelf angle trapeze hanger or unistrut with rods or angles by welding or bolting. Sway bracing shall be provided, minimum of one at right angle to each duct run.

2.06 ACCESS DOORS

A. The doors shall be rigid and shall be provided with airtight gaskets and shall not vibrate or cause noise under service. Doors in insulated ducts shall be the insulated type. Doors shall be continuous-hinged type with ventlock latch on outside.

2.07 FLEXIBLE CONNECTIONS

A. Flexible connection joints shall be airtight and have a minimum allowance of 1-inch slack all around. Flexible connections shall be designed to be removed from the line and be reinstalled without disassembling adjacent ductwork.

B. Connections shall be installed with a minimum 4-inch clearance between metal parts on fan connections, equipment connections, and distribution devices.

2.08 TURNING VANES

A. Turning vanes shall be 2-inch blades for ducts up to 18 inches in either dimension and shall be 4-1/2-inch blades for larger ducts. All turning-vane assemblies shall be finished with an air-dried phenolic corrosion-resistant coating prior to installation. All turning vanes shall be constructed of double-thickness vanes.

2.09 DAMPERS

A. General:
   1. All dampers shall be made of material similar to the ductwork in which the damper is located. Aluminum construction is acceptable for installation in galvanized steel ductwork.

B. Balancing Dampers:

1. Manually-operated, opposed-blade or single-blade, quadrant-type balancing dampers. All balancing dampers shall be made of material (similar to the ductwork) two gauges thicker than the duct in which the damper is located. Each damper shall have an operator with indicator handle and a locking mechanism. Damper operator shall be Young Regulator, Ventfabrics Inc., or approved equal.

C. Control Dampers:

1. Control dampers shall be low-leakage design constructed of galvanized steel, extruded aluminum or stainless steel as required, and configured for installation as shown on the Drawings. Blades shall be parallel-opening and shall be provided with felt, vinyl, polyurethane or neoprene edge seals mechanically locked into blade edge. Minimum 4-inch channel type frames with flanges to facilitate mounting. Bearings shall be corrosion-resistant synthetic and linkage shall be concealed-in-frame. Where specified, corrosion-resistant, factory-applied coatings shall be Heresite, applied in strict conformance with the paint manufacturer's instructions. Dampers shall be configured for internal actuator mounting. Manufacturers shall be Ruskin, Greenheck, or approved equal.
    a. Damper Actuators: Actuators shall be internal-mount type. Manufacturer shall be Ruskin, Honeywell, or approved equal.
    b. See Control Damper Schedule on the Drawings for specific requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Ductwork shall be installed in accordance with SMACNA and National Fire Protection Association (NFPA). All ductwork indicated on the Drawings is schematic. Therefore, changes in duct size, duct configuration, and location may be necessary to conform to field conditions.

B. Ductwork and accessories shall be installed to provide a system free from buckling, warping, breathing, and vibration. Ductwork installation shall permit installation of other required services without piercing, crimping, or reducing duct sizes. Where space conditions permit, full-radius turns shall be used at offsets. The inside of all ducts visible through grilles and registers shall be painted flat black.

C. All ductwork shall be made airtight. Flanged joints shall be sealed with closed-cell neoprene gaskets compressed between mating flanges. All other joints and seams shall be sealed with liquid- or mastic-type sealants. Taped joints shall not be permitted. All joints shall comply with the requirements of SMACNA Seal Class A.

3.02 TESTS

A. Tests shall be as specified in Section 23 05 93. Duct test holes with patches in ducts shall be provided where directed or necessary for testing and balancing purposes.

3.03 DUCTWORK SCHEDULE

A. Ductwork material and pressure classification with respect to equipment number shall be as follows:

Equipment No.	Duct Material	Pressure Classification
AHU-1	Galvanized Steel	2 inches w.c.

END OF SECTION

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SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This Section specifies wall-mounted fans complete with fans, motors, dampers and accessories required for ventilation systems.

B. Type: Fans shall be propeller wall-mounted exhaust fans.

C. Operating Requirements: Fan capacities, electrical characteristics, special features, and accessories shall be as specified in the Equipment Schedules shown on the Drawings.

D Sound and Vibration: Fans specified in this section shall operate at noise levels below 20 sones, as defined by Air Moving and Conditioning Association (AMCA) Standard 300, and at tip speeds below 6,000 fpm.

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AMCA Standard 210	Laboratory Methods of Testing Fans for Rating
AMCA Standard 300	Test Code for Sound Rating

B. Standards: Fans shall bear the AMCA rating seal.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:

1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
2. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams and Mechanical Layout Drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Manufacturer's catalog and/or other data confirming conformance to specified design, material, accessories, and equipment requirements.
4. Fan-performance curves for the specified operating conditions.
5. Motor data form as required in Section 43 05 21.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer’s product, nor shall it be construed that a named manufacturer’s standard product will comply with the requirements of this section.

B. Candidate manufactures include Greenheck, Loren Cook, Penn, or equal.

2.02 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

Component	Material

Component	Material
Propeller	Aluminum
Venturi	Steel
Wall Panel	Steel
Fan Propeller Shaft	Steel
Fasteners	Stainless steel
Pillow Blocks	Cast iron
Sheaves	Cast iron

2.03 EQUIPMENT

A. Fan:

1. The fan shall be V-belt or direct-driven as specified on the Drawings. The fan shaft on belt-driven fans shall be mounted in heavy-duty, ball-bearing, pillow blocks with grease fittings. Bearings shall be rated for a minimum Anti-Friction Bearing Manufactures Association (AFBMA) L-10 bearing life of 50,000 hours.
2. Belt-driven fans shall be furnished with adjustable pitch sheaves and adjustable motor bases suitable for a ± 5% adjustment in operating speed. The V-belt drive shall be as specified in Section 43 05 11-2.03.

B. Motor: Unless otherwise specified, motors shall operate at 1,750 rpm and shall be Type 2 as specified in Section 43 05 21. Motors 1-hp and larger shall be the high-efficiency type. Motors 1/12-hp and smaller shall be the fan manufacturer's standard motor.

C. Fan Panel: Each fan panel shall have a spun venturi to direct air smoothly to the propeller blades. The fan, drive motor and fan guard shall be securely attached to the fan panel by means of a four-legged angle or tubular frame and mounting pads. The fan panel, frame, and mounting pads shall receive the manufacturer's standard enamel coating unless otherwise specified.

D. Accessories:

1. The fan shall be provided with a steel-mounting collar, and a spring-loaded aluminum backdraft damper where specified. Mounting collars shall be protected with a baked-epoxy finish. Fans shall be provided with inlet guards constructed of steel wire with lacquer finish. Inlet guards shall conform to Occupational Safety and Health Administration (OSHA) standards and shall be removable to provide motor access.
2. Each fan shall be provided with wall louvers that comply with Section 23 37 00-2.03.

2.04 SPARE PARTS

One set of V-belts shall be provided for each belt-driven fan.

2.04 CONTROL

A. Provide low-voltage or line-voltage thermostats for each fan where shown on the Drawings. Thermostat shall be wall-mounted and have a minimum 40 to 90°F temperature range.

B. The fan is controlled by the thermostat to activate when room temperature rises above 85°F (adjustable) and deactivate when room temperature drops below 75°F (adjustable).

2.05 SPARE PARTS

A. The following spare parts shall be provided:
   1. One set of V-belts for each belt-driven fan.

2.06 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Motor data as specified in Section 43 05 21.
   2. Bearing ratings for the fan and motor at operating conditions.
   3. Certification that the units have been tested and rated in accordance with the applicable AMCA Standard Test Code and Certified Ratings Program.
   4. Applicable operation and maintenance data.

PART 3 EXECUTION

3.01 INSTALLATION

Each fan shall be installed as specified and in accordance with the manufacturer's recommendations.

3.02 FIELD TESTING

Each fan shall be completely field-tested in accordance with Section 23 05 93 to guarantee compliance with the Project Manual.

END OF SECTION

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This section includes Specifications for supply grilles and wall louvers.

B. Type: All air outlets and inlets shall be of the size, model, and capacity specified in the Equipment Schedules shown on the Drawings.

1.02 QUALITY ASSURANCE

A. References:
   1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AA 45	Designation System for Aluminum Finishes
AMCA Standard 500	Test Methods for Louvers, Dampers, and Shutters
ASTM B221	Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM C1071	Standard Specification for Thermal and Acoustical Insulation (Mineral Fiber, Duct Lining Material)

B. Louvers shall bear the Air Moving and Conditioning Association (AMCA) certified ratings seal for both air performance and water penetration.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to

indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer’s product, nor shall it be construed that a named manufacturer’s standard product will comply with the requirements of this section.

B. Candidate manufactures for supply grilles include Titus, Carnes, Krueger, Agitair, or equal.

C. Candidate manufactures for louvers and louvers include Greenheck, Loren, Cook, or equal.

2.02 SUPPLY GRILLES

A. General:

1. The horizontal face bars shall be adjustable. The frame shall have a 1-1/4-inch border. Construction shall be of the same material as the ductwork in which they are installed, unless specified otherwise.

B. Accessories:

1. The diffusers, grilles, and registers shall be equipped with an opposed-blade volume damper, unless noted otherwise on Drawings.

2.03 LOUVERS

A. Blades:

1. Blades shall be of the fixed, drainable type with interlocking blade braces to provide an uninterrupted horizontal line. Blades for all louvers shall be minimum 0.081-inch thick. Blade material shall be American Society for Testing and Materials (ASTM) B221, 6063-T52 extruded aluminum alloy. Slidable interlocked mullions shall have provisions for expansion and contraction.

B. Frame: The frame shall be minimum 0.081-inch thick by 4-inches deep. Frame material shall be ASTM B221, 6063-T52 extruded aluminum alloy. The louver frame shall be assembled by welding. The head, sill, and jamb shall be one-piece structural members and shall have an integral calking slot and retaining bead. Fasteners shall be stainless steel or aluminum.

C. Screen: The louver shall be furnished with a removable insect screen constructed of 18-16 mesh, 0.11 inch wire and secured within an aluminum frame. The screen shall be mounted on the interior louver face but independent of the louver.

D. Finish: Unless otherwise specified, all louvers shall receive a 215-R1, Aluminum Association Code AA-C22A41, anodized finish after assembly. Minimum coating thickness shall be 0.7-mil. Color shall be chosen by the Owner during the submittal process.

PART 3 EXECUTION

3.01 INSTALLATION

A. Diffusers, grilles, registers and extractors shall be aligned, connected and installed in accordance with the manufacturer's recommendations and with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Standards. Each unit shall be set flat against the room surface finish and shall have a felt gasket or seal. Paint visible ductwork behind register and grille flat black. Touch-up marks and abrasions to match original finish.

3.02 TESTING AND BALANCING

A. Testing, adjusting and balancing shall be as specified in Section 23 05 93 to guarantee compliance with the Project Manual.

END OF SECTION

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SECTION 23 81 43

AIR SOURCE UNITARY HEAT PUMP UNITS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This Section specifies split-system heat pump for indoor space conditioning applications.

B. Design and Performance Requirements: Split-system heat-pump capacities, electrical characteristics, special features, and accessories shall be as specified in the Equipment Schedules shown on the Drawings.

1.02 QUALITY ASSURANCE

A. References:
   1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEC	National Electrical Code
ANSI/ASHRAE	15-2010: Safety Standards for Refrigeration Systems
ARI 210/240	Unitary Air-Conditioning and Air-Source Heat Pump Equipment
ARI 270	Sound Rating of Outdoor Unitary Equipment
ARI 340/360	Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment
ARI 410	Standard for Forced Circulation Air-Heating and Air-Cooling Coils
NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
NFPA 90B	Standard for Installation of Warm Air Heating and Air Conditioning Systems
UL 1995	Heating and Cooling Equipment

B. Approval and Conformance: Unit heaters shall bear the Underwriters Laboratories (UL) label and conform to National Electric Code (NEC) requirements.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
   2. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams and Mechanical Layout Drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
   4. Installation requirements, showing clearance required for maintenance and safety purposes.
   5. Electrical and control diagrams.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer’s product, nor shall it be construed that a named manufacturer’s standard product will comply with the requirements of this section.

B. Candidate manufactures include Carrier, Trane, or equal.

2.03 OUTDOOR HEAT PUMP UNIT

A. General:
   1. Heat pump shall be outdoor package, factory assembled, air-to-air. Unit shall consist of scroll compressor, air-cooled coil, condenser fan, all factory wiring, piping, controls, and

refrigerant charge shall be R-410A. Unit shall be configured for outdoor pad-mount installation as shown on the Drawings.

2. All unit power wiring shall enter unit cabinet at a single location. Unit shall include a complete self-contained, low-voltage, control circuit complete with starters, step-down transformers, and other accessories required for a complete functioning system.
3. Unit shall be equipped with a factory-installed and internally-mounted 115-volt, ground-fault circuit-interrupter (GFCI) type convenience outlet. Outlet shall be powered from the main power supply to the outdoor heat pump unit. Provide step-down transformer as required to power outlet.

B. Cabinet: Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a pre-painted baked enamel finish. Frame shall be included with a heavy-gauge, roll-formed perimeter base rail with forklift slots.

C. Condenser Fan: Condenser fan shall be direct-drive propeller-type with forward-swept fan blades and upward discharge, corrosion-resistant shaft, and motor suitable for multi-speed operation. Fan shall be statically and dynamically balanced. Fan motor shall be totally enclosed with permanently-lubricated ball bearings, and shall be provided with internal thermal overload protection.

E. Compressor: Compressor shall be hermetically-sealed scroll-type, mounted on rubber vibration isolators, and covered with sound absorbing blanket. Motor shall be National Electrical Manufacturers Association (NEMA) rated and provided with internal overload to protect against over-current and over-temperature. Compressor shall be equipped with a crankcase heater.

F. Outdoor Coils: Outdoor coil shall consist of seamless copper tubes with mechanically-bonded aluminum fins. Coils shall be provided with a flexible epoxy polymer coating applied to entire coil surface without material bridging between fins.

2.04 INDOOR AIR-HANDLING UNIT

A. General:
1. Unit shall be an electronic-communicating constant-volume fan coil for operation using R-410A refrigerant, matching the outdoor split-system heat pump unit. Unit shall consist of an outside air economizer, filter housing, condensate drain, single-point power connection, all factory wiring, piping, and controls. Unit shall be configured for horizontal installation as shown on the Drawings.
2. Refrigerant piping between outdoor heat pump unit and air-handling unit shall be as recommended by the equipment manufacturer.

B. Cabinet:
1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a pre-painted baked enamel finish. Cabinet shall be fully insulated with a minimum of 1/2-inch fire-retardant material. Cabinet shall include corrosion-resistant drain pans with bi-directional sloping capabilities. Include condensate drain trap. Frame shall be included with a heavy-gauge roll-formed perimeter base rail with forklift slots.
2. Unit shall be equipped with a filter frame upstream of the cooling coil to take 2-inch cleanable or disposable type commercially available MERV 8 filters. Disposable filters to

be supplied with the unit. Filter access shall be from either the right- or left-hand side of the unit.

C. Fan: Unit shall be equipped with a direct-drive, multi-speed, forward-curved fan. Fan shall have permanently-lubricated bearings and adjustable belt drives.

D. Indoor Coils: Coil shall consist of 3- or 4-row seamless copper tubes with mechanically-bonded aluminum fins. Coil shall include factory-installed thermal expansion valve capable of external adjustment and bypass line with check valve assembly to allow liquid flow from the coil to the outdoor unit during heating mode.

E. Economizer: Unit shall be equipped with an outside air economizer for providing outside air as specified on the Drawings. Economizer shall be fully modulating and capable of partial cooling. Outside-air, dry-bulb thermostat shall be provided for control of the economizer. Economizer damper motors shall be 120-VAC, spring return and shall be powered by the air-handling unit, unless noted otherwise.

2.05 CONTROLS

A. Provide thermostats for split-system heat pump unit system where shown on the Drawings. Thermostat shall be wall-mounted and have a minimum 40 to 90°F temperature range. Thermostats shall be digital programmable with seven different day types and capable of night setback. Thermostats shall have fan "AUTO-ON" switch and system "OFF-HEAT-AUTO-COOL" and manual temperature settings. Thermostats shall be capable of a 5-degree minimum deadband.

B. The system is controlled by a programmable thermostat supplied with the unit. The system operates through its "ON/OFF/AUTO" selector switch in ON or AUTOMATIC operation.

C. ON: With its "HAND/OFF/AUTO" selector switch in the "HAND" position, the fan operates continuously and bypasses all safety and operating controls.

D. OFF: With its "HAND/OFF/AUTO" selector switch in the "OFF" position, the mini-split heat pump unit and all of its components are inoperative.

E. AUTOMATIC: With its "HAND/OFF/AUTO" selector switch in the "AUTO" position, the system shall operate through the on-board controller as described in this Section. The on-board controller controls the heat pump unit to maintain a set room temperature of 80°F for cooling (adjustable) and 60°F for heating (adjustable):

1. Normal Operation: Normal operating condition is supply fan operating, outside air damper at minimum setting, relief air damper fully closed, return air damper fully open, and both cooling and heating deactivated.
2. Cooling Mode (Outside Air Temperature Greater than 70°F): When room temperature rises above setpoint, cooling is activated. When set room temperature is reached, cooling is deactivated and system reverts back to normal operation.
3. Economizer Mode (Outside Air Temperature is 50 to 70°F): When room temperature rises above setpoint, relief damper fully opens, outside air damper modulates open, and return air damper modulates closed to utilize outdoor air for cooling. If outside air damper is fully open and room temperature continues to rise, outside air damper

returns to minimum setting, return air damper fully opens, relief damper fully closes, and system reverts to cooling mode.

4. Heating Mode: When room temperature drops below setpoint, heating is activated. When set room temperature is reached, heating is deactivated and system reverts back to normal operation.

2.05 PRODUCT DATA

A. The following product data shall be provided in accordance with Section 01 33 00:
   1. Applicable operating and maintenance information specified in Section 01 78 23.
   2. Control wiring diagram.
   3. Manufacturer's catalog data confirming conformance to specified design, material and equipment requirements.

PART 3 EXECUTION

Outdoor split-system heat pumps and indoor air-handling units shall be installed where specified and in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 23 82 39

UNIT HEATERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This Section specifies electric unit heaters for indoor space heating applications.

B. Type: Unit heaters shall be fan-forced, horizontal-discharge type designed for continuous operation.

C. Design and Performance Requirements: Unit heater capacities, electrical characteristics, special features, and accessories shall be as specified in the Equipment Schedules shown on the Drawings.

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEC	National Electrical Code
NFPA	National Electrical Code (NEC)
UL 823	Electric Heaters for Use in Hazardous (Classified) Locations
UL 1025	Electric Air Heaters

B. Approval and Conformance: Unit heaters shall bear the Underwriters Laboratories (UL) label and conform to National Electrical Code (NEC) requirements.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
   2. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams and Mechanical Layout Drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
   4. Installation requirements, showing clearance required for maintenance and safety purposes.
   5. Electrical and control diagrams.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. The Owner and Design Engineer believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer’s product, nor shall it be construed that a named manufacturer’s standard product will comply with the requirements of this section.

B. Candidate manufactures include Trane, Brasch, Reznor, Markel, or equal.

2.02 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

Component	Material
Fan	Aluminum
Cabinet	Steel
Heating Element	Steel or copper-clad steel
Hardware	Stainless steel

2.03 EQUIPMENT

A. Cabinet: Unit heater cabinet shall be welded and galvanized steel with baked-enamel finish. Adjustable discharge louvers shall be mounted horizontally across the cabinet discharge opening. The cabinet construction shall incorporate a means for mounting the unit heater by either suspension rods or mounting brackets.

B. Motor: The fan motor shall be permanently lubricated and thermally protected. Motor voltage and phase shall be as specified in paragraph 1.01D. Motor enclosures shall be as specified in Division 26.

C. Heating Coil: The heating coil shall be composed of tubular finned heating elements in a shock-proof mounting and enclosed within the unit heater cabinet. The heating coil shall be overheating-protected.

D. Accessories:
   1. Each electric unit heater shall be provided with the following accessory:
      a. Wall-mounting bracket.

2.04 CONTROLS

A. The controls shall be line voltage up to 480 volts. Integral contactors and transformer shall be provided on each unit heater using control voltage rather than line voltage.

B. Unless otherwise specified, an integral thermostat shall be provided for each unit heater. The thermostat shall be set at 60°F.

2.05 PRODUCT DATA

A. The following product data shall be provided in accordance with Section 01 33 00:
   1. Applicable operating and maintenance information specified in Section 01 78 23.
   2. Control wiring diagram.
   3. Manufacturer's catalog data confirming conformance to specified design, material and equipment requirements.

PART 3 EXECUTION

Unit heaters shall be installed where specified and in accordance with the manufacturer's recommended clearances from combustibles.

END OF SECTION

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This Section specifies general requirements for electrical work. Detailed requirements for specific electrical items are specified in other Sections but are subject to the general requirements of this Section. The Electrical Drawings and Schedules included in this Project Manual are functional in nature and do not specify exact locations of equipment or equipment terminations.
2. Work Sequence: Section 01 12 16.
3. Replace the existing Mingus Pump Station (PS):
    a. Provide replacement pump station and electrical room with equipment:
        1) Provide utility power.
        2) Provide temporary generator power for standby backup during demolition of the existing pump station and construction of the replacement pump station standby generator. Provide outdoor roll-up generator termination cabinet for this purpose. Refer also to Section 01 12 16.
    b. Demolish the existing pump station:
        1) Remove utility power.
    c. Provide replacement pump station standby generator in location of demolished existing pump station.
4. Replace the existing North Tank remote telemetry unit (RTU) power utility line:
    a. Provide replacement underground power utility:
        1) Disconnect overhead utility power.
        2) Provide temporary generator power for standby backup during switchover. Refer also to Section 01 12 16.
        3) Connect underground replacement utility power.
5. Replace the existing Mingus Tanks with one tank:
    a. Demolish the Tanks:
        1) Disconnect utility power.
        2) Remove and salvage the existing Mingus Tanks' RTU and antenna for the Mingus PS. No level control signals are now available for the existing Mingus PS operation until tank replacement is complete.
        3) Remove and salvage the existing Mingus Tanks' level transmitter and level switches.
    b. Provide replacement tank and electrical equipment:
        1) Restore utility power.
        2) Provide level instruments.
        3) Provide Mingus Tank RTU and antenna for Mingus PS operation.
        4) Make replacement Mingus Tank RTU communicate with replacement Mingus PS RTU.

6. Removed equipment as part of demolition shall be turned over to the Owner.
7. Refer to Section 40 61 13 for further details.

B. Definitions:
   1. Elementary or schematic diagram:
      a. A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
   2. One-line diagram:
      a. A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.
   3. Arrangement, layout, or outline drawings:
      a. An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.02 QUALITY ASSURANCE

A. References:
   1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NFPA	National Fire Protection Association
NFPA-70	National Electric Code (NEC)
NFPA-70E	National Electrical Safety Code (NESC)
ACI 318	Building Code Requirements for Structural Concrete

B. Identification of Listed Products:

1. Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). An independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.
2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original Contract Price.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
2. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications.
3. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Catalog cuts of equipment, devices, and materials requested by the individual Specification sections. Catalog information shall include Technical Specifications and application information including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.
5. Safety disconnect switch list, including legend with equipment tag, equipment description, and power feeder circuit source and location information.

C. Action Submittals – Conduit Layout:

1. Conduit layout drawings indicating size, location, and support, for all conduits other than single runs of 1-inch diameter or less cast-in-concrete construction.
    a. Conduit layout drawings shall illustrate a system which conforms to the requirements of paragraph 3.01.
    b. For layouts that do not conform to paragraph 3.01, provide engineering design and calculations signed and sealed by a Professional Engineer registered in the State of Arizona. Engineering design and calculations shall demonstrate that the proposed layout does not impair or significantly reduce the design structural strength.

D. Informational Submittals:
   1. Record Documents specified in paragraph 3.03.

E. Closeout Submittals – Operations and Maintenance:
   1. Applicable operation and maintenance (O&M) information on an item-by-item basis in accordance with Section 01 78 23. O&M information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of Project completion as required by Section 01 78 23, whichever is the earlier. Full-size drawings shall be reduced to 11 x 17 inches.

1.04 DRAWINGS

A. Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 11-inch by 17-inch drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

B. Drawing quality and size of presentation shall be such as to permit 50% reduction of such drawings for insertion in O&M manuals.

1.05 PROJECT/SITE CONDITIONS

A. General: Unless otherwise specified, equipment and materials shall be sized and derated for the ambient conditions specified in Section 01 11 80, but not less than an ambient temperature of 40°C at an elevation ranging from 5,480 to 5,860 feet without exceeding the manufacturer's stated tolerances.

B. Corrosive Areas:
   1. The following areas are designated as corrosive:
      a. None.

C. Hazardous (Classified) Areas:
   1. The following areas are designated as hazardous (classified) in accordance with the NEC:
      a. None.

D. Seismic:
   1. Electrical equipment, supports, and anchorage shall be designed and installed in accordance with the seismic design requirements specified on Structural Drawings.

1.06 STORAGE OF MATERIALS AND EQUIPMENT

A. Materials and equipment shall be stored as specified in Section 01 66 00-2.05. Equipment and materials to be located indoors shall be stored indoors and sealed with plastic film wrap.

1.07 ELECTRICAL NUMBERING SYSTEMS

A. Raceway Numbers:
   1. Raceways shall be tagged at all terminations. Contractor shall assign raceway numbers in accordance with the following system where raceway numbers have not been assigned:

Raceway Prefix	Type of Function
C	Control or Power – 120 volts or less
H	Power above 600 volts
N	Pneumatic Tubing
P	Power 208 Volts to 600 Volts
S	Signal - Data Communication or Instrumentation
X	Spare

   2. Prefixes shall be followed by a 4-digit number. Add a letter suffix to distinguish the raceways where more than one raceway is routed to a particular piece of equipment. Example: Raceway number = P3109A where:
      a. P = conduit contains power
      b. 3109 = unique 4-digit number
      c. A = letter to distinguish raceways to same equipment

B. Conductor Numbers:
   1. Conductors shall be identified with numbers at both ends. Conductor tag numbers shall consist of the equipment number followed by a dash followed by the conductor number specified on the control diagram. Example:
      a. Equipment Tag number = 1900 – L1 where:

         1900 = cable number

         L1 = conductor number
   2. Conductors in parallel or in series between equipment shall have the same conductor number. Neutral conductors shall have the same conductor number. Wherever possible, the conductor number shall be the same as the equipment terminal to which it connects.
   3. Where factory-wired equipment has terminal numbers different than the conductor numbers shown on the control diagrams:
      a. Both shall be shown on the interconnection diagram.
      b. Include a copy of the interconnection diagram inside the equipment cabinet.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. General:
   1. Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

B. Equipment Finish:
   1. Unless otherwise specified, electrical equipment shall be painted by the manufacturer.

2.02 WIRE MARKERS

A. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 American Wire Gauge (AWG) or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking-tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

B. Conductors shall be identified in accordance with paragraph 1.07. Adhesive strips are not acceptable.

C. The letters and numbers that identify each wire shall be machine-printed on sleeves with permanent black ink with figures 1/8-inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

D. Conductor and Wire Marker Manufacturer:
   1. TMS Thermofit Marker System by Raychem Co.
   2. Sleeve-style wire marking system by W. H. Brady Co.
   3. Or equal.

2.03 NOT USED

2.04 NAMEPLATES

A. Nameplates shall be made from laminated phenolic plastic.
   1. Nominal size: 3/4-inch high by 2-inches long.
   2. Black backgrounds with 3/16-inch white letters.
   3. Fastened using self-tapping stainless steel screws.

B. Abbreviations shall be submitted to the Construction Manager prior to manufacture because of space limitations. Nameplate adhesives will not be permitted on the outside of enclosures.

2.05 TERMINAL BLOCKS

A. Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips that permanently identify with the connecting wire numbers as shown on the Drawings:
   1. Terminal blocks for P-circuits (power 208-600 volts):
      a. Rated not less than the conductor current rating.
      b. Rated less than 600-volt AC.
   2. Terminal blocks for C-circuits and S-circuits:
      a. Rated not less than 20 amperes.
      b. Rated less than 600-volt AC.

3. Terminals shall be tin-plated.
4. Insulating material shall be nylon.

2.06 DISCONNECT SWITCHES

A. Safety Disconnect Switches:
   1. Heavy-duty fused and non-fused disconnect switches with current range of 30 to 600 amperes shall be provided as shown on the Drawings, with the enclosure type National Electrical Manufacturers Association (NEMA) Type 4 indoors and outdoors.
   2. Provide lock-off provision for a hasp padlock.
   3. Provide visible knife blades through a cover viewing window.
   4. Provide shielded or insulated line terminals with quick-make/quick-break switch operator.
   5. Provide internal barrier kit for additional personnel barrier from accidental contacts with live parts.
   6. Provide a nameplate with equipment tag, equipment description, and power feeder circuit source and location identification.
   7. Provide fusible disconnect switches with ratings as indicated with built-in fuse pullers. Provide LPS, LPN, or LPJ 200KAIC current limiting fuses as appropriate for the circuit type and the circuit voltage.

PART 3 EXECUTION

3.01 GENERAL

A. Construction:
   1. The work under Division 26 shall be performed in accordance with these Specifications.
   2. Refer to the NECA National Electrical Installation Standards (NEIS) for Standard Practices for Good Workmanship in Electrical Contracting (NECA-1) as a minimum baseline of quality and workmanship for installing electrical products and systems that define what is meant by “neat and workmanlike” as required by NEC Section 110-12. Specified requirements supersede NECA practices.
   3. Electrical Layout Drawings are diagrammatic, unless otherwise detailed or dimensioned. The Contractor shall coordinate the location of electrical material or equipment with the work.
   4. Major electrical openings may compromise the structural integrity of the slab and wall elements. Major electrical openings are defined as openings or penetrations greater than two times the wall thickness in any dimension, and include duct bank transitions into a building through structural elements. Major electrical openings shall be constructed according to standard details on the Drawings, up to an opening dimension of 3 feet. For opening dimensions greater than 3 feet, construct walls and slabs as specifically detailed on the Drawings for that case. Major electrical openings proposed by the Contractor shall be submitted to the Structural Engineer of Record for the project for review.
   5. Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

B. Housekeeping:
   1. Electrical equipment shall be protected from dust, water and damage. Motor control centers, switchgear, and buses shall be wiped free of dust and dirt, kept dry, and shall be vacuumed on the inside within 30 days of acceptance of the work.
   2. Before final acceptance, the Contractor shall touch up any scratches on equipment as specified in Section 09 90 00-3.03.
   3. Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be protected as specified in Section 01 66 00-2.06.

C. Electrical Equipment Labeling:
   1. Electrical equipment shall have field-marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.
   2. Electrical equipment shall have NFPA 70E labels installed stating the results of the arc flash analysis specified in Section 26 05 74.
   3. Electrical distribution equipment and utilization equipment shall be field-labeled to identify the power source and the load as specified. Refer to NEC Article 110.22 for identification of disconnecting means installation criteria. Specific information is required such as the equipment tag number and equipment description of both the power source and the load equipment.

D. Motor Connections:
   1. Verify that the motors are purchased with the correct size motor termination boxes for the circuit content specified as shown on the power single-line diagrams or submit custom fabrication drawing indicating proposed motor termination box material, size, gasket, termination kit, grounding terminal, motor lead connection method, and motor terminal box connection/support system. Verify the motor termination box location prior to raceway rough-in.

E. Conductor Installation:
   1. An enclosure containing disconnecting means, overcurrent devices, or electrical equipment shall not be used as a wireway or raceway for conductors not terminating within the enclosure. Provide wireways, raceways, termination boxes, or junction boxes external to the enclosure for the other conductors.

3.02 TESTING

A. General:
   1. Prior to energizing the electrical circuits, insulation-resistance measurements tests shall be performed per Section 26 08 00.

3.03 RECORD DOCUMENTS

A. Contract Documents shall be maintained and annotated by the Contractor during construction, including the Record Drawings specified in General Conditions and Division 01.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to document shall mean the documents in effect at the time of Advertisement for bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NFPA 70	National Electric Code (NEC)
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each

deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Complete catalog cuts for all conductors, wire, and cable.

PART 2 PRODUCTS

2.01 GENERAL

A. Unscheduled Conductors and Cables:
   1. Where not specified on the Drawings, conductors and cables shall be sized in accordance with the NEC for the particular equipment served with the minimum size as specified herein. Unscheduled conductor with insulation shall be provided in accordance with the following:
      a. CABLESPEC "MEPR/CPE" multi-conductor power and control cable.
      b. CABLESPEC “XHHW” for single conductors.
      c. CABLESPEC “XHHW” for indoor lighting and receptacles.

B. Cable Specification Sheets (CABLESPEC):
   1. General requirements for conductors and cables specified in this section are listed on CABLESPEC sheets in paragraph 3.06.

2.02 COLOR CODING

A. Control Conductors:
   1. Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Foreign Voltage (AC)	Yellow
Power, Control (DC)	Blue
Analog Signal (+)	Black
Analog Signal (-)	White

B. Power Conductors:
   1. Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

C. Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

D. Signal Conductors:
   1. Signal-cable conductors shall be color-coded black and white for pairs; or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600-VOLT

A. Single Conductor:
   1. Provide stranded conductors for all cable or wires. Provide minimum conductor size of 12 American Wire Gauge (AWG) for power and lighting circuits.

B. Multiconductor Cable:
   1. Provide multiconductor power cable and multiconductor control cable where identified on the Drawings. Provide stranded conductors for all cable or wires.

2.04 SIGNAL CABLES

A. General:
   1. Factory cable between manufactured instrument system components shall be provided in compliance with the instrument manufacturer's recommendations.
   2. Signal cable shall be provided for instrument signal transmission. Single instrument cable (SIC) and multiple-circuit instrument cable (MIC) shall be provided in accordance with the following examples:
      a. CABLESPEC “SIC.”
         1) Cable designation:
            a) 1PR#18S shielded twisted pair (STP).
         2) Cable designation:
            b) 1TR#18S triad (STT).

2.05 PORTABLE CORD

A. Portable cord shall be provided in accordance with CABLESPEC "CORD," unless otherwise specified. Cords shall contain an equipment grounding conductor.

2.06 SPLICING AND TERMINATING MATERIALS

A. Connectors shall be tool-applied compression-type of correct size and Underwriter Laboratories (UL) listed for the specific application. Connectors shall be tin-plated high-conductivity copper. Wire nuts for a splice is prohibited.

B. Signal and control conductors shall be connected to terminal blocks and field devices and instruments shall be terminated with conductor terminals as specified in Section 26 05 00-2.02.

C. Connectors for wire sizes No. 8 AWG and larger shall be compression-tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical-clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Construction Manager.

D. Power-conductor splices shall be compression-type, made with a compression-tool die approved for the purpose, as made by Thomas and Betts Corp., or equal. Splices shall be covered with electrical products designed for the application, insulated, and covered with a heat-shrinkable sleeve or boot, as specified elsewhere.

E. Motor-connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high-dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

F. Motor-connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances. Refer to the electric motor Section 43 05 21.

2.07 CORD GRIPS

A. Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and be sized to accommodate the flexible cord.

PART 3 EXECUTION

3.01 GENERAL

A. Conductors shall be identified at each connection terminal and at splice points. The identification marking system shall comply with Section 26 05 00.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacture recommended and UL-listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

C. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

D. Scratch-brush the bus-bar contact areas and tin-plate the connection where flat bus-bar connections are made with un-plated bar. Bolts shall be torqued to the bus manufacturer's recommendations.

3.02 600-VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

B. Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

C. Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure. Provide dedicated electrical wireways and insulated cable holders mounted on unistrut in manholes and handholes.

D. Raceway fill limitations shall be as defined by NEC and the following:
   1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.
   2. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems. Install in separate raceways.
   3. Slices and terminations are subject to inspection by the Construction Manager prior to and after insulating.
   4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.
   5. In-line splices and tees, where approved by the Construction Manager, shall be made with tubular compression connectors and insulated as specified for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or Raychem splicing kits.
   6. Terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors within the termination box.
   7. Terminations at valve and gate motor actuators shall be made directly into the actuator where possible. Power termination shall be made in the actuator power disconnect. Control and signal cable may be routed to a termination box near the actuator on 20-ampere rated terminal strips with label identification for the control and signal conductors. Single-wire control conductors and analog cable (SIC) then installed in flexible conduit to the actuator control and signal termination compartments.

3.03 SIGNAL CABLE

A. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Circuits shall not be made using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required.

C. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies utilizing coaxial cables. Common ground-return conductors for two or more circuits are not acceptable.

D. Shields shall be bonded to the signal ground bus at the control panel only and isolated from ground at the field instrument or analyzer and at other locations. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

E. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes.

F. Where instrument cable splicing is required, provide an instrument stand with terminal box rated for the area and environment and mounted approximately 3 feet above grade for instrument cable splices with the circuits and individual conductors provided with label as specified in Section 26 05 00.

3.04 PORTABLE CORD

A. Portable power cords feeding permanent equipment, such as pendant cords feeding motors for pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to relieve the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with dedicated boxes and terminals blocks.

3.05 TESTING

A. The Contractor shall test conductors, wire, and cable in accordance with Section 26 08 00.

3.06 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. General:
   1. Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable Specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC Sheets.

B. CABLESPEC Sheets:
   1. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
SIC	600	P-OS: 1-PR#18SH or 1-TR#18SH	Cable-Tray Rated Instrument Cable
XHHW	600	XLP Insulated Industrial Grade Conductor	Power, Control, Lighting, and Receptacles
MEPR/XLP	600	Multiconductor Rubber Insulated Cable with Jacket Examples: Control Cable: 19/C #14	Cable-Tray Rated Control
MXLPE/S/ PVC	1000	Multiconductor Shielded Motor Cable with PVC Jacket	Flexible 3/C Cable with NEC Ground Conductor. Motor Feeder Range: 16 AWG – 500 kcmil
CORD	600	Heavy-Duty Cable: SJOOW	Portable Items

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC) – SIC

A. Cable System Identification:
   1. SIC.

B. Description:
   1. Single-twisted, shielded pair or triad, 18 AWG, instrumentation and signal cable; UL-listed; cable-tray rated.

C. Voltage:
   1. 600 volts.

D. Conductor Material: Bare annealed copper; stranded per American Society for Testing and Materials (ASTM) B8.

E. Insulation:
   1. 15-mil, polyvinyl chloride (PVC) with 4-mil nylon, 90°C temperature rated; color code per Insulated Cable Engineers Association (ICEA) Method-1: Pairs-Black and White with one conductor in each pair printed alpha-numerically for identification.

F. Lay:
   1. Twisted on a 2-inch lay

G. Shield:
   1. 100-percent, 1.35-mil aluminum-Mylar tape with a 7-strand tinned copper drain wire.

H. Jacket:
   1. 45-mil PVC.

I. Flame Resistance:
   1. UL 1277.

J. Manufacturer(s):
   1. Okonite, Okoseal-N Type P-OS (Pair(s) Overall Shield) and Type TOS (Triad(s) Overall Shield); or Cooper Industries-Belden equal; or General Cable equal.

K. Execution:
   1. Use:
      a. Analog signal cable and resistance temperature detection (RTD) device Triad extension cable.

2. Installation:
    a. Install in accordance with paragraph 3.03.
3. Testing:
    a. Test in accordance with paragraph 3.05.

3.08 CABLE SPECIFICATION SHEETS (CABLESPEC) – XHHW

A. Cable System Identification:
    1. XHHW.

B. Description:
    1. Industrial-grade single conductor.
    2. Sizes: 14 AWG through 750 kcmil as shown.

C. Voltage:
    1. 600 volts

D. Conductor Material:
    1. Bare annealed copper; stranded per ASTM B8.

E. Insulation:
    1. NEC Type XHHW-2: 90°C dry and wet.
    2. Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44.
    3. Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue.

F. Jacket:
    1. None.

G. Flame Resistance:
    1. UL 83.

H. Manufacturer(s):
    1. Okonite, X-Olene; Cablec, Durasheath XLP; or equal.

I. Uses Permitted:
    1. Power, control, lighting and outlet circuits.

J. Execution:
    1. Installation:
        a. Install in accordance with paragraph 3.02.
    2. Testing:
        a. Test in accordance with Section 26 05 00-3.02 and Section 26 08 00.

3.09 CABLE SPECIFICATION SHEETS (CABLESPEC) – MEPR / XLP

A. Cable System Identification:
   1. MEPR/XLP.

B. Description:
   1. Multiconductor power cable and multiconductor control cable: 14 AWG stranded conductors; cable-tray rated.

C. Power Cable:
   1. Insulated green grounding conductor sized per the NEC.

D. Ground Conductor Size:
   1. Multiple sets of multiconductor power cable:
      a. Oversize the grounding conductor per NEC 250.

E. Control Cable Type:
   1. ICEA Method 1, E-2, without white neutral conductor or green ground conductor.

F. Control Cable Identification:
   1. Conductors color-coded per ICEA and conductors numbered.

G. Voltage:
   1. 600 volts.

H. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8, coated per ASTM B33.

I. Insulation:
   1. RHW/RHH, 90° C dry, 75°C wet, ethylene propylene rubber (EPR) per ICEA 2-68-516 and UL 44.

J. Jacket:
   1. Cross-Linked Polyethylene (XLP).

K. Flame Resistance:
   1. IEEE 383.

L. Manufacturer(s):
   1. Okonite, Okonite-Okolon-Okoseal series 202-11-3XXX; Cablec, Durasheath EP; or equal.

M. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.02.
   2. Testing:
      a. Test in accordance with Section 26 05 00-3.02 and Section 26 08 00.

3.10 CABLE SPECIFICATION SHEETS (CABLESPEC) – MXLPE / S / PVC

A. Cable System Identification:
   1. MXLPE/S/PVC.

B. Description:
   1. 1000-volt rated - flexible motor supply shielded cable.

C. Power Cable:
   1. Multi-conductor shielded motor feeder cable with PVC jacket:
      a. 3/C cable with conductor sizes from #16 AWG to #2 AWG with grounding conductor.

D. Ground Conductor Size:
   1. Sized per NEC 250.

E. Application:
   1. Feeder cable between variable-frequency drive (VFD) motor controller and motor.

F. Conductor Material:
   1. Flexible copper with high strand count.

G. Insulation:
   1. Thermoset crosslinked polyethylene (XLPE):
      a. 90° C dry, 75° C wet, per UL 44.

H. Jacket:
   1. PVC over assembly; jacket thickness per UL 1277 cable-tray rated UL 1277 Type TC.

I. Shield:
   1. Tinned copper braid and foil.

J. Flame Resistance:
   1. Institute of Electrical and Electronics Engineers (IEEE) 383 Fire Test (70,000-BTU).
   2. IEEE 1202: Limited-smoke rated and labeled on cable jacket.
   3. UL 1685: Vertical-tray flame exposure test.

K. Manufacturer(s):
   1. Anixter B2095XX series.
   2. Belden 295XX series.
   3. LAPPUSA OLFLEX VFD Symmetrical: 1 AWG – 500 kcmil LAPPUSA OLFLEX Servo 2YSLCY-JB flexible cable.

L. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.02. Install in conduit or cable tray. Not to be used for open wiring installation. Ground shields at both ends. Shield terminating gland may be used at the motor to ensure grounding the shield.
   2. Testing:
      a. Test in accordance with paragraph 3.05 and Section 26 08 00.

3.11 CABLE SPECIFICATION SHEETS (CABLESPEC) – CORD

A. Cable System Identification:
   1. CORD.

B. Description:
   1. Industrial Grade Flexible Portable Cord: Synthetic rubber insulation with oil-resistant thermoset jacket construction:
      a. Type SOOW for 600-volt circuits; Type SJOOW for 300-volt circuits.

C. Voltage:
   1. 600-volt RMS where shown or where unspecified: Type SOOW.

D. Conductor Material:
   1. Flexible rope stranded annealed copper per ASTM B189 and B33.

E. Insulation:
   1. Ethylene propylene (EPR) per ICEA S-68-516 and rated for continuous operation at 90° C.
   2. Green used for ground only.
   3. Color:
      a. 2/C Black and White; 3/C Black, White, and Green; 4/C Black, White, Red and Green; 5/C Black, White, Red, Green, and Orange.

F. Jacket:
   1. Heavy-duty neoprene per ICEA S-68-516. Color: Black

G. Manufacturer(s):
   1. Okonite: Okocord; American Insulated Wire Cord equal; or Engineer-accepted equal.

H. Execution:
   1. Installation:
      a. Install in accordance with paragraph 3.02.
   2. Testing:
      a. Test in accordance with paragraph 3.05.

END OF SECTION

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies the system for grounding electrical distribution and utilization equipment, including but not limited to cabinets, motor frames, manholes, instrumentation, metal surfaces of process/mechanical equipment that contain energized electrical components, metal structures and buildings, outdoor metal enclosures, fences and gates.

B. The equipment grounding conductor shall ground or bond equipment, structures, or equipment frames to the Grounding Electrode System as defined in the National Electric Code (NEC) Article 250 and addressed herein.

C. The minimum size of the equipment grounding conductors installed with the circuit conductors shall be per the NEC Table 250.122. The circuit grounding conductor size routed with a feeder or branch circuit conductors is as shown on the Drawings.

1.02 REFERENCES:

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE Std 81.2-1991	Guide to Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
NETA - ATS	InterNational Electrical Testing Association Inc. - Acceptance Testing Specifications
NFPA 70	National Electric Code (NEC) Article 250

1.03 SUBMITTALS:

A. The following information shall be submitted for review in accordance with Section 01 33 00:

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Marked product literature for ground rods, test wells, grounding bars, grounding bus bars, and equipment ground plate.

C. Informational Submittals.

1. Ground resistance readings specified in Part 3.

PART 2 PRODUCTS

2.01 GROUND CONDUCTORS

A. The system ground conductor shall be soft-drawn, bare annealed copper, concentric stranded, as specified. The minimum sizes shall be as follows, where American Wire Gauge (AWG) conductor sizes are not shown or specified:

1.	480V SES, switchboards	4/0
2.	480V ATS and VFD	4/0
3.	Lighting & Power panels	2 AWG
4.	Exposed metal cabinets	2 AWG
5.	Electrical equipment	2 AWG
6.	Buildings and enclosure	2 AWG
7.	Fences and gates	2 AWG
8.	Motors 25-hp to 250-hp	2 AWG
9.	Motors 1-hp to 25-hp	6 AWG
10.	Ground grid, ductbank	4/0

2.02 GROUND RODS

A. Ground rods shall be copper covered steel, 3/4-inch diameter and 10-feet long. Rods shall have threaded-type removable caps so that extension rods of same diameter and length may be added where necessary.

2.03 COMPRESSION CONNECTORS

A. Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or equal.

2.04 BOLTED CONNECTORS

A. Bolted connectors shall be Burndy, O. Z. Gedney, or equal.

2.05 WELDED CONNECTORS

A. Exothermic welding products shall be Erico's Cadweld Plus system with a remotely-operated, battery-powered, electronic-ignition device and moisture-resistant weld metal cup for the required mold, or equal.

2.06 TEST WELLS

A. Provide concrete test well with cover and connect the ground grid extension using a removable connector.

2.07 EQUIPMENT GROUND BARS

A. Copper equipment ground bars shall be Erico Eritech EGB Series or equal, sized as required for the installation.

2.08 GROUND ELECTRODE GROUNDING BARS

A. Ground electrode grounding bars shall be 1/4-inch thick copper electro-tin plating, Erico Eritech EGBA Series CC Pattern, Burndy Type BBB or equal. Minimum length shall be 12 inches.

B. Insulators (Stand Off) material shall be halogen-free, fiberglass-reinforced, thermal-set, unsaturated polyester-molded compound with indoor rating of 600 volts.

C. Brackets shall be 1/8-inch thick, Type 304 stainless steel.

D. Fasteners shall be 3/8-inch Type 304 stainless steel.

2.09 EQUIPMENT GROUND PLATE

A. Equipment ground plate shall be two-hole copper flush-mounted grounding plate, Erico Cadweld, Burndy YGF Series, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding system shall be provided in compliance with the National Fire Protection Association (NFPA) 70 NEC. Grounding conductor shall not be used as a system neutral.

B. Embedded and buried ground connections shall be made by compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2-AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Alternate method allowed: exothermic welding using a remote igniter device.

C. Tools and dies shall be approved for this purpose; dimple compressions are not acceptable. Compression connections shall be prepared in accordance with the manufacturer's instructions. Compression-type lugs shall be used in accordance with manufacturer's recommendations. Exposed ground connections to equipment shall be made by bolted clamps, unless otherwise specified. No solder material shall be used in any part of the ground circuits.

D. Embedded ground conductors and fittings shall be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement.

E. Notify the Construction Manager 2 hours prior to backfilling as each part of the grounding system installed below finished grade is complete and ready for inspection. Non-compliance shall affect the payment schedule for this work.

F. Grounding conductors extended beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Provide grounding fittings, pads, or plates as shown in the electrical details. Minimum grounding conductor extension shall be 3 feet.

G. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by rigid conduit bonded to the grounding conductors, or terminated in a flush grounding plate.

H. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals or less. Grounding conductors for shown and future equipment shall be terminated using an equipment grounding plate.

I. Ground conductors entering electrical enclosures shall be bonded to a single-ground bus or terminal strip in the enclosure and to metallic raceways within or terminating at the enclosure. Direct ground connections to enclosure chassis or back plate are not acceptable. Prior to making ground connections or bonds, the metal surface at the point of connection shall be cleaned.

J. Lightning arresters shall be directly connected to the ground grid system using lightning industry braided copper conductors, sized as specified.

K. Metallic sheaths or shields of shielded power cable shall be terminated by a copper ground bus provided with cable connection for connection to the grounding system.

L. Grounding system shall be separate from, and interconnected to, the Lightning Protection Grounding System.

M. Grounding system shall be separate from, and interconnected to the Radio Antenna/Transmission Grounding System.

3.02 RACEWAY GROUND

A. All service, feeder and branch circuit raceways shall contain a green insulated ground conductor sized per applicable NFPA 70 NEC tables:
   1. T250.66 – Grounding Electrode Conductor for Alternating - Current Systems or
   2. T250.122 – Minimum Size Equipment Grounding Conductors for Grounding Raceways and Equipment.

B. Metallic conduits terminating at concentric knock-outs or reducing washers shall be bonded using insulated grounding bushings. Grounding bushings shall be connected to the grounding system using conductors sized in compliance with NEC.

3.03 EQUIPMENT AND ENCLOSURE BONDING

A. Electrical distribution and utilization equipment enclosure ground bus, motor frames, manholes, metal structures and buildings, outdoor metal enclosures, fences and gates shall be bonded to the grounding system with conductor sizes as specified.

B. Connect the conductor to the metal enclosure using an Underwriters Laboratories (UL) listed connector, where the enclosure does not contain an internal ground bus

C. Non-electrical equipment with metallic enclosures that are located outdoors and without a cover or a shade shall be connected to the grounding system.

3.04 SERVICE AND SEPARATELY DERIVED SYSTEM BONDING

A. A neutral bonding jumper shall be installed in only one location for each service or separately derived system. The bonding jumper shall be located at the service source or the first immediate distribution point downstream from the source. The neutral and ground buses shall be kept isolated from each other, except where the bonding jumper is installed.

3.05 GROUNDING SYSTEM TESTS

A. The Contractor shall test the facility grounding system and the building grounding system to determine the ground resistance. The grounding test shall be Institute of Electrical and Electronics Engineers (IEEE) Standard 81 using the InterNational Testing Association (NETA) Fall-of-Potential procedure. A plot of ground-resistance readings for each isolated ground rod, ground mat, or ground bus shall be submitted on 8-1/2 x 11-inch size graph paper. Point-to-point resistance measurements are not acceptable.

B. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test or as recommended by IEEE Standard 81. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it,

in direct line between the ground rod or center of grid and the current reference electrode.

C. A grounding system that shows greater than 2-ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded.

D. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2-ohm requirement. Additional ground rods will be paid for as extra work where the required numbers exceed that specified when authorized and approved by the Construction Manager.

E. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, manholes, handholes, cable trays, fittings and supports. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
JIC EMP-1	Electrical Standards for Mass Production Equipment
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70	National Electric Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery
IBC	International Building Code
UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 360	Liquid Tight Flexible Electrical Conduit
UL 514	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers

Reference	Title
UL 651	Rigid Nonmetal Electrical Conduit
UL 870	Wireways, Auxiliary Gutters, and Associated Fittings

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Manufacturer's descriptive literature for materials.

PART 2 PRODUCTS

2.01 RACEWAYS AND FITTINGS

A. General requirements for raceway materials specified in this section are listed in the RACESPECS sheets at the end of this section. The type of raceways and raceway fittings to be used for any given area and application shall conform to the requirements in this section.

2.02 BOXES, GUTTERS, TERMINAL CABINETS, MANHOLES, AND HANDHOLES

A. Table A specifies the electrical enclosure material and rating for the location and application.

Table A

Location	Electrical Enclosure Material and NEMA Rating
Indoor: Electrical Room	NEMA 12: Mild Steel
Indoor: Process Areas	NEMA 4: Mild Steel
Outdoor: Non-Corrosive Areas	NEMA 4: Mild Steel

B. Pull Boxes and Wiring Gutters:

1. Indoor boxes and enclosures larger than FD boxes shall be constructed of sheet steel and galvanized after fabrication. Outdoor boxes and enclosures shall be provided with neoprene gaskets on the hinged doors or removable covers. Box and gutter sizes, metal thickness, and grounding shall comply with the NEC. Bolt-on junction box

covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle. Covers larger than 3-feet x 4-feet shall be split.

C. Terminal Cabinets:
   1. Terminal cabinets shall be provided with adjustable terminal strip mounting, back-panels for equipment mounting, print pockets in the doors, continuous door hinges, and three-point lockable latches. Terminal cabinets located indoors shall be National Electrical Manufacturers Association (NEMA) 12. Terminal cabinets located outdoors and in process areas shall be NEMA 4 with three-point latch, and filtered ventilation, if required. Terminal block shall conform to Section 26 05 00.

D. Manholes: Not used.

E. Handholes:
   1. Handholes shall be precast concrete with checker plate, galvanized, traffic covers designed for H 20 loading. Handholes shall be provided with precast solid concrete slab bottoms with sumps. Handholes shall be constructed of 3000-psi reinforced concrete. Handhole cover shall be engraved "ELECTRICAL" or "SIGNAL," as applicable.
   2. Dimensions shall be as specified on the Drawings. Handhole walls shall be provided with boxouts, as specified for manholes.

F. Handhole Cable Supports:
   1. Provide heavy-duty, non-metal cable racks for support of conductors. Racks shall be Underwriters Laboratories (UL) listed glass-reinforced nylon consisting of slotted wall brackets for support arms designed for a minimum of a 400-pound load. Each support bracket shall from the top to the bottom and the arms shall be adjustable and installed on 24-inch centers. Use 1/2-inch stainless steel bolts, hardware, inserts, and fasteners. Cable supports, clamps or racks shall be provided to support the cable at minimum 2-foot intervals. Concrete inserts shall be embedded on 24-inch centers in walls and ceiling.
   2. Cable Support Products or Equal:
      a. Underground Devices Incorporated Type RA arms with CR36 support brackets.
      b. Unistrut Power-Rack F20N-STA33 Stanchions with F20N-ARM14 Arms.

G. Ground Bus:
   1. Provide a ground bus in concrete manholes, handholes, and electrical pullboxes with dimension of 3-foot width x 3-foot length x 3-foot depth and larger. Provide a NEMA threaded 4-hole grounding plate for connecting two to four 1-hole ground connectors that enter the enclosure from two to four duct banks.
      a. Products:
         i. Burndy, T&B, or equal.

2.03 RACEWAY SUPPORTS

A. Conduit Supports:
   1. Framing channel with end caps and straps shall be provided to support groups of conduit. Individual conduit supports shall be one-hole pipe straps used with clamp backs and nesting backs where required. Material as specified herein.

2. Conduit supports for polyvinyl chloride (PVC) coated rigid steel and PVC conduit systems shall be one-hole PVC-coated rigid steel clamps or oversized stainless steel clamps.

B. Ceiling Hangers:

1. Ceiling hangers shall be adjustable steel rod hangers and fittings. Provide J-Type conduit support for single conduit. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise shown, hanger rods shall meet American Society for Testing and Materials (ASTM) A193 and be sized as 3/8-inch up to 2-inch conduit and shall be 1/2-inch all-thread rod over 2-inch conduit. Material as specified herein.

C. Suspended Raceway Supports and Racks:

1. Suspended raceway supports shall consist of concrete inserts, steel rod hangers, and jamb nuts supporting framing channel or lay-in pipe hangers as required. Framing channel shall be a minimum of 12-gauge. Material as specified herein.
2. Hanger rods shall be 1/2-inch diameter all-thread rod and shall meet ASTM A193. Suspended raceway supports and racks shall be braced for seismic forces as specified in Section 26 05 00.

D. Materials:

1. Table B specifies the type of raceway supports required for each location and application.

Table B

Location	Framing Channel	Threaded Rod, Hardware and Fittings
Indoor, Electrical Room	Steel, HDG	Steel, HDG
Indoor, Process Areas	Steel, HDG	Steel, HDG
Outdoor Areas, Non-corrosive	Steel, HDG	Steel, HDG
Note: *HDG = hot-dip galvanized finish*		

2.04 CONCRETE-ENCASED DUCT BANKS

A. Concrete used for duct banks shall be Class E with red color added and a minimum 28-day compressive strength of 2,000-psi as specified in the Cast-in-Place Concrete Section 03 30 00.

2.05 UNDERGROUND MARKING TAPE

A. Underground detectable marking tape shall be for early warning protection of digging around direct buried cables, conduits, and concrete duct banks. Tape shall be Occupational Safety and Health Administration (OSHA) approved.

B. Marking Tape Example:

1. Low-density polyethylene plastic, nominally 6 inches wide and 4-mil thickness with metallic-lined tape with red polyethylene film on top and clear polyethylene film on the bottom. Tape shall be imprinted with a warning continuously along the length similar to: "CAUTION – STOP DIGGING - BURIED ELECTRIC LINE BELOW."

C. Tape Products:
   1. Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

2.06 NAMEPLATES

A. Nameplates shall be provided for boxes in accordance with the requirements of Section 26 05 00. Nameplate wording shall be as shown on the Drawings. Provide the functional description of the device on the nameplate, where wording is not specified

2.07 NOT USED

2.08 RACEWAY IDENTIFICATION

A. Raceway number tags:
   1. Solid brass with 0.036-inch minimum thickness.
   2. Raceway number stamped in 3/16-inch minimum height characters.
   3. Attached to the raceway with 316 stainless steel wire.

2.09 ELECTRICAL SEALANT

A. Electrical sealant putty shall be non-hardening, non-oxidizing, non-corrosive, non-poisonous, and non-injurious to human skin with service temperature range of 30 to 200 degrees Fahrenheit (°F). Product shall be used to seal against the entrance of water.

2.10 NOT USED

2.11 PULLING LINE

A. Pulling line shall be polyethylene type, mildew- and rot-resistant with minimum of 200-pound tensile strength and minimum 1/4-inch diameter. Install in all “future” raceways. Manufacturer: Greenlee, Ideal, or equal.

2.12 CONDUIT THREAD LUBRICANT

A. Thread lubricant shall be conductive with anti-seize and anti-corrosion properties, compatible with steel and aluminum conduit materials. Manufacturer: T&B CP8 KOPR-Shield; Robroy Threadcompound; or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Table C specifies the type of raceway required for each location and application by RACESPEC sheet. Unscheduled conduit shall be galvanized, rigid steel, RACESPEC type GRS.

Table C

Location	Application/Condition	RACESPEC
Indoor	Exposed	GRS
Outdoor	Exposed (other)	GRS
Concealed	Power circuits embedded in concrete structure or beneath slab-on-grade	PVC4
Concealed	Instrumentation, communications and data signals encased in concrete, duct bank	PVC4
Underground	Power circuits encased in concrete, duct bank	PVC4
Underground	Instrumentation, communications and data signals directly buried	PVC4
Nonhazardous	Final connection to equipment and light fixtures	LFS

Notes:
GRS = galvanized rigid steel
PVC = polyvinyl chloride
LFS = liquidtight flexible steel

3.02 CONDUIT

A. General:
   1. The conduit systems, installation, and hazardous location fittings are specified herein.

B. Indoor and Outdoor Conduit Systems:
   1. In general, Contractor shall be responsible for determining conduit routing that conforms to the specified installation requirements:
      a. Conduits for Lighting and Outlets: Concealed.
      b. Conduits for Process Equipment: Concealed.
      c. Conduit Inside Structures: Concealed.
   2. Conduit installation shall conform to the requirements of the RACESPEC sheets and the following specified installation requirements:
      a. Exposed Conduit: Install parallel or perpendicular to structural members and surfaces. Install conduit horizontally and allow minimum headroom of 7 feet.
      b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.
      c. Space exposed conduit installed on supports not more than 10 feet apart. Space multiple conduits in parallel and use framing channel.
      d. Comply with the requirements of Section 26 05 00 and herein where conduits are suspended from the ceiling.
      e. Secure conduit rack supports to concrete walls and ceilings with cast-in-place anchors or framing-channel concrete inserts.
      f. Install conduits at least 6 inches from high-temperature piping, ducts, and flues with temperatures higher than 90°C (degrees Centigrade).
      g. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces.
      h. Place conduits under the reinforcement in slabs with only a single layer of reinforcing steel. Separation between conduits, conduits and reinforcement, and

conduits and surfaces of concrete shall be maintained in accordance with the Universal Building Code (UBC).

i. Route conduit clear of structural openings and indicated future openings.

j. Provide conduits with flashed and watertight seals routed through roofs or metal walls.

k. Grout conduits into openings cut into concrete and masonry structures.

l. Cap conduits or plug-flush conduits during construction to prevent entrance of dirt, trash, and water. Cap or plug empty conduits designated as “future,” “spare,” or “empty” and include a pulling line accessible at both ends. Use anti-seize compound on cap and plug threads prior to installation.

m. Determine concealed conduit stubup locations from the manufacturer's shop drawings. Terminate concealed conduit for future use in specified equipment.

n. Install conduit flush with structural surfaces with galvanized couplings and plugs. Caps and plugs shall match the conduit system.

o. Provide concealed portions of conduits for future equipment where the Drawings indicate future equipment. Match the existing installation for duplicate equipment.

p. Terminate conduits that enter enclosures with fittings that match the NEMA rating of the enclosure.

q. Underground metallic or nonmetallic conduit that turn out of concrete, masonry or earth: Install a 90-degree elbow of PVC-coated rigid steel conduit before emergence above ground.

C. Underground Conduit System:

1. Excavation, backfilling, and concrete work shall conform to respective sections of these Specifications. Underground conduit shall conform to the following requirements:

a. Underground conduits shall be reinforced concrete encased that are not shown otherwise on the Drawings.

b. Concrete-encased conduit shall have minimum concrete thicknesses of 2 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches between reinforcing and earth, unless shown otherwise in an electrical detail.

c. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

d. Underground ductbank conduit bend radius shall be not less than 2 feet minimum at vertical risers and shall be not less than 3 feet elsewhere.

e. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads protected. Steel surfaces shall be given two coats of epoxy paint.

f. Underground conduits and conduit banks shall have 2-feet minimum earth cover unless otherwise shown.

g. Underground conduit banks through building walls shall be cast-in-place or installed with concrete into boxouts with waterstops on all sides of the boxout. Waterstops shall be as specified in the Cast-in-Place Concrete section. Extend the horizontal reinforcement from the duct bank into the boxout terminating with J-hook bends.

h. Conduits not encased in concrete and passing through walls with one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber-sealing elements.

i. Thoroughly swab conduits and raceways on the inside immediately upon completion of pouring concrete.

j. Label raceways in accordance with Section 26 05 00.

k. After the concrete has set and before backfilling, pull a mandrel through each conduit. The mandrel shall have a diameter equal to the nominal conduit inside diameter minus 1/2-inch and shall not be less than 4 inches long.

l. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.

m. Provide manufactured plastic conduit spacers anchored to prevent movement during the concrete pour. Manufacturer: Carlon, PW Pipe, Underground Devices, or equal.

n. Form the concrete, pour 10 feet from the wall, manhole, or handhole and form to allow for future conduit entry.

o. Backfill duct banks with clean fill compacted to 90 percent in 6-inch lifts after concrete has cured. Refer to Section 03 30 00 for concrete requirements, including minimum 7 days of cure time prior to backfill over duct banks

p. Allow and provide for two offsets per conduit and raceway for each 100 linear feet to account for unexpected field conditions, including for excavation and backfill limited to 3 feet of extra width and/or depth. Include these specified provisions in the bid price.

q. Provide PVC threaded adapter with female threads where PVC conduit is joined to steel conduit. Procedure:

   1) Before assembly: Double-coat steel conduit with Red-Robroy, Green-Permacote, Blue-Ocal or equal product.

   2) After assembly: Seal with 65-mil thick, 2-inch wide mastic sealing tape to 1/2-inch beyond threads. Products: 3M Scotch 2228; Plymouth 02625; or equal.

   3) Cover with 20-mil corrosion protection tape applied in 1/2-lap layers to 2-inch beyond threads. Products: 3M Scotchwrap 51; Plymouth Plywrap 12; or equal.

r. Where reinforced concrete duct banks enter the side of a building, manhole, or handhole and the reinforcement cannot be brought into a window and be terminated, then drill the structure and embed the reinforcement in epoxy to minimum of 3-inch depth.

s. Provide PVC conduit with bell ends where duct banks terminated at walls, manholes, or handholes. Install bell ends flush with finished concrete.

t. Provide PVC conduit with bell ends where conduit rise below grade into a floor-mounted electrical panel, electrical cabinet, motor control center (MCC), switchboard, or switchgear.

u. Separate power conduits from signal conduit within the same ductbank by 12-inch or greater separation, as shown. Refer to the Drawings or Schedules for signal to be installed in metal conduits instead of PVC ducts.

v. Provide wireways for transition from underslab conduits rising into wall-mounted panels where the number of conduits exceed the NEC allowable panel space in

the bottom of the panel. Provide conduit sleeves or fitting for panel transition. Continuous-thread or all-thread is prohibited.

D. Conduits in Concrete Construction:
   1. Conduits for power, control and instrumentation may be embedded in and pass through concrete construction subject to the limitations in this paragraph. Where concrete strength or serviceability requirements prevent the direct embedment of conduit, provide adequate support, bracing, and serviceability details:
      a. Concrete strength shall not be impaired significantly by the embedment of conduits in or through structural sections.
      b. Conduit layout shall conform to the requirements of American Concrete Institute (ACI) 318, Sections 3.3 – Aggregates and 6.3 – Conduits and Pipes Embedded in Concrete.
      c. Conduits shall be treated similarly to reinforcing steel for purposes of clearance. In general, code sections require conduit spacing the greater of:
         1) 1.33 times the maximum concrete aggregate size, clear:
         2) 3 diameters center to center
         3) Alternate spacing and layout shall be as reviewed and accepted by the Engineer.
   2. Conduit and raceway penetrations through walls and slab: Where one side is a conditioned or an occupied space and the other side not, or one side has liquid or groundwater contact and the other side not, shall be detailed and constructed to prevent liquid and moisture penetration through the wall or slab section for each conduit.

E. Conduit in Block Walls
   1. Install multiple runs of conduit that stub-up into a block wall and connect to recessed electrical panels with adequate space for the conduit. Coordinate the electrical work with the structural work and block installers to provide a chase to install the conduit. Install conduit in the cells that do not contain structural reinforcement. Install conduits in the center of the cell to avoid affecting the structural integrity of the wall.
   2. Avoid conduit and electrical boxes installation that blocks the cell from being grouted or that blocks the cell reinforcing bars from being grouted. Avoid conduit in the first cell adjacent to doors, windows, corners and wall intersections and install conduits in the center of the first available cell a minimum of 1 foot from the edge of these openings.
   3. Where solid grouting of masonry walls is specified, install conduit and electrical boxes so as to provide sufficient space for grout to flow pass the boxes and conduit in order to fully fill the space beneath and behind. Where boxes need to be held in place, secure the boxes from the face of the block wall. Do not place items behind or next to electrical boxes to hold in place.
   4. Coordinate split-face, slump-and-scored block installation with the masonry contractor to supply smooth-face block at the location of receptacles and switches so that the device covers install flush to the wall. Install translucent weather-proof sealing material under device covers on outdoor or wet-area locations.

F. Not Used.

G. Conduit and Innerduct Sealing Material:
   1. Provide HYDRA-SEAL® Handi-Polyurethane-Foam or equal product to seal conduits and innerducts.
   2. Sealing product required features:
      a. Compatible with common cable jacket materials.
      b. ASTM E-84 flame spread requirements and UL Classified.
      c. Pre-pressurized, portable, one-component closed-cell foam sealing system.
      d. Dries tack-free within 15 minutes and cures within 24 hours.
      e. Reacts with applied moisture or with ambient humidity.
      f. Remove over-spray with acetone and remove cured foam mechanically.
   3. Application Criteria:
      a. Apply in ambient temperatures between 60° to 100° F.
      b. Apply bead onto clean surface.

3.03 HANDHOLES

A. Unless otherwise specified, handhole installation shall be as follows:
   1. Handholes and pull boxes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.
   2. Handholes shall be set plumb so that water shall drain to the sump.
   3. Metallic hardware inside handholes shall be bonded to the ground plate or ground bus using bolted connections, bonding jumpers and grounding bushings.

3.04 RACEWAY NUMBERING

A. Each new and reused conduit shall be provided with a number tag at each end and in each manhole, handhole, or pull box.

3.05 RACEWAY SPECIFICATION SHEETS (RACESPEC) – GRS

A. Raceway Identification:
   1. GRS.

B. Description:
   1. Galvanized Rigid Steel Conduit (GRS).

C. Compliance:
   1. American National Standards Institute (ANSI) and UL.

D. Finish:
   1. Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.

E. Manufacturers:
   1. Allied Tube and Conduit Corp., Wheatland Tube Co., or equal.

F. Minimum Size:
   1. Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.

G. Fittings:
   1. Locknuts, Rings, Hubs:
      a. Hot-dip galvanized insulated throat with bonding locknut or ring. The hubs shall utilize a neoprene "O" ring and provide a watertight connection. O-Z Gedney, CHM-XXT, or equal
   2. Unions:
      a. Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal. Threadless fittings are not acceptable.
   3. Conduit Bodies:
      a. Oversized Conduit Bodies: Ferrous alloy type with screw taps for fastening covers to match the conduit system. Gaskets shall be made of neoprene.

H. Boxes:
   1. Indoor:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
   2. Outdoor and Indoor Process Areas:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.

I. Elbows:
   1. 3/4-inch thru 1-1/2-inch – Factory-fabricated or field-bent.
   2. 2-inch thru 6-inch – Factory-fabricated only.

J. Conduit Bodies (Oversized):
   1. 3/4-inch thru 4-inch – Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for conduit entrances.
   2. 5-inch and 6-inch – Electro-galvanized iron or cast iron box.

K. Expansion Fittings:
   1. Expansion fittings in embedded runs shall be watertight with an internal bonding jumper. The expansion material shall be neoprene allowing for 3/4-inch movement in any direction.

L. Manufacturers:
   1. Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or equal.

M. Installation:
   1. Rigid steel conduit shall be made up tight and with conductive thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs or framing channel.

2. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.
3. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

3.06 RACEWAY SPECIFICATION SHEETS (RACESPEC) – LFS

A. Raceway Identification:
   1. LFS.

B. Description:
   1. Liquidtight Flexible Steel Conduit.

C. Application:
   1. Final connection to equipment subject to vibration or adjustment.

D. Compliance:
   1. UL 360.

E. Construction:
   1. Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.

F. Minimum Size:
   1. 3/4-inch.

G. Fittings:
   1. Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral.
   2. O-ring seals around the conduit and box connection and insulated throat.
   3. Provide 45- and 90-degree fittings where applicable.
   4. Provide PVC-coated flexible conduit and fittings where the conduit system is PVC-coated.

H. Installation:
   1. Length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit and not exceed 36 inches in length. Use conductive thread compound.

3.07 RACEWAY SPECIFICATION SHEETS (RACESPEC) – PVC4

A. Raceway Identification:
   1. PVC4.

B. Description:
   1. Rigid Nonmetallic Conduit.

C. Application:
   1. Heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.

D. Compliance:
   1. NEMA TC2, UL 651.

E. Construction:
   1. Schedule 40, high-impact PVC.

F. Minimum size:
   1. 3/4-inch exposed; 1-inch embedded or encased.

G. Fittings:
   1. PVC solvent weld type.

H. Boxes:
   1. Indoor:
      a. NEMA 4, nonmetallic.
   2. Outdoor:
      a. NEMA 4, nonmetallic.

I. Installation:
   1. PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O ring.
   2. Joints shall be made with standard PVC couplings.
   3. PVC conduit shall have bell ends where terminated at walls and boxes.

3.08 RACEWAY SPECIFICATION SHEETS (RACESPEC) – WW

A. Raceway Identification:
   1. WW.

B. Description:
   1. Wireway and Auxiliary Gutter: Match the conduit or raceway system specified and shown on the Drawings.
   2. Minimum: Flanged, oiltight type with hinged covers.

C. Application:
   1. As shown on the Drawings.

D. Compliance:
   1. JIC EMP-1.

E. Sizes as Shown:
   1. 4-inch by 4-inch, 6-inch by 6-inch, 8-inch by 8-inch.

F. Finish:
   1. Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.

G. Indoor Electrical Room:
   1. NEMA 12, or as shown on the Drawings.

H. Outdoor and Indoor Process Areas:
   1. NEMA 4 or as shown on the Drawings.

END OF SECTION

SECTION 26 05 74

ARC FLASH AND SHOCK RISK ASSESSMENT, SHORT-CIRCUIT STUDY
AND PROTECTIVE-DEVICE COORDINATION REPORT

PART 1 GENERAL

1.01 DESCRIPTION

A. General:
   1. This section specifies that the Contractor subcontract an independent full member InterNational Electrical Testing Association (NETA) Engineering and Study Firm/ Testing Firm to prepare:
      a. Electrical equipment short-circuit study (SCS) report for the new equipment being installed.
      b. Protective-device coordination study (PDCS) report for the new equipment being installed.
      c. Arc flash analysis and shock risk assessment (AFA) and labeling for the new equipment being installed.
   2. Study Sites:
      a. Mingus Pump Station.
      b. Mingus Tank.

B. The Testing Firm shall be as described in Section 26 08 00 and shall also be responsible for the electrical testing described therein.

C. Scope:
   1. The Short-Circuit and Protective-Device Coordination Report shall provide the analysis, including utility company equipment that affect the installed equipment's short-circuit ratings, protective-device ratings and protective-device settings.
   2. Report shall also include analysis of the equipment's short-circuit ratings, protective-device ratings and protective-device settings affected by the installed equipment.
   3. Report shall include the results of the arc flash hazard analysis study for energized electrical equipment in accordance with the methods outlined in Institute of Electrical and Electronics Engineers (IEEE) Standard 1584 and stated hereinafter.
   4. Work shall include the fabrication of signs with the arc flash hazard study results and the installation of the signs on the equipment in accordance with National Fire Prevention Association (NFPA) 70E Table 3-3.9.3 that includes the personal protective equipment (PPE) risk category, the energy available, and the clothing recommendation.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, 1999

1.03 SCHEDULE

A. The report shall be completed, submitted to the Construction Manager for acceptance and reworked to include the Construction Manager comments and corrections, as required. The report shall be approved by the Construction Manager prior to purchase and fabrication of electrical equipment including switchgear.

B. A copy of the Construction Manager accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

1.04 SUBMITTALS

A. Action Submittal – Report:
   1. The report specified in this Section shall be provided in accordance with Section 01 33 00.

PART 2 PRODUCTS

2.01 REPORT

A. The product shall be a certified report summarizing the SCS and PDCS and conclusions or recommendations which may affect the integrity of the electrical power distribution system. As a minimum, the report shall include the following:
   1. The equipment manufacturer's information used to prepare the study.
   2. Power utility company system information applicable to the project.
   3. Short-circuit calculations listing short-circuit levels at each bus. Provide a sketch of the bus and use both the project term and the bus-code name to identify the bus, branches, sources, loads. Base the system on the project’s one-line diagram.
   4. PDCS time-current curves, including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.

5. Comparison of short-circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.
6. Data used as input to the report that includes cable impedances, source impedances, equipment ratings for the equipment being purchased for the project, etc.
7. Assumptions made during the study.

PART 3 EXECUTION

3.01 GENERAL

A. Provide a SCS and PDCS on the electrical power distribution system as specified and as described in Section 6.1 of NETA ATS. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the American National Standards Institute (ANSI) method of short-circuit analysis in accordance with ANSI C37.010.

B. The studies shall be performed using actual equipment data for both existing and new equipment. The PDCS shall use the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

C. For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.

D. Not used.

E. Any power distribution equipment outages shall be scheduled in advance and coordinated with the Owner to limit process outages as required per plant process capacities.

3.02 QUALIFICATIONS

A. The short-circuit and coordination report shall be performed by the Testing Firm as described in Section 26 08 00. The studies shall be signed by the professional electrical engineer responsible for the studies and registered to practice engineering in the State of Arizona.

3.03 SHORT-CIRCUIT STUDY

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. As a minimum, the SCS shall include the following:
   1. One-Line Diagram:
      a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
      b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
      c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
      d. Type, manufacturer, and ratio of all instrument transformers energizing each relay.

e. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.
f. Sources of short-circuit currents such as utility ties, generators, synchronous motors, and induction motors.
g. Circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
h. Emergency as well as normal switching conditions, as applicable.
i. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.

B. Impedance Diagram:
1. Available megavolt ampere (mVa), voltage, and impedance from the power utility company.
2. Local generated capacity impedance.
3. Bus impedance.
4. Transformer and/or reactor impedances.
5. Cable impedances.
6. Equipment impedances.
7. System voltages.
8. Grounding scheme for the project:
a. Resistance grounding, solid grounding, or no grounding.

C. Calculations:
1. Determine the paths and situations where short-circuit currents are the greatest.
2. Study shall address bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.
3. Calculate the maximum and minimum fault currents.

3.04 ARC FLASH ANALYSIS AND SHOCK RISK ASSESSMENT

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. The AFA study shall include the following IEEE Standard 1584 nine-step analysis process:
1. Collect system and installation data.
2. Determine modes of operation.
3. Determine bolted fault current.
4. Determine arc fault current.
5. Determine protective-device characteristic and arc-fault duration.
6. Document system voltages and equipment class.
7. Select working distances.
8. Calculate incident energy.
9. Calculate the arc flash protection boundary.

3.05 PROTECTIVE-DEVICE COORDINATION STUDY

A. As a minimum, the PDCS for the power distribution system shall include the following on 5-cycle, log-log graph paper:
   1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.
   2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Construction Manager shall be notified as to the cause.
   3. Time-current curves and points for cable and equipment damage.
   4. Circuit-interrupting device operating and interrupting times.
   5. Indicate maximum fault values on the graph.
   6. Sketch of bus and breaker arrangement.

3.06 IMPLEMENTING PDCS SETTINGS AND ARC FLASH SIGN INSTALLATION

A. The Testing Firm shall implement the PDCS settings on new and existing equipment as required in Section 26 08 00, based on the Engineers accepted Protective Device Coordination Report specified herein and submit a final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

B. The Testing Firm shall work with the Contractor and the Study Firm for implementing the Arc Flash Hazard sign installation requirements for electrical equipment as specified in National Electric Code (NEC) Article 110.16 Flash Protection and NFPA 70E.

END OF SECTION

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SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. The electrical equipment and conductors to be tested are specified herein and shown on the electrical drawings of the Contract Documents.
2. The Contractor shall retain an independent InterNational Electrical Testing Association (NETA) member Engineering and Testing Firm (Testing Firm) for specified on-site acceptance testing of the project electrical power distribution system and utilization equipment covered by this Contract. The equipment Manufacturer shall not provide the Testing Firm services.
3. The Testing Firm shall be responsible for the Short-Circuit and Protective-Device Coordination Report as specified in Section 26 05 74. The Testing Firm shall verify the protective-device settings are implemented in accordance with Section 26 05 74. The Testing Firm work includes the arc-fault equipment labeling work as specified in Section 26 05 74.
4. Tests performed by the Testing Firm shall be witnessed by the Owner's Representative. Provide the Construction Manager 30-day advanced notice for Testing Firm tests. Insulation tests by the Contractor typically will not be witnessed. Critical equipment witness testing may be requested by the Construction Manager.
5. The manufacturer of the electrical equipment supplied for the project shall complete their on-site factory inspection, testing, and setup prior to the Testing Firm's acceptance testing and subsequent protective-device setting verification work. The power monitors shall be set up by the factory representatives and power monitor readings and settings verified by the Testing Firm. Manufacturer work is specified in the respective equipment sections.
6. The Installation Contractor shall test motors, conductors, and equipment as specified and shown. Contractor shall provide the labor, tools, material, including quality power sources required by the Testing Firm equipment, and other services necessary to provide specified tests and retesting.
7. Submit proposed electrical test procedures for tests to be performed by the Installation Contractor, other than insulation resistance testing, and proposed test procedures for tests to be performed by the Testing Firm.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective

date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/NETA ATS	International Electrical Testing Association (NETA) - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

B. Testing Firm:
   1. The Testing Firm and its proposed project team shall possess the following minimum qualifications:
      a. Testing Firm shall be an independent testing organization providing unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems to be evaluated.
      b. Testing Firm shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
      c. Testing Firm shall be a “NETA Accredited Company” of the NETA-provided testing in accordance with the American National Standards Institute (ANSI)/NETA ATS published specifications or the pre-approved firms that use the NETA methods and published testing specifications.
      d. If firm's own published testing specifications are proposed, then submit a copy to the Engineer for acceptance and submit the qualifications of the testing staff.
      e. Testing Firm's lead technical person shall be currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution systems testing. Submit proof of technical training and certification for performing testing work.
      f. Testing Firm's technicians shall be regularly employed, qualified testing staff. The equipment manufacturer is not acceptable as a testing firm.
      g. The following are pre-qualified Testing Firms:
         1) Emerson Electrical Reliability Services.
         2) Power Systems Testing Co.
         3) Southwest Energy Systems.

C. Testing Firm Qualifications:
   1. For any Testing Firm not pre-qualified, the Contractor shall receive Construction Manager approval of the proposed Testing Firm, its proposed project team, and its test procedures prior to the Pre-Test Submittals.
      a. Project Team:
         1) Identify lead technical person and testing staff and provide documentation of training and experience demonstrating compliance with the qualifications specified.

b. Testing Firm:
   1) Provide reference names and current phone numbers of the Owner, Contractor, Engineer, or Construction Manager that has knowledge of the Firm's work:
      a) Three projects for Owner completed within the past 4 years, or
      b) Three projects for Brown and Caldwell completed within the past 4 years, or
      c) Provide references for five recent projects that were completed within the last 4 years. Provide a description of the scope of the referenced project.

c. For Testing Firm's experience to be judged acceptable, the Contractor shall demonstrate that the proposed Testing Firm's reference projects are of similar scope and size to this project, and in performing these projects the following has been achieved:
   1) Testing Firm's work did not delay the projects or adversely impact the progress of the Contractor's work or the Owner's project.
   2) Specified requirements were achieved.
   3) Work was performed in accordance with ANSI/NETA ATS, MTS, or other Engineer-accepted testing criteria.
   4) Submittals approved with two or fewer re-submittals after the initial submittal.
   5) No warranty claims related to the Testing Firm's work.

d. Provide documentation demonstrating NETA accreditation and compliance with the qualification specified.

1.03 SUBMITTALS

A. Contractor shall submit the following information in accordance with Section 01 33 00.

B. Action Submittal – Testing Firm Qualifications:
   1. For any Testing Firm not pre-qualified per paragraph 1.02, submit qualifications per paragraph 1.02. Qualifications shall be submitted separately and prior to Pre-Test Submittals.

C. Action Submittal – Testing Firm Pre-Test Submittals:
   1. Description or list of all specified tests to be provided.
   2. Sample test report forms for all of the specified tests.

D. Action Submittal – Contractor Pre-Test Submittal:
   1. Preliminary schedule listing equipment to be tested.
   2. Notification form for the work scheduled.
   3. Pre-functional test procedures and testing schedule.
   4. Functional test procedures and testing schedule.

E. Action Submittal – Contractor Post-Test Submittal:
   1. Completed Section 01 99 90 Test Records:
      a. Wire and Cable Resistance Test Data Form: 26 05 00-A.
      b. Installed Motor Test Form: 26 05 00-B.

F. Action Submittal – Testing Firm Post-Test Submittal:
   1. Test Reports specified in Part 3 of this section.

PART 2 PRODUCTS

2.01 TESTING EQUIPMENT AND INSTRUMENTS

A. The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology (NIST).

B. The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall submit a schedule for the Testing Firm work and notify the Construction Manager 30 days prior to commencement of any witnessed testing.

B. The required tests, including correction of defects where found, and subsequent retesting, shall be completed prior to energizing electrical distribution system, utilization systems, and conductors and completed prior to functional testing. The installation of the protective device, breaker, and relay settings shall be completed and verified.

3.02 INSTALLATION CONTRACTOR TESTING

A. General:
   1. Submit all completed test report forms in a 3-ring binder type notebook at the project Substantial Completion date.

B. Insulation-Resistance Measurements:
   1. Tests:
      a. Insulation-resistance measurements shall be made on conductors and electrical equipment that will carry current. Where not specified, the minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, Insulated Cable Engineers Association (ICEA), National Electrical Manufacturers Association (NEMA), or ANSI standards for the equipment or material being tested.
   2. The ambient temperature at which insulation resistance is measured shall be recorded on the test form. A megohmmeter shall be used for insulation-resistance measurements.
   3. Refer to Section 01 99 90 for the test forms required to document the testing performed by the Installation Contractor.
   4. Conductor and Cable Tests:
      a. The phase-to-ground insulation resistance shall be measured for circuits 120 volts and above, except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation-resistance

measurements shall be recorded on Form 26 05 00-A provided in Section 01 99 90, and submitted. Insulation with resistance of less than 100-megohms is not acceptable.

5. Motor Tests:
   a. The Installed Motor Test Form, Form 26 05 00-B, provided in Section 01 99 90, shall be completed for each motor after installation and submitted. All motors shall have their insulation resistance measured before they are connected.
6. Motors 50-horsepower (hp) and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation-resistance values less than 50-megohms are not acceptable.
7. Verify that motors are connected to rotate in the correct direction with the load disconnected. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.
8. Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall be less than 5% difference between phases.

C. Power Distribution Equipment:
   1. Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Insulation-resistance values less than 10-megohms are not acceptable.

D. Power Utilization Equipment:
   1. Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.

E. Signal and Data Cable Tests:
   1. Signal conductors and shield drain shall be tested for insulation resistance with the other conductors in the cable grounded. Each shield drain conductor shall be tested for continuity. Insulation-resistance measurements shall be recorded on Form 40 61 13-A provided in Section 01 99 90, and submitted.
   2. Instruments used for continuity measurements shall have a resolution of 0.1-ohms and an accuracy of better than 0.1% of reading plus 0.3-ohms. A 500-volt or 1000-volt megohmmeter shall be used for insulation-resistance measurements as appropriate.

F. Pre-Functional Checkout:
   1. Prior to energizing equipment, the Contractor shall perform a pre-functional checkout of the power and the control circuit. Protective devices shall be installed and available for service and calibrated or adjusted with specified setpoints installed. Contractor selected initial setpoints shall be installed and recorded, when specified setpoints are not required from the manufacturer or the Engineer.
   2. Contractor shall submit a description of proposed test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of pre-functional testing.
   3. Pre-functional checkout shall consist of energizing each control circuit and operating each control device, protective device, monitoring or alarm device, and each interlock and verify the specified action or response occurs. Coordinate testing with the requirements specified in Section 01 45 20.

G. Functional Testing:
   1. Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.
   2. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits as specified in the following and in Division 40. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.
   3. Record and submit data sheets as specified. Coordinate testing with the requirements specified in Section 01 45 20.

3.03 TESTING FIRM ACCEPTANCE TESTING REQUIREMENTS

A. Acceptance Test Reports:
   1. The Contractor shall maintain a written record of all inspection and test results and, upon completion of the project, shall assemble and certify a final test report
   2. A copy of the preliminary test results shall be provided to the Construction Manager at the end of each day of testing.
   3. Furnish two copies of the complete acceptance testing final report to the Construction Manager at Substantial Completion of the project.

B. Acceptance Test Documentation: The Contractor shall submit test documentation forms and a detailed description of the proposed inspection and test procedures to be performed by the Testing Firm. Testing shall not commence until the Construction Manager has approved the proposed forms and procedures.

C. The description shall identify the test equipment required for each specified test to be performed. Test report forms shall include the following information:
   1. Electrical equipment description.
   2. Electrical equipment identification number.
   3. Electrical equipment nameplate data.
   4. Electrical equipment settings.
   5. Time and date of test.
   6. Ambient conditions at time of test.
   7. Inspection checklist and results.
   8. Test results.
   9. Test equipment used with manufacture, model number, and calibration date.
   10. Remarks about test procedures, results, and suggestions.
   11. Name and signature of testing personnel.
   12. Name and signature of test witness.

D. Acceptance Testing Firm Tests:
   1. Acceptance testing procedures and test results shall be as specified in ANSI/NETA ATS. The following types of equipment and systems shall be inspected and tested by

the Testing Firm. Acceptance testing work shall not be limited to equipment shown on the Drawings. Refer to Division 26 Specifications for the electrical equipment specified.

a. Refer to the electrical drawings for location and identification of the electrical distribution system equipment, utilization equipment, and electrical conductors, included but not limited to:
   1) Switchboard Assemblies.
   2) Transformers Dry-Type Air-Cooled.
   3) Circuit Breakers Low-Voltage, 100A frame and larger.
   4) Instrument Transformers.
   5) Metering, include non-utility power metering equipment.
   6) Grounding Systems, include installed grounding systems and existing grounding systems that are being utilized.
   7) Ground Fault Protection Systems.
   8) Adjustable Speed Drive Systems and harmonic testing per Section 26 29 23-3.02.
   9) Surge Protection Devices, include lightning arresters and surge capacitors.
   10) Engine Generators.
   11) Automatic Transfer Switches (ATS).

3.04 ACCEPTANCE TEST VALUES

A. Minimum acceptable test values shall be as specified in ANSI/NETA ATS. Where acceptance test values are not specified, the equipment manufacturer's recommended test values shall be used. Where acceptance test values are not specified and the equipment manufacturer's recommended test values are not available, request acceptance test values from the Construction Manager.

3.05 ACCEPTANCE TEST FINAL REPORT

A. Test report shall be assembled as described in ANSI/NETA ATS. Test results shall be organized by electrical distribution system equipment, project utilization equipment, and electrical conductors, with individual tab dividers with labels to identify each group of items and cross-referenced to the Contract Documents. The equipment description, equipment number, and equipment tag number shall be used as shown on the Drawings or listed in Specifications.

B. Final test reports that are illogically assembled, labeled, and organized shall be returned for rework at no cost to the Owner and resubmitted in an acceptable format.

C. Deficiencies and non-compliant test results found during acceptance testing shall be identified in the test report and cover letter. The Testing Firm shall certify in the final test report that all deficiencies and non-compliant test results listed have been "corrected" and shall include a description of the resolution for each problem listed.

3.06 PROTECTIVE-DEVICE FIELD SETTINGS

A. The Testing Firm shall verify, and certify in the acceptance test final report, that the protective-device coordination study settings for new and existing equipment based on

the Short-Circuit and Protective-Device Coordination Report specified in Section 26 05 74 have been implemented and recorded on the Testing Firm's Data Sheets.

3.07 ARC FLASH STUDY RESULTS

A. The Testing Firm shall provide and install labels on the project electrical equipment for personal protective clothing requirements as specified in Section 26 05 74.

END OF SECTION

SECTION 26 09 16

ELECTRICAL CONTROLS AND RELAYS

PART 1 GENERAL

1.01 DESCRIPTION

A. The vendor, manufacturer, and custom control panels shall provide enclosures, selector switches, pushbuttons, indicators, terminal strips, surge devices, nameplates, testing procedures, wiring method, wiring color coding, wire labeling, separation between power, controls and instruments, and hardwired logic relays.

B. This section specifies electrical control and monitoring devices:
   1. Control Devices:
      a. Pushbuttons
      b. Selector Switches
      c. Indicating Lights
      d. Control Station Enclosures
   2. Control Relays:
      a. Load-Switching

C. This section specifies power devices:
   1. Magnetic Contactors:
      a. Lighting Contactors
   2. Safety Disconnect Switches
   3. Elapsed Time Indicators
   4. Intrusion Switches and Override Key Switches

D. Request clarification where conflicts occur with this section and other sections in Divisions 23, 26, 40, and 43.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that

date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA ICS-1	General Standards for Industrial Controls and Systems
NEMA ICS-2	Industrial Control Devices, Controllers, and Assemblies
NEMA KS 1	Enclosed Switches

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Manufacturer's catalog data, marked for all material provided under this section.

PART 2 PRODUCTS

2.01 CONTROL DEVICES

A. Pushbuttons:

1. Pushbuttons shall be flush-head, heavy-duty, with National Electrical Manufacturers Association (NEMA) rating to match enclosure type. Operators shall be green for start function, red for stop functions, and black for all other functions. The escutcheon legend shall be as specified on the drawings.
   a. Underwriters Laboratories (UL) listed.
   b. Dielectric Strength: 1300 volts for 1 minute for Logic Reed contacts, 2200 volts for 1 minute for other contacts.
   c. 30.5-mm mounting hole.
   d. Temperature operating range –10°C. to +55°C.
   e. Momentary-contact type.
   f. When switching circuits are monitored by programmable controllers or other solid-state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150 -ac and 0.06 amperes at 30-Vdc.

g. When switching circuits are not monitored by programmable controllers or other solid-state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120-Vac.

2. Manufacturer: Allen-Bradley 800T/800H series or equal.

B. Selector Switches:

1. Selector switches shall be heavy-duty with NEMA rating to match enclosure type. Selector switches shall have maintained-position contacts. Switches shall be provided with contact blocks and number of positions as required performing the specified or indicated operations.
2. The escutcheon legend shall be as specified on the drawings. Provide:
   a. UL listed.
   b. Dielectric Strength: 1300 volts for 1 minute for Logic Reed contacts, 2200 volts for 1 minute for other contacts.
   c. 30.5-mm mounting hole.
   d. Temperature operating range –10°C. to +55°C.
   e. Standard knob operator (not lever-type nor wing-lever type).
   f. Number of positions and contact configuration as shown on Drawings.
   g. When switching circuits are monitored by programmable controllers or other solid-state circuits, furnish hermetically-sealed, logic-reed type contacts rated not less than 0.15 amperes at 150-Vac and 0.06 amperes at 30-Vdc.
   h. When switching circuits are not monitored by programmable controllers or other solid-state circuits, furnish contacts with NEMA Utilization Category rating A600 rated not less than 10 amperes continuous and 6 amperes break at 120-Vac.
3. Manufacturer: Allen-Bradley 800T/800H series or equal.

C. Indicating Lights:

1. Red, amber, green, and blue indicating lights shall be heavy-duty full-voltage 120-Vac or 24-Vdc push-to-test LED type with NEMA rating to match enclosure type for installation in a 30.5-mm hole. Furnish with 28-chip high-visibility LED. The escutcheon and lens color shall be as shown on Drawings or scheduled.
2. White indicating lights shall be as above, incandescent-type lamp.
3. Manufacturer:
   a. Allen-Bradley 800H-QRTH10 series or equal for 120-Vac applications with colors other than white.
   b. Allen-Bradley 800HQRTH24 series or equal for 24-Vdc applications with colors other than white.
   c. Allen-Bradley 800H-QRT10 series or equal for 120-Vac applications with white.
   d. Allen-Bradley 800H-QRT24 series or equal for 24-Vdc applications with white.
4. Indicating Light Lens Color:

Lens Color	Typical Function	Example
Green	Danger, running, open	Equipment operating, motor running, valve open, power voltage applied, cycle in automatic
Red	Fault condition, attention	Equipment failure, status abnormal

Lens Color	Typical Function	Example
Red	Off, closed, ready	End of cycle; unit or head returned; motors stopped; motion stopped; contactors open, valve closed
White or Clear	Normal condition	Normal pressure of air, water, lubrication, control power on, status okay
Blue	Advisory	Control mode not in automatic

D. Control Station Enclosures:
   1. Enclosure locations and ratings:
      a. Indoors – Conditioned space: NEMA 12.
      b. Outdoors – Process areas: NEMA 4.

E. Control Power Transformers:
   1. Sized for the panel devices and products.
   2. Dual primary and single secondary fusing.

2.02 CONTROL RELAYS

A. Load-Switching Control Relays:
   1. Control relays used for switching loads such as solenoids, actuators, contactors, motor starter coils, remote interlocking, etc., shall be heavy-duty machine-tool type.
   2. Contacts shall be 4-pole and be field interchangeable to either normally open or normally closed. Relay shall be capable of accepting a 4-pole adder.
   3. AC relays shall have NEMA A600 contact ratings and electrical clearances for 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances for 250 volts.

B. Timers:
   1. Multi-function, micro-controller based, socket-mounted timing relay.
   2. Single functions:
      a. Delay on Make
      b. Delay on Break
      c. Recycle (on time first, equal recycle delays)
      d. Single shot
      e. Interval
      f. Trailing edge single shot
      g. Inverted single shot
      h. Inverted delay on break
      i. Accumulative delay on make
      j. Re-triggerable single shot
   3. Time delay range, switch selectable:
      a. Single function 0.1 second to 1,705 hours in 8 ranges.
      b. Setting accuracy +/- 1 percent or 50 milliseconds, whichever is greater.
      c. Repeat accuracy +/- 0.1 percent or 16 milliseconds, whichever is greater.

4. Output:
    a. Two Form-C electromechanical isolated contacts rated 10-amperes resistive at 240-Vac.
    b. Rated 1/3-horsepower at 120- or 240-Vac.
    c. Double-pole double-throw: DPDT.
    d. Mechanical life: 10,000,000 operations.
5. Electrical life: 1,000,000 operations at full load.
   Mounting: Magnal Plug 11-pin socket.
6. Environment: -20 to +65°C.
7. Manufacturer:
    a. ABB/SSAC's multifunction type TRDU time delay relay with dip-switch function setting with 12-Vdc, 24-Vac, 120-Vac, 240-Vac inputs as required or indicated or equal.

2.03 MAGNETIC CONTACTORS

A. Lighting Contactor:
    1. Lighting contactors shall be 100 percent rated for ballast and tungsten lighting, resistance and other non-motor loads.
    2. Contactor shall be rated 600-Vac, 60-Hertz with the ampere rating and number of poles as indicated on the drawings. Provide a minimum of two poles per NEMA ICS 2-211B for industrial-duty applications.
    3. The following options shall be available and shall be provided as indicated on the drawings:
        a. Auxiliary contacts rated 5-amperes at 600-Vac.
        b. Timer or time clock attachment.
        c. Transient suppression module for 120-Vac control circuits.
        d. Electrically or mechanically held as specified.
    4. Contactors shall be provided with disconnecting means and overcurrent protection mounted in the same enclosure.
    5. Manufacturers:
        a. Allen Bradley Bulletin 500L or 500LP.
        b. Square D Class 8903.
        c. ASCO 918 Remote Control with control module.
        d. Or equal.

2.04 ELAPSED TIME INDICATORS

A. Elapsed time indicators shall be panel-mounted, non-resettable, 5.5-digit, hour indicator, rated 120-Vac, 60-Hertz.

2.05 TERMINAL STRIPS, BLOCKS, AND DEVICES

A. Power Wiring: Provide back plate mounted terminal strips rated at 600-Vac.

B. Control Wiring: Provide a DIN rail with spring-powered contact rated at 300-Vac 24-ampere with pluggable terminals.

C. Terminal identification standard to the product provided.

D. Manufacturer:
   1. Standard: Allen Bradley or equal.
   2. Standard: DIN rail: Phoenix Contact or Weidmuller Z-Series.

2.06 INTRUSION DEVICES

A. The intrusion switch shall be wide-gap industrial grade magnetic door switch with maximum gap 2.5 inches between the sensing elements. The magnet element shall be mounted on the moving part of the door. The sensor switch shall close when the door is closed. The sensor switch shall open when the door is opened. Provide with appropriate mounting bracket for the entrance doors.
   1. Manufacturer: George Risk Industries - Series 4400 (800-445-5218), [http://www.grisk.com/security_products.htmhttp://www.grisk.com/security_products.htm] or equal.

2.07 NAMEPLATES

A. Nameplates for all control stations, relays, timers, motor contactors and disconnect switches shall be provided in accordance with the requirements of Section 26 05 00-2.04.

PART 3 EXECUTION

3.01 INSTALLATION

A. Control stations and contactors shall be mounted 48 inches above the floor, ground, or slab to center of device.

B. Miscellaneous electrical devices shall be tested in accordance with Section 26 05 00 and Section 26 08 00.

END OF SECTION

SECTION 26 21 16

LOW-VOLTAGE UNDERGROUND ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies outdoor-rated, 480-Vac, four-wire, service entrance section (SES) with Arizona Public Service power utility metering equipment and main disconnecting means as shown on the Drawings.

B. The SES shall consist of the following:
   1. Enclosure Section 1:
      a. Power utility metering compartment that meets the Electric Utility Service Equipment Requirements Committee (California) (EUSERC) standards in an outdoor National Electrical Manufacturers Association (NEMA) 3R, non-walk-in enclosure.
   2. Enclosure Section 2:
      a. Includes the fixed “Main” circuit breaker.
      b. Ground fault interrupting system initially set to the maximum setting.
      c. Surge protective device specified.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/IEEE	Definitions and Requirements for 600 Volt Air Switches, Insulators, and Bus Supports
ANSI C37.46	Specifications for Power Fuses and Fused Disconnecting
ANSI C37.47	Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses
NEMA PB 2	Deadfront Distribution Switchboards

Reference	Title
UL 489	Underwriters Laboratories – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 891	Underwriters Laboratories - Deadfront Switchboards
UL 943	Underwriters Laboratories – Ground-Fault Circuit-Interrupters
UL 1066	Underwriters Laboratories – Low Voltage AC and DC Breakers used in Enclosures

B. Factory Tests:

1. Switchboards shall be tested for operation at the specified voltage and current ratings after assembly. The main circuits shall be given a dielectric test of 2200 volts for 1 minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for 1 minute between live parts and ground.
2. Instrument transformers shall have ratio- and phase-angle tests made in conformance with American National Standards Institute (ANSI) C57.13.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Mingus Pump Station Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the Contract Documents' Electrical Drawings E-101, E-401, E-601, and E-602, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Electrical single-line, schematic diagrams, and conductor connection diagram.
4. Layout drawings indicating arrangement, dimensions, cable entries, and weights.
5. Manufacturer's product and catalog data indicating equipment specifications and features, including interrupting, withstand, and continuous current ratings of all relevant equipment and components. Catalog data shall be edited or "arrowhead" to indicate only the models and options to be provided as part of this Specification.
6. Submittal requirements of Section 26 43 13.

C. Action Submittals – Mingus Tank Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. A copy of the Contract Documents' Electrical Drawings E-411 and E-611, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Electrical single-line, schematic diagrams, and conductor connection diagram.
4. Layout drawings indicating arrangement, dimensions, cable entries, and weights.
5. Manufacturer's product and catalog data indicating equipment specifications and features, including interrupting, withstand, and continuous current ratings of all relevant equipment and components. Catalog data shall be edited or "arrowhead" to indicate only the models and options to be provided as part of this Specification.
6. Panelboard circuit breaker sizes and schedule.

D. Informational Submittals – Power Utility:

1. The SES submittal information shall also be submitted to power utility metering department for their approval.
2. After power utility approval, submit one approved copy with utility comments to the Owner.

E. Action Submittals – Structural Bracing:

1. Manufacturer shall provide this submittal separately from and after review of the shop drawings submittal. Provide the following per the requirements of Structural Drawings.
2. A copy of this Specification section and related Structural Drawings, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The

remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
4. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
5. Weight for each complete equipment assembly.
6. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

F. Informational Submittals - Final Structural Bracing Certification:
   1. Provide the final reviewed complete Structural Bracing submittal, including review comments for review by the Owner's Authority Having Jurisdiction.

G. Closeout Submittals – Operation and Maintenance (O&M):
   1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
      a. O&M information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01 78 23, whichever is the earlier.
      b. Full-size drawings shall be reduced to 11 x 17 inches.
   2. Include the following in each O&M manual:
      a. Final reviewed submittals, including revised as-built drawings.
      b. Manufacturer's O&M instructions, edited for this project.
      c. Field set configuration settings per Part 3.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include:
   1. Eaton Cutler-Hammer.
   2. General Electric Co.
   3. Square D.
   4. Or equal

2.02 SERVICE ENTRANCE SECTION

A. General:
   1. Coordinate with power utility for the correct meter socket, test devices, potential transformers, current transformers, and other items installed in the metering section. Refer to power utility electric service requirements, latest edition.
   2. Equipment and materials shall be new and free from defects.
   3. Continuous Current Ratings: Refer to Drawings.

B. Power Disconnect – Circuit-Breaker Type:
   1. The circuit breaker with adjustable solid-state trip with sizes as indicated. The circuit-breaker settings shall be confirmed with a protective-device coordination study provided by others.
      a. General:
         1) Circuit breakers shall be a stored-energy type mechanism to provide quick-make, quick-break, trip-free operation:
            a) Insulated or molded case UL-listed 100 percent continuous current capacity.
            b) Ground fault protection shall be provided as specified or indicated.
      b. Circuit breakers shall provide manual switching operation by means of a low-torque handle or pushbutton on the front of the unit. Automatic operation during overload and short-circuit conditions shall be provided by solid-state or thermal-magnetic tripping devices located in the circuit-breaker frame as specified on the Drawings.
      c. Circuit breakers shall be front-accessible, stationary, individually-mounted, and shall have short-circuit capabilities equal to or greater than the system in which they are installed. Unless otherwise noted, circuit breakers shall have a minimum interrupting current of 65,000 amperes symmetrical Root-Mean-Square (RMS) at 480-Vac.
      d. Static Tripping Devices:
         1) Solid-state static tripping devices shall consist of current sensors, logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame and shall not require any external relaying or power supplies.
      e. Tripping functions shall be field-adjustable and contain the following tripping characteristics:
         1) Overload tripping:
            a) Adjustable ampere setting.
            b) Adjustable long-time delay.
         2) Short-circuit tripping:
            a) Adjustable short-time pickup.
            b) Adjustable short-time delay.
            c) Adjustable instantaneous pickup.
         3) Ground fault tripping:
            a) Adjustable ground fault pickup.
            b) Adjustable ground fault delay.

C. Power Bus:
   1. The bus shall be insulated tin-plated copper bus bar. Unless otherwise specified, buses shall be braced to withstand short-circuit stresses up to 65,000 RMS amperes.

D. Enclosure:
   1. The enclosure shall be designed for outdoor installation. Each of the enclosure sections shall have a full-length flanged front door.
   2. The structure supporting current carrying parts shall be flame-retardant non-tracking glass polyester or porcelain.

E. Not used.

F. Surge Protective Device:
   1. Refer to Section 26 43 13.

G. Grounding:
   1. A common ground bus shall extend the entire length of the assembly with ground lugs furnished at each end where multiple enclosures are attached together. A ground lug, sized for a 4/0 bare copper ground wire, shall be bolted to the interior of the enclosure.

H. Neutral:
   1. A neutral bus shall extend the entire length of the assembly with lugs furnished at each end where multiple cabinet enclosures are attached together.

I. Finish:
   1. The finish shall be manufacturer’s standard.

J. Nameplates:
   1. In addition to the manufacturer's identification, an external nameplate shall be provided with equipment number and name as shown.
   2. Each section compartment shall be provided with nameplates indicating utility meter, main breaker circuit name with equipment number and description of load, pull sections, transient voltage surge suppressor (TVSS), and any additional designations describing the compartment function or usage.
   3. Provide machine-engraved laminated black phenolic nameplates with white lettering for panel-mounted equipment with the instrument tag number/description in 3/32-inch minimum size lettering and attach to the panel or enclosure with a minimum of two self-tapping 316 stainless steel screws. Provide nameplates for power sources indicating the power loads and nameplates for power loads that indicate the power sources, in accordance with these specifications and the National Electric Code (NEC).

K. Wiring:
   1. Internal switchboard wiring shall consist of single conductor SIS 90°C copper wire and UL-listed for panel wiring. The wire shall be sized to suit load requirements. Minimum size shall be No. 14 AWG (American Wire Gauge).

L. Structural Bracing:
   1. Assembly shall be braced by the manufacturer per the seismic requirements of the Structural Drawings and Specifications. Submit bracing information.

2.03 SERVICE PEDESTAL

A. General:
   1. Refer to Drawings.
   2. Padlockable.
   3. Meter socket and construction per power utility requirements.
   4. Meyers, or equal.

PART 3 EXECUTION

3.01 INSTALLATION AND INSPECTION

A. Coordinate the SES conduit installation with the power utility and request its inspection of the work prior to covering up the work.

3.02 PROTECTIVE-DEVICE SETTING COORDINATION

A. Refer to Section 26 05 74 for Short-Circuit and Protective-Device Coordination Studies and Section 26 08 00 for device setting implementation requirements and Arc Flash labeling requirements.

3.03 PROTECTIVE-DEVICE SETTINGS

A. The power utility metering instrument transformer ratios shall be confirmed with the power utility metering department.

B. The protective devices shown on the Drawings are preliminary and are subject to confirmation with the coordination study in Section 26 05 74.

C. The ground fault protective device and the fuses or tripping devices shall be adjusted to the settings specified in the protective-device coordination study in Section 26 05 74 prior to energizing the SES.

3.04 FIELD TESTING

A. The SES equipment shall be tested in accordance with Section 26 08 00. Verify the ground fault setting and trip functions. Perform ground fault protection performance test per manufacturer's instructions. Provide written successful test results.

END OF SECTION

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SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies dry-type transformers with primary winding rated 600 volts and less used for power distribution, lighting and control purposes as specified or shown.

1.02 QUALTIY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/IEEE C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers
ANSI/UL 506	Specialty Transformers
NEMA ST20	Dry-Type Transformers for General Application

B. Transformers:

1. Voltage, frequency, number of phases and kilovoltampere (kVA) as indicated.
2. Conform to American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) C57.12.01 and ANSI/UL (Underwriters Laboratories) 506.

1.03 SUBMITTALS

A. The following information shall be submitted in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to

indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Contract Document Single-Line Diagram E-601 and Plan Drawing E-401, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Layout drawings indicating arrangement, dimensions, cable entries, and weights.
4. Manufacturer's product and catalog data indicating equipment specifications and features including interrupting, withstand, and continuous current ratings of all relevant equipment and components. Catalog data shall be edited or “arrowhead” to indicate only the models and options to be provided as part of this Specification.

C. Action Submittals – Structural Bracing:
   1. Manufacturere shall provide this submittal separately from and after review of the shop drawings submittal. Provide the following per the requirements of Section 01 73 24.
   2. A copy of this Specification section and a copy of Section 01 73 24 and related Structural Drawing S-001, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Manufacturer’s written certification confirming that the equipment bracing complies with the specified requirements.
   4. Manufacturer’s scaled drawings for the equipment showing internal assembly bracing.
   5. Weight for each complete equipment assembly.

6. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Informational Submittals – Final Structural Bracing Certification:
   1. Provide the final reviewed complete Structural Bracing Submittal, including review comments for review by the Owner's Authority Having Jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include:
   1. ABB.
   2. General Electric.
   3. Eaton Cutler-Hammer.
   4. Siemens.
   5. Square D.
   6. Or equal.

2.02 INSULATION

A. Transformers temperature rise based on 40-degree Centigrade (40°C) ambient temperature:
   1. Not exceed 115°C temperature rise.

2.03 COILS

A. Transformer Coils:
   1. Copper
   2. 15-kVA and above:
      a. Impregnated with varnish.

2.04 WINDING CONFIGURATION

A. Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified or shown. Provisions shall be made to permit separate grounding of the neutral conductor and the enclosure. Single-phase transformers shall be the four-winding type.

2.05 TRANSFORMER TAPS

A. Transformers 15-kVA and above shall be provided with two 2-1/2 percent full-capacity taps above normal voltage and four 2-1/2 percent full-capacity taps below rated voltage on the primary winding.

2.06 TERMINAL COMPARTMENTS

A. Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for the cable specified.

2.07 ENCLOSURES

A. Transformer Enclosures:
   1. Indoor over 15-kVA:
      a. Drip-proof, ventilated enclosures.
   2. Assembly shall be braced by the manufacturer per the seismic requirements of the Structural Drawings. Submit bracing information.

2.08 MOUNTING

A. Transformers shall be floor-mounting type.

2.09 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 26 05 00.

2.10 SOUND LEVELS

A. The sound levels shall not exceed the following values:

kVA	dB
0-9	40
10-45	42

PART 3 EXECUTION

3.01 GENERAL

A. Bond transformer enclosures and neutrals together and connect to the ground grid.

3.02 INSTALLATION

A. Install transformers on walls or floors at locations shown on the Drawings. Install floor-mounted transformers on raised concrete bases. Provide sufficient access and working space for ready and safe operation and maintenance.

B. Mount transformers so that vibrations are not transmitted to the structural parts of the building or to other equipment. Make connections to transformers with flexible conduit.

C. Adjust tap settings to provide proper voltage at panelboards.

D. Ground transformer in conformance with the National Electrical Code.

3.03 TESTING

A. Transformers shall be tested in accordance with Section 26 08 00.

END OF SECTION

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SECTION 26 24 13

SWITCHBOARDS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies indoor, front-accessible, deadfront power distribution switchboards rated 600-volts, 3-phase, 3-wire, 60-Hertz.

B. Provide metal oxide varistor (MOV) surge protective device (SPD) integral within each switchboard.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C57.13	Requirements for Instrument Transformers
IEEE	Institute of Electrical and Electronic Engineers
NEMA PB 2	National Electrical Manufacturers Association Deadfront Distribution Switchboards
UL 891	Underwriters Laboratories - Deadfront Switchboards

B. Listed Products: Electrical equipment and materials shall be listed for the purpose per Section 26 05 00.

C. Factory Tests:

1. Switchboards shall be tested for operation at the specified voltage and current ratings after assembly. The main circuits shall be given a dielectric test of 2200 volts for 1 minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for 1 minute between live parts and ground.

2. Instrument transformers shall have ratio- and phase-angle tests made in conformance with American National Standards Institute (ANSI) C57.13.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A copy of the Contract Documents' Electrical Drawings E-401, E-601, and E-602, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. A copy of the Contract Document Process and Instrumentation Diagram I-605 with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   4. Catalog data on all electrical devices and components mounted on or within the switchboard.
   5. Manufacturer's data indicating interrupting, withstand, and continuous current ratings of all relevant equipment and components.
   6. Arrangement and layout drawings of the switchboard enclosures indicating equipment and bus arrangement and dimensions including areas of permissible cable entries. A list of material and components shall accompany the layout drawings. Include weight and shipping split data.
   7. Manufacturer's certification that equipment meets the seismic requirements.
   8. Submittal requirements of Section 26 43 13.

C. Action Submittals – Structural Bracing:
   1. Manufacturer shall provide this submittal separately from and after review of the shop drawings submittal. Provide the following per the requirements of Structural Drawings.

2. A copy of this section and related Structural Drawings, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark (✓) shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
4. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
5. Weight for each complete equipment assembly.
6. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Informational Submittals - Final Structural Bracing Certification:
1. Provide the final reviewed complete Structural Bracing submittal, including review comments for review by the Owner's Authority Having Jurisdiction.

E. Closeout Submittals – Operation and Maintenance (O&M):
1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
   a. O&M information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01 78 23, whichever is the earlier.
   b. Full-size drawings shall be reduced to 11 x 17 inches.
2. Include the following in each O&M manual:
   a. Final reviewed submittals, including revised As-Built Drawings.
   b. Manufacturer's O&M instructions, edited for this project.
   c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for the power quality monitor.
   d. Field set configuration settings per Part 3.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchboards shall be provided in accordance with UL 891, NEMA PB 2, and as specified. Provide arc flash mitigation products that are offered in the manufacturer's literature.

B. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include:
   1. Eaton Cutler-Hammer.
   2. General Electric Co..
   3. ABB.
   4. Siemens.
   5. Schneider – Square D.
   6. Or equal.

2.02 CONSTRUCTION

A. Arrangement:
   1. Switchboards shall be new, deadfront, indoor-type, metal-enclosed, self-supporting, and suitable for 600-volts, 3-phase, 3-wire service. Suitable for mounting against a wall without back access.
   2. Switchboards shall be provided with vertical sections bolted together to form rigid units with switching and protective devices of the number, rating, and type specified.
   3. Interconnections, instrumentation, and control wiring shall be completed in the factory so that site work is limited to bolting shipping sections and connecting cable assemblies.

B. Structure: Structural members shall be universal frame die formed type, bolted and braced using self-tapping bolts. Cover plates shall be steel having formed edges. Front plates shall be sectionalized and removable. Lifting eyes shall be provided and switchboards shall be capable of being rolled or moved into position and bolted directly to the floor without the use of floor sills. Switchboard enclosure rating shall be NEMA-1 gasketed.

C. Structural Bracing:
   1. Switchboard assembly shall be braced by the manufacturer per the seismic requirements of Structural Drawings. Submit bracing information.

2.03 COMPONENTS

A. Bus Bars:
   1. Buses shall be tin-plated copper of sufficient size to limit the temperature rise to 65°C, based on UL 891.
   2. Unless otherwise specified, buses shall be braced to withstand short-circuit stresses up to 65,000 root mean square (RMS) amperes. Main horizontal bus shall be mounted on glass polyester insulators and shall have the continuous capacity specified.
   3. A ground bus having a momentary rating at least equal to the highest momentary rating of any circuit breaker in the assembly shall extend the full length of the switchboard. Ends of the ground bus shall be provided with clamp-type terminals for No. 4/0 AWG (American Wire Gauge) bare copper grounding conductors.

B. Circuit Breakers:
   1. General: Circuit breakers shall be a stored-energy type mechanism to provide quick-make, quick-break, trip-free operation:
      a. Insulated or molded case UL-listed 100% continuous current capacity.
      b. Molded case UL-listed 80% continuous current capacity.
   2. Circuit breakers shall provide manual switching operation by means of a low-torque handle or pushbutton on the front of the unit. Automatic operation during overload and short-circuit conditions shall be provided by solid-state or thermal-magnetic tripping devices located in the circuit-breaker frame as specified on the Drawings.
   3. Circuit breakers shall be front-accessible, stationary, individually mounted, and shall have short-circuit capabilities equal to or greater than the system in which they are installed.
   4. Circuit breakers shall have a minimum interrupting current of 65,000-amperes symmetrical RMS at 480-Vac.
   5. Static Tripping Devices: Solid-state static tripping devices shall consist of current sensors, logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame and shall not require any external relaying or power supplies.
      a. Tripping functions shall be field adjustable and contain the following tripping characteristics:
         1) Overload tripping:
            a) Adjustable ampere setting.
            b) Adjustable long-time delay.
         2) Short circuit tripping:
            a) Adjustable short-time pickup.
            b) Adjustable short-time delay.
            c) Adjustable instantaneous pickup.

C. Panel Instruments and Accessories:
   1. Current transformers shall be furnished with 800:5 ratios. The accuracies shall conform to ANSI C37.13.
   2. Power Quality Monitor combination units shall have harmonic analyzer ability that displays the voltage/current harmonic and the total harmonic distortion for the electrical equipment being monitored.
      a. Power Monitor to include 480- to 120-Vac power supply or transformer and fusing to the bus.
      b. Power Monitors shall have the following analog 4-20 mAdc outputs:
         1) Phase-Phase Voltage.
         2) Average Current.
         3) Power Factor.
   3. Surge Protective Device:
      a. Refer to Section 26 43 13.

D. Nameplates:
   1. In addition to the manufacturer's identification, switchboards shall be provided with phenolic nameplates indicating switchboard, main breaker, and feeder breaker

designations as specified. Nameplates shall comply with Section 26 05 00 and the National Electric Code (NEC) for uniquely labeling the power loads and using equipment Tag Numbers and Tag Descriptions where shown on the Drawings or Schedules.

E. Conductor Markers:
   1. Conductor markers shall comply with Section 26 05 00.

F. Wiring:
   1. Internal switchboard wiring shall consist of single-conductor SIS 90°C copper wire and UL listed for panel wiring. The wire shall be sized to suit load requirements. Minimum size shall be No. 14 AWG.

PART 3 EXECUTION

3.01 PROTECTIVE-DEVICE SETTINGS

A. The protective relays and static tripping devices shall be adjusted to the settings specified in the protective-device coordination study in Section 26 05 74 prior to energizing the switchboard.

B. The instrument transformer ratios and protective devices shown on the Drawings are preliminary and are subject to confirmation with the coordination study in Section 26 05 74.

3.02 FIELD TEST

A. Each switchboard breaker shall be tested in accordance with Section 26 08 00.

B. Switchboard manufacturer or its authorized personnel shall provide one man-day of on-site configuration and testing for the power quality monitor.
   1. All power monitor jumper, switch, and parameter settings shall be recorded and provided in the O&M Manuals.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 DESCRIPTION

A. Single-phase, three-wire 120/240-volt, dead-front, circuit-breaker type panelboards with current rating of 400-amperes or less.

B. Provide metal oxide varistor (MOV) surge protective device (SPD) integral within each panelboard.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
NFPA 70	National Electric Code (NEC)
UL 50	Cabinets and Boxes
UL 67	Underwriters Laboratories, Electric Panelboards
UL 489	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 1449	Surge Suppression Devices

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to

indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Contract Documents' Electrical Drawing E-601 and E-602, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Catalog data on all electrical devices and components mounted on or within the switchboard.
4. Manufacturer's data indicating interrupting, withstand, and continuous current ratings of all relevant equipment and components.
5. Arrangement and layout drawings of the switchboard enclosures indicating equipment and bus arrangement and dimensions including areas of permissible cable entries. A list of material and components shall accompany the layout drawings. Include weight and shipping split data.
6. Submittal requirements of Section 26 43 13.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include:

1. Eaton/Cutler-Hammer:
   a. PRL1a and PRL3a, and Clipper Power Visor Surge Protective Device series.
2. General Electric:
   a. AQ and AD, with internal Surge Protective Devices.
3. Square D:
   a. NQOD and NF, with internal Surge Protective Device.
4. Or equal

2.02 ARRANGEMENT AND CONSTRUCTION

A. The front of the panel shall have concealed trim clamps and hinges. The locks shall be flush with cylinder tumbler-type with spring loaded door pulls. The fronts shall not be removable with doors in the locked position. Panelboard locks shall be keyed alike.

B. Gutter space shall be provided on all sides of the breaker assembly to neatly connect and arrange incoming wiring.

C. Panelboard shall be composed of individually mounted circuit breakers designed to be removable without disturbing other breakers.

D. A directory holder with clear plastic plate and metal frame shall be mounted on the inside of the door.

2.03 BUS

A. Bus shall be tin-plated copper and shall have current ratings as shown on the panelboard schedules, sized in accordance with UL 67. Ratings shall be determined by temperature rise test.

B. The minimum bus size shall be 100-amperes. Panel fault withstand rating shall be not less than the interrupting rating of the smallest circuit breaker in the panel. Series rating is prohibited.

C. Panelboards shall be provided with a separate ground bus and, where specified, with a full-capacity neutral bus. The neutral bus shall be mounted on insulated stand-offs.

2.04 CIRCUIT BREAKERS

A. Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers shall be bolt-on type. Circuit breakers shall be listed in accordance with UL 489 for the service specified. Load terminals of circuit breakers shall be solderless connectors.

B. Circuit breakers rated 120/208-volt and 120/240-volt alternating current shall have a minimum interrupting current rating of 18,000 amperes symmetrical at 240-volt AC.

C. Not used.

D. Provide circuit breakers with special features such as ground fault interrupting (GFI), heating air conditioning and refrigeration (HACR) rating, or locking capability as shown on the Drawings or Schedules.

2.05 FINISH

A. Panelboard cabinet shall be fabricated from hot-dip galvanized steel in accordance with UL 50. Panelboard fronts shall have a gray, baked enamel finish.

2.06 SURGE PROTECTIVE DEVICE

A. Refer to Section 26 43 13.

2.07 NAMEPLATES

A. A Nameplate indicating panelboard tag number, power source, and voltage shall be provided in accordance with the requirements of Section 26 05 00.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall type in the circuit description on the circuit directory as shown on the final Record Drawings or Panelboard Schedule.

B. Provide “Circuit Directory and Circuit Identification” in accordance with National Electrical Code (NEC) 408.4. Each circuit shall be of sufficient detail to allow each circuit to be distinguished from other circuits. Circuit identification shall include load location and provide equipment or instrument Tag Number and Tag Description, where shown on the drawings.

3.02 TESTING

A. Panelboards shall be tested for proper operation and function.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies wiring devices consisting of receptacles, switches and appurtenances.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA WD-1	General Requirements for Wiring Devices
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the

paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Manufacturer's descriptive literature for materials.

PART 2 PRODUCTS

2.01 GENERAL

A. Wiring devices shall be Underwriters Laboratories (UL) approved for the current and voltage specified and shall comply with National Electrical Manufacturers Association (NEMA) WD-1. Devices shall contain provisions for back wiring and side wiring with captive binding screws.

B. Provide devices colored to conform to manufacturer's or industry standard for special use such as orange for isolated ground receptacles, blue for surge suppression receptacles, and red for emergency power receptacles. Unless shown otherwise on the Drawings or Schedules, normal use devices shall be brown, except those located in finished areas shall be ivory.

2.02 RECEPTACLES AND PLUGS

A. General:
   1. Receptacles shall be grounding-type.

B. 120V Receptacles:
   1. Indoor Electrical Room:
      a. Unless shown otherwise on the Drawings or Schedules, receptacles shall be duplex 20-ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Where the manufacturer of cord connected equipment requires and isolated ground, a receptacle with isolated ground shall be provided.
         1) Manufactures: Hubbell 5362, 5362-AI or equal.
         2) Isolated ground receptacle manufactures: Hubbell IG-5362, Arrow-Hart IG5362, or equal.
   2. Outdoor, Process Areas:
      a. Receptacle shall be duplex, 20-ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Receptacle and plug shall be corrosion-resistant, marine-duty with yellow polycarbonate weatherproof lift covers.
         1) Manufacturers: Hubbell 53CM62/53CM21, 15W33W/O BOX, or equal.

C. Not used.

D. Not used.

E. Three-Phase Receptacles and Plugs:
   1. Receptacles shall be suitable for 480-volt, 3-phase, 4-wire service, with ampere ratings as specified. Receptacles and plugs shall be designed so that the grounding

pole is permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, and a gasketed screw-type, weathertight cap with chain fastener. Each receptacle shall be provided with one plug.

2. Manufacturers:
   a. Crouse-Hinds "Arktite," Appleton "Powertite," or equal.

2.03 SWITCHES

A. General Purpose (Indoor Electrical Room):
   1. General purpose switches shall be quiet AC-type, specification-grade, back- and side-wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings or Schedules. Switches shall match receptacles in color.
   2. Manufactures:
      a. General Electric, Hubbell, or Construction Manager accepted substitute , as follows:

	20A, 120-277V	
	G.E. Co.	Hubbell
Single	PS 20AC1	HBL1221
3-way	PS 20AC3	HBL1223
4-way	PS 20AC4	HBL1224
SPST Momentary	--	--
Three-Position Center-Off Momentary	--	HBL1557

B. Switches for Outdoor and Process Areas:
   1. Switches shall be 20-ampere with weatherproof/ corrosion resistant neoprene plate. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.
   2. Manufactures:
      a. Hubbell or Arrow-Hart as follows:

	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single-pole	1281	2991
Double-pole	1282	2992
3-way	1283	2993
4-way	1284	2994

2.04 DEVICE PLATES

A. Device plates shall be provided with switches. In indoor electrical room, receptacle device plates shall be made of sheet steel, zinc-electroplated with chrome finish as manufactured by Crouse-Hinds, Appleton, or equal.

B. Device plates in process or outdoor areas shall be corrosion-resistant/marine-duty type. Device plates for explosion-proof equipment shall be factory-provided with the equipment.

C. Device plates shall be provided with engraved laminated phenolic nameplates with 1/8-inch white characters on black background.

D. Nameplates for switches shall identify panel and circuit number and area served. Nameplates for receptacles shall identify panel and circuit, and voltage if other than 120-volt, single-phase.

PART 3 EXECUTION

3.01 INSTALLATION

A. Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

B. Receptacles and switches installed in sheet steel boxes shall be flush-mounted. Flush-mounted receptacles shall be located 18 inches above the floor unless otherwise indicated. Switch boxes shall be mounted 48 inches above the floor. Receptacles installed in cast device boxes shall be located 48 inches above the floor.

C. Wiring devices shall be tested for correct connections.

END OF SECTION

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies individual motor starters and motor controllers installed in enclosures other than motor control centers. Refer to Drawings for product, device, and circuit requirements.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NEMA ICS 1	General Standards for Industrial Control and Systems
NEMA 250	Enclosures for Electrical Equipment (1000-Volt Maximum)

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 013300.

B. Action Submittals - Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner's Representative shall be the final authority

for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy Drawings E-601 and E-606, with addendum updates included, check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification.
3. Marked product literature.
4. Verification of fault withstand ratings, as applicable, and interrupting ratings
5. Layout drawing and schematic diagram.
6. Nameplate engraving.

C. Closeout Submittals:
   1. Applicable operation and maintenance information (not required for manual starters):
      a. Operating instructions.
      b. Preventative maintenance procedures.
      c. Corrective maintenance procedures.
      d. Appendices with parts' identification drawings, warranty information, manufacturer contact information.
      e. Final reviewed submittal.
      f. As-Built Drawings.

PART 2 PRODUCTS

2.01 ENCLOSURE

A. The door to the motor starter enclosure shall be interlocked with an externally operated disconnect handle. Disconnect handle shall be arranged to indicate disconnect position. The disconnect operator handle shall have provisions to accept up to three 3/8-inch shackle padlocks to lock the disconnect in the open position.

B. Enclosures shall be:
   1. National Electrical Manufacturers Association (NEMA) 4 for outdoor and indoor process locations.

2.02 MOTOR BRANCH CIRCUIT PROTECTION

A. Molded-Case Motor Circuit Protectors:
   1. The motor circuit protector (MCP) type molded-case circuit breaker shall only be used as a part of a combination motor starter.
   2. The MCP shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short-circuit protection. The trip setting shall be adjustable over a range of 700 to 1300% of the full-load current of the motor served and shall be adjustable from the front of the breaker.
   3. The MCP circuit breaker shall be rated to interrupt 25,000-ampere symmetrical when used in conjunction with an individual motor starter.

2.03 MOTOR STARTERS

A. The basic full voltage, non-reversing motor starter (FVNR) shall consist of a 3-pole, 600-volt AC contactor, transient surge suppressor, and solid-state overload relay, NEMA Size-1 minimum.

B. The contactors shall comply with NEMA ICS and NEMA rated for the horsepower as specified.

C. Overload relays shall be adjustable solid-state with protection for each of the poles. An overload condition shall cause the overload relay to latch in the open position. Reset shall be accomplished with a reset button located on the unit door exterior. Trip setting shall be adjustable from 85 to 115% of rating.

2.04 TERMINAL BLOCKS

A. Terminal blocks shall be heavy duty, rated at 20-amperes, 600-volts, and shall contain integral marking strips.

B. Terminal blocks shall be provided for external control connections. Spare terminals shall be provided as specified. Terminals shall be permanently identified with the numbers specified.

2.05 CONTROL DEVICES

A. Combination starters shall be provided with door-mounted control devices as shown on the diagrams.

B. Control devices shall be Allen-Bradley 800T/800H series or equal, with NEMA rating to match enclosure.

C. Pilots shall be push-to-test type with light-emitting diode (LED) lamp. Green color for run, Red for alarm.

2.06 TRANSIENT SURGE SUPPRESSORS

A. Transient surge suppressors shall be provided in each starter. Suppressors shall be encapsulated, three component, solid-state circuit, in a module suitable for mounting directly to the starter coil. Additional space for suppressors shall not be required. Suppressors shall be rated 120-volts AC/DC.

2.07 CONTROL-CIRCUIT TRANSFORMERS

A. Each combination motor control unit shall be provided with a control-circuit transformer rated for 480 x 120V, single-phase, 60-Hertz. Unless otherwise specified, transformers shall have a minimum volt-ampere rating as follows:

Starter	CPT Minimum Volt-Ampere Rating
Size 1	100
Size 2	150
Size 3	200
Size 4	300

B. The transformer size shall be increased if the devices applied will cause a control transformer overload or secondary terminal voltage to drop to or below 95% of rated secondary control voltage when rated primary voltage is applied. Each control transformer shall be mounted within the enclosure along with its associated circuit breaker and starter.

2.08 CONTROL-CIRCUIT FUSING

A. Two primary fuses, rated to interrupt 200,000-amperes at 600-volts, shall be provided on all motor starters.

B. Each control-circuit transformer shall be provided with one control-circuit secondary fuse. The secondary fuse shall have an interrupting rating of 10,000-amperes at 250-volts. The secondary fuse shall be sized at 125% of full-load current. Fuses shall have time-delay characteristics as required to prevent false tripping due to coil in-rush currents.

2.09 WIRING

A. Conductors shall be 90°C switchboard type. Conductors shall be identified with tag numbers as specified in Section 26 05 00.

2.10 MANUAL STARTERS

A. Manual starters shall comprise a horsepower-rated quick-make, quick-break, toggle mechanism together with overloads in all phase conductors.

2.11 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 26 05 00. Engraving shall include equipment tag number and name, power source and voltage.

PART 3 EXECUTION

3.01 DEVICE CALIBRATION AND TESTING

A. The Contractor shall size the overload relay heater elements or adjust the solid-state overload device to the actual nameplate full-load amperes of the motor connected to the starter.

B. The Contractor shall adjust motor circuit protector to the lowest setting not causing false tripping.

C. The Contractor shall record the settings on each motor controller and record the settings as part of the Record As-Built Drawing submittal.

3.02 MOUNTING HEIGHT

A. The Contractor shall mount local motor starters at 48 inches above the floor.

3.03 TESTING

A. Local motor starters and circuits shall be tested in accordance with Section 26 08 00.

END OF SECTION

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SECTION 26 29 23

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies 480-Vac rated adjustable-frequency drive (AFD) motor controller systems using insulated gate bipolar transistors (IGBT) for pulse-width modulation technology (PWM).
2. The AFDs specified in this section shall be the product of a single vendor and mounted in the specified cabinet enclosure.
3. The terms AFD (adjustable-frequency drive), ASD (adjustable-speed drive), VFD (variable-frequency drive), and VSD (variable-speed drive) are interchangeable for the purposes of this Specification.
4. Refer to the Drawings for control and monitoring requirements, including special interlocking requirements.

B. System Requirements:

1. The AFD system shall convert 460-volt, 60-Hertz nominal input to a suitable voltage and frequency to cause a premium efficient, inverter duty, squirrel-cage induction motor to run at a speed proportional to an external input analog 4 to 20-mA (milliamps) DC or digital input command as specified for the required AFD speed range.
2. The AFD system shall include rectifier units, inverter units, control circuitry, protective equipment, input line reactors and output load reactors and other filters and accessories as necessary to provide the specified functions to meet voltage and current harmonics at the specified point of common connection and to mitigate the motor reflected voltage wave. Unless otherwise specified, the point of common connection for AFDs shall be the 480-distribution bus (switchboard) immediately upstream of the AFD.
3. The AFD system torque requirement shall match the pump torque requirement. Verify the pump type and select variable torque (VT) or constant torque (CT) as specified in the AFD Schedule.

C. AFD Schedule:

Equipment Name & Tag Number	Drive Number	Drive Horse Power	Drive Speed Range*	Driven Equipment Specification	AFD Type	AFD Enclosure & Mounting	Distance (ft) from AFD to Driven Equipment Motor
Mingus Pump 1 P3110	VFD3110	60	1100-1800	43 23 13.21	VT, 18 Pulse	NEMA-1 Gasketed, Floor Mount	40
Mingus Pump 2 P3120	VFD3120	60	1100-1800	43 23 13.21	VT, 18 Pulse	NEMA-1 Gasketed, Floor Mount	40
Mingus Pump 3 P3130	VFD3130	60	1100-1800	43 23 13.21	VT, 18 Pulse	NEMA-1 Gasketed, Floor Mount	40
Mingus Pump 4 P3140	VFD3140	60	1100-1800	43 23 13.21	VT, 18 Pulse	NEMA-1 Gasketed, Floor Mount	40
Jockey Pump P3150	VFD3150	20	1100-1800	43 23 13.21	VT, 18 Pulse	NEMA-1 Gasketed, Floor Mount	40

*Verify minimum speed range with Engineer based on final review submittals prior to VFD on-site configuration and testing.

D. Environmental Conditions:
   1. High-altitude ambient conditions are specified in Section 01 11 80.

E. Seismic:
   1. Free-standing AFDs shall be braced per requirements of Structural Drawings.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power System
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts
NEMA ICS 6	Industrial Control and Systems: Enclosures
NEMA ICS 7	Industrial Control and Systems: Adjustable-Speed Drives
NEMA ICS 7.1	Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems
NFPA 70	National Electric Code (NEC)
UL Standard 508	Industrial Control Equipment

B. Industry Standards:
   1. The AFD shall be Underwriters Laboratories (UL) 508 listed and shall conform to the requirements specified in National Electrical Manufacturers Association (NEMA) ICS 2, 6, 7 and 7.1.

C. Unit Responsibility:
   1. The Contractor shall assign unit responsibility for the AFDs in this section to the pump manufacturer specified in Section 43 23 31.21, as specified in Section 43 05 11-1.02 Unit Responsibility. The Contractor shall submit letters of certification with the shop drawings from the AFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A copy of the Contract Document Electrical Drawings E-401, E-601, and E-605, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. A copy of the Contract Document Process and Instrumentation Diagram (P&ID) I-602 and I-603 with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. A copy of the Certificate of Unit Responsibility from submittal for Section 43 23 31.21 attesting that the Contractor has assigned, and that the pump manufacturer accepts, unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
5. Catalog and technical data, including outline dimensions, shipping section dimensions, weight, and foundation requirements for all assemblies.
6. Schematic diagrams and wiring connection diagram showing functions and identification of terminals.
7. Spare parts to be provided.
8. Voltage and current Total Harmonic Distortion (THD) calculations with line reactors or filter design to mitigate harmonics to meet Institute of Electrical and Electronics Engineers (IEEE) 519, if applicable.

C. Action Submittals – Structural Bracing:
1. Manufacturer shall provide this submittal separately from and after review of the shop drawings submittal. Provide the following per the requirements of Section 01 73 24 and Structural Drawings.
2. A copy of this section and related Structural Drawings, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (√) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
4. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
5. Weight for each complete equipment assembly.
6. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Informational Submittals - Final Structural Bracing Certification:
1. Provide the final reviewed complete Structural Bracing submittal, including review comments for review by the Owner's Authority Having Jurisdiction.

E. Closeout Submittals – Operations and Maintenance.
   1. Applicable operation and maintenance information on an item-by-item basis in accordance with Section 01 78 23.
      a. Operation and maintenance information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01 78 23, whichever is the earlier.
      b. Full-size drawings shall be reduced to 11 x 17 inches.
   2. Include the following in each operation and maintenance manual:
      a. Final reviewed submittals, including revised as-built drawings.
      b. Manufacturer's operation and maintenance instructions, edited for this project.
      c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each VFD per Part 3.
   3. Installation certification Section 43 05 11-Form A as specified in paragraph 3.01.
   4. Training certification Section 43 05 11-Form B as specified in paragraph 3.03.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this section. AFDs shall be installed in the custom enclosures as specified and candidate manufacturers include:
   1. Eaton Cutler-Hammer.
   2. Or equal

2.02 ENCLOSURES

A. Provide AFD in NEMA enclosures with filtered fan cooling.
   1. General:
      a. Provide enclosures with AFDs and custom control as required for the project and as indicated on the Drawings. Each drive shall be designed for stand-alone operation, and multiple drives shall not utilize shared components. Review the project site location, elevation, temperature, humidity, and load current-torque requirements to size the AFD and its associated enclosure with requirements specified herein and the control and monitoring devices and interlocks as indicated.
      b. Enclosures shall be designed for indoor service. Each AFD system shall be mounted in a NEMA 250 internally force ventilated enclosure with UL-approved Class 1 filters on ventilation openings. Enclosures shall be fabricated from 12-gage minimum thickness sheet steel with an interior frame or formed to provide a rigid structure.
      c. Provide enclosure size to allow entry of power source and motor load cables as indicated on the Drawings. Submit drawing of the source and load power cable location within the enclosure and indicated barriers from control and instrument wiring.

d. Door width shall not exceed 36 inches and shall be hung on removable-pin hinges, with three-point latch hardware, and handle latch for 3/8-inch shackle padlock.
e. Enclosure shall house AFD and 18-pulse transformer. Separate transformers are not acceptable.

2. Finish and Coatings:
a. AFD systems enclosures shall be finished with corrosion-protection coatings inside and outside for hydrogen-sulfide atmospheres. The electrical and electronic assemblies shall have conformal coatings.

B. Structural Bracing:
1. Assembly shall be braced by the manufacturer per the seismic requirements of Structural Drawings. Submit bracing information.

2.03 AFD ASSEMBLIES

A. General:
1. AFDs shall include the following assemblies:
a. Power disconnect using a thermal-magnetic circuit breaker disconnect sized for the specific application by the manufacturer.
b. Line 18-pulse transformer, for harmonic mitigation.
c. Rectifier, direct current bus filter, and inverter.
d. Control-circuitry interface with Operator Interface Unit (OIU).
e. Output protection, including phase overload.

B. AFD Features:
1. Provided with the following features:
a. Fused control-circuit transformer and microprocessor for system logic-sequencing functions. Provide fuses with blown-fuse indicator lamps.
b. Accept 4- to 20-mAdc speed reference signal.
c. A 4- to 20-mAdc output signal proportional to inverter output frequency for the speed range specified.
d. Adjustable minimum/maximum frequency limits:
1) Minimum frequency shall be adjustable from 6- to 40-Hertz.
2) Maximum frequency shall be adjustable from 48- to 90-Hertz.
e. Adjustable and independent timed linear acceleration and deceleration functions, adjustable from 6 to 20 seconds.
f. Current limiting.
g. Automatic restart.
h. Control wiring:
1) 600-volt stranded copper.
2) 90 degrees Centigrade (°C) color-coded insulation.
3) No. 16 AWG (American Wire Gauge).
i. Wiring identification and termination:
1) Crimp-type wire lugs with sleeve-type markers at each termination point and numbered terminal blocks for external connections.
j. Electrically isolated discrete output contacts for signals shown on P&IDs.

k. Not used.

l. Control power:

1) Provide a 120-Vac, triple-fused, control-power transformer for cooling fans and external control circuits when required. Control circuits shall be isolated from power circuits by distance and by insulated barriers.

m. Provide 120-Vac or 24-Vdc as required for OIU.

C. Functional Requirements:

1. Supply power:

a. Operate continuously with supply power of 480-volts plus or minus 10 percent, 60-Hertz plus or minus 3 percent and remain on line and operate without damage to the AFD or connected load during a supply power under-voltage variation to the drive up to 85 percent of its nominal value for 30 milliseconds at full load.

2. Load:

a. Capable of driving the specified maximum motor load continuously and under the following conditions:

1) Deliver 110 percent of the specified load for up to 60 seconds in variable-torque applications.

2) Deliver 150 percent of the specified load for up to 60 seconds in constant-torque applications.

3. Efficiency:

a. Not less than 95 percent at 60-Hertz output driving the specified maximum load at rated torque and speed at 40°C ambient based on measured input power versus output power with all specified components in the system.

4. Frequency and voltage regulation:

a. Output frequency regulated to within 0.6-Hertz of the signal/output frequency relationship. Output voltage regulated to within 1 percent to produce minimum motor heating at any operating frequency within the specified range.

5. Frequency range:

a. AFD shall be capable of continuous operation with the specified load at any frequency between 6- and 60-Hertz, unless noted otherwise.

6. Space and AFD access:

a. Enclosure size shall not exceed the size allotments specified on the Drawings nor shall any portion of the AFD system exceed a height of 90 inches.

b. Front-accessible only and shall not require rear access.

c. Mount against the wall without any clearance for ventilation or other purposes.

d. Submit AFD in the enclosure drawing with the detail of front door and the internal arrangement, including the feeder and motor cables, the control cables, and the instrument cable location and terminations.

7. Ambient noise:

a. Free field noise generated shall not exceed 85-dBA at 3-feet out from any point on the AFD enclosure under any normal operating condition.

8. Not used.

D. Protection and Annunciation:

1. Overcurrent protection:

a. Electronic current limit at 150 percent of motor nameplate current and provide motor running overcurrent protection in compliance with National Fire Protection Association (NFPA) 70.

2. Short-circuit protection:
   a. Protected against load faults: bolted faults, phase-to-phase or phase-to-ground shall not damage the unit. Fault protection based on a power source short-circuit capacity of 42,000-amperes RMS symmetrical at the AFD power input terminals, with impedance or current limiting device provided.
3. Line voltage:
   a. Protected against high- and low-line voltage on one or more phases.
4. Internal faults:
   a. Internal fault monitoring system to detect malfunctions to protect from transient and sustained faults and to limit damage that may be caused.
5. Motor over temperature:
   a. Interface to motor over temperature device 2-ampere output contact to shut down and alarm if the motor becomes overheated.
6. Fault alarm:
   a. Indicates the cause of any shutdown visible on the AFD keypad/display without opening the AFD enclosure. As a minimum, the following faults shall be alarmed:
      1) Motor over-temperature.
      2) Motor overcurrent.
      3) Incoming power line over/under/unbalanced voltage.
      4) AFD over-temperature.
      5) AFD over-voltage.
      6) AFD control failure.
7. Safety features:
   a. The AFD shall include:
      1) Padlock main disconnect handle in the “Off” position.
      2) Mechanical interlock to prevent opening enclosure door with disconnect in the “On” position while the unit door is open.
      3) Auxiliary contact on main disconnect to isolate 120-Vac control power when fed from external source.
      4) Barriers and warning signs on terminals that are energized with the power disconnect “OFF.”
      5) Separation and insulated barriers between the power and control and instrument products.
      6) External emergency stop input
8. Reverse direction protection:
   a. Provide protection from inadvertent operation in reverse where reverse rotation can damage the driven equipment.
9. Critical speed bypass:
   a. Provide capability to program speed bypass for minimum two critical speed points.
10. Transient voltage protection:
    a. Provide solid-state transient voltage protection to meet or exceed American National Standards Institute (ANSI) C37.90.

2.04 CONTROL AND MONITORING DEVICES

A. Front-door mounted on the AFD enclosure between 36 inches and 72 inches above the floor for each unit:
   1. Digital Operator keypad/display.
   2. Pilots, pushbuttons, and selector switches shown on P&ID.
   3. Manual speed control: Potentiometer function.
   4. Internal terminal strips for remote monitoring:
      a. Signals as indicated on the Schematic Drawing.

B. Operator Interface Unit:
   1. Digital keypad/display for monitoring and controlling the drive and to input drive parameter settings with a backlit LCD or equally visible display with a minimum of 16 characters per line.
   2. Digital keypad for numerical settings in English engineering units and a guide to parameter settings. Setup operations and adjustments stored in non-volatile EEPROM memory transferable to new and spare boards. Settings shall be protected from unauthorized tampering, revision, or adjustment by a personal lockout code.
   3. The digital keypad to provide programming of the drive and include:
      a. Up and Down Arrow Keys:
         1) Increase or decrease output frequency or data values.
      b. Monitor Key:
         1) Selection of control mode.
      c. Run and Stop Keys:
         1) Starting and stopping in the manual mode.
      d. Fault Clear/Enter Keys:
         1) Reset fault conditions and enter change.
      e. Program Key:
         1) Enter the program mode and adjust parameters.
      f. Remote/Local Location Keys:
         1) Operation location and local speed control.
      g. Auto/Manual Mode Keys:
         1) Program mode.
      h. Number Keys:
         1) 0 through 9 keys to access specific parameters.
      i. Keypad Digital Illustrations:
         1) English and display the last five faults.
      j. Frequency/Motor Speed Indication:
         1) Calibrated in Hertz and RPM.
      k. Run Status Indication.
      l. Ready Status Indication.
      m. Fault Alarm Indication.

C. Control and Monitoring Communication
   1. Ethernet/IP protocol network port for interface to Allen-Bradley PLCs:

2.05 KEYPAD FUNCTIONS AND OPERATION

A. Adjustment of the following parameters through the OIU digital keypad:
   1. Current limit and torque boost.
   2. Maximum voltage level.
   3. Minimum/Maximum speed, Volts/Hertz, Upper and Lower limit.
   4. Adjustable acceleration rate and deceleration rate.
   5. Electronic thermal overload setting.
   6. Coast, controlled ramp or DC injection selectable modes of stopping.
   7. PID setpoint and time-function selection.
   8. Critical frequency avoidance:
      a. Three setpoints selectable from 0 to maximum frequency with setpoints adjustable from 0- to 30-Hertz.

2.06 SPARE PARTS

A. The following spare parts shall be supplied with each type or frame size AFD:
   1. Three sets of all replaceable fuses.

PART 3 EXECUTION

3.01 FIELD INSTALLATION

A. Each adjustable speed controller shall be installed and tested by the Contractor with the assistance of factory-trained pump manufacturer engineer/technician and AFD engineer/technician in accordance with the manufacturer's specifications and Section 26 08 00, and witnessed by the Construction Manager.

B. Manufacturer’s factory representatives shall provide field testing for devices, including the setup of the OIU and the setup of the data communication devices, where used. Upon satisfactory completion of the testing, the Contractor shall submit two certified copies of the test report to the Construction Manager.

C. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

D. The installation shall be certified on Form 43 05 11-A specified in Section 01 99 90.
   1. Adjust drive and perform “start-up” tests as recommended by manufacturer. Set parameters and carrier frequency for existing motors to avoid insulation damage.
   2. Establish proper direction of rotation for the motor controlled by the drive. Verify that the AFD is precluded from operating in a direction that can damage the driven equipment. Change motor or AFD power lead connection and not the AFD direction, where rotation is incorrect.
   3. Verify that the drive will operate properly both in the “manual speed control mode” and in the “remote or automatic mode” from a remote speed signal input.
   4. Set the maximum “locked rotor” current drawn during start-up recommended by the manufacturer and approved by the Construction Manager.
   5. Set the minimum and maximum speeds and the acceleration and deceleration “ramps” recommended by the Construction Manager.

6. Verify the motor high-temperature switch contacts are wired into the AFD 120-Vac control circuit and will trip on high-winding temperature. Test or simulated the alarm and trip feature at the motor for high temperature and for high vibration, where used.
7. Configure AFD to prevent operation below minimum speed per Paragraph 1.01 C in either hand or automatic modes.
8. Check for excessive heating of the drive and motor. Report any discrepancies to the Construction Manager.

3.02 HARMONIC TESTING

A. The Testing Firm specified in Section 26 08 00 shall perform a harmonics acceptant test with all AFD motor controllers operating to verify compliance with IEEE-519 of less than 5 percent voltage THD and 12 percent current THD at the defined point of common connection when running from power utility power source with a BMI-Dranetz or equal harmonic test set that provides a hard-copy record of the test results.

B. The test shall also be run with power sourced from the standby generator where such a power source is being used at the project site. THD shall be limited to a maximum level of 8 percent voltage THD on standby-generator operation.

C. Submit the test performance to the Construction Manager per latest version InterNational Testing Association (NETA) ATS Acceptance Testing Specifications. Refer to the electrical testing Section 26 08 00.

3.03 TRAINING

A. Two hours of on-site AFD operation and maintenance training shall be provided for the Owner's Operation and Maintenance Staff.

B. Manufacturer's factory representative shall conduct the training, upon acceptance of a resume submitted by the trainer.

C. Training shall be certified on Form 43 05 11-B provided in Section 01 99 90.

END OF SECTION

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SECTION 26 32 13.13

DIESEL-ENGINE DRIVEN GENERATOR SETS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This Section specifies the requirements for providing factory-testing, and on-site acceptance testing of complete and operable standby diesel-engine driven generating system (GenSet) with an outdoor metal enclosure, belly tank fuel storage container, and the devices and equipment required for the system operation. Generators utilizing two engine generators are not acceptable.

B. The generation system shall include the following:

1. Digital control, monitoring, and display system.
2. Cooling system.
3. Belly tank.
4. Exhaust silencer mounted inside of the enclosure.
5. Noise-dampening mounting system.
6. Sound-attenuated outdoor enclosure accessories.
7. Accessories:
   a. Battery charger.
   b. Block heater.
8. Control system testing.
9. Testing with load bank.

C. Operating Requirements:

1. The electric power generating system shall have ratings as indicated with 0.95 power factor, 480-volts, wye-connected generator, three-phase, three-wire, 60 Hz, 1,800 rpm and rated for standby operation per National Electric Code (NEC) Article-701. Generator size shown is based on one manufacturer. Provide generator size required and submit generator manufacturer calculations and certification that generator will consistently start the booster pumps while operating all other power loads specified.

D. Generator Set Schedule:

Tag No.	Description	Enclosure
GEN-3192	Standby Diesel-Fueled Generator	Outdoor

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under

this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C57.13	Requirements for Instrument Transformers
IEC 34-5	Rotating Electrical Machines - Part 5: Degrees of Protection by Enclosures for Rotating Machinery
IEC 60529	Guidelines for Panel Testing
ISO	International Organization for Standardization
MG1	Motors and Generators
NEMA MG1	National Electrical Manufacturers Association Standards Publication MG-1
NEMA SG31	Low Voltage Power Circuit Breakers
NEMA SG51	Power Switchgear Assemblies
NFPA 37	National Fire Protection Association Standard 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	National Electric Code (NEC)
NFPA 110	Emergency and Standby Power Systems
OSHA	Occupational Safety and Health Act
SAE J 1349	Society of Automotive Engineers Engine Power Test Code
UL 142	Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids

B. Unit Responsibility:

The Contractor shall assign unit responsibility, as specified in Section 43 05 11, to the manufacturer of the GenSet provided under this Section. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in Section 43 05 11, for both the GenSet equipment assembly specified in this section and for the automatic transfer switch specified in Section 26 36 23. A completed, signed, and notarized Certificate of Unit Responsibility (Section 01 99 90-Form 43 05 11-C) shall be provided.

C. Design Requirements:

1. Engine:
   a. Rating:
      1) Engine brake horsepower shall be sufficient to deliver full-rated GenSet kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans, fuel pumps, and cooling water pumps.

b. Fuel:
    1) Diesel engines shall be able to deliver rated power when operating on low-sulfur No. 2 diesel fuel having 35-degree American Petroleum Institute (API) (60°F) specific gravity.
c. Fuel Consumption:
    1) Diesel fuel rates shall be based on fuel having a low heating value (LHV) of 42,780 kJ/kg (18,390 Btu/lb) when used at 29°C (85°F) and weighing 838.9 g/l (7.001 lb./U.S. gal).

2. Generator:
    a. Motor Starting:
        1) Variable-speed controllers, as indicated.
    b. Generator Performance:
        1) Voltage dip for motor starting shall not exceed 25% for any individual load step.
3. GenSet start time and load acceptance:
4. Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds.

D. Noise Requirements and Control:
    1. GenSet enclosure sound pressure level when GenSet is fully loaded shall not be greater than: 72 dBA at 7 meters (23 feet) from enclosure.

E. Manufacturer's Qualifications and Warranty:
    1. The complete power-generation system shall be the product of one manufacturer who has been regularly engaged in the production of complete generating systems for at least 25 years.
    2. The supplier shall be the engine-generating system manufacturer's authorized local representative that shall provide installation assistance, startup services, and Owner's staff training. The supplier shall have 24-hour service availability with factory-trained technicians qualified to perform troubleshooting, repairs on the system, and warranty-compliance services.
    3. The GenSet supplier shall provide the following warranty that includes battery warranty, in addition to the warranty specified in the General Conditions:
        a. 2-year parts and labor with travel time included.

F. Manufacturer Factory Testing:
    1. Functional Tests:
        a. Functional testing of the complete power-generation system final assembly shall be performed at the GenSet manufacturer's factory to assure proper system operation.
        b. GenSet shall be load-tested after the assembly is installed into the enclosure and operate continuously without stoppage for a period of 8 hours.
        c. GenSet shall operate for one hour at 1/2, 3/4, and full load, at 0.8 power factor or greater. Restart the test if stopped for any reason.

2. Prototype Test:
    a. The GenSet manufacturer shall certify that engine, generator, and controls have been tested as complete systems in accordance with National Fire Protection Association (NFPA) 110 of representative engineering models (not on equipment sold).
3. Sound Test:
    a. Provide a GenSet factory test for sound pressure level measured in accordance with Institute of Electrical and Electronics Engineers (IEEE) Standard 85, Test Procedure for Airborne Sound Measurement on rotating electrical machines. Refer to paragraph 1.02 for sound test criteria.

G. Shipment, Handling, and Storage:
1. The equipment shall be protected during shipment, handling, and storage per Section 01 66 00.

1.03 ENVIRONMENTAL CONDITIONS

A. General:
1. The GenSet manufacturer shall verify that the diesel engine is correctly sized and is capable of driving the generator with all accessories in place and operating, at the generator's kW rating after derating for the range of temperatures expected in service and the project site altitude.

B. Seismic:
1. Equipment and supports shall be braced per Structural Drawings.

C. Site Conditions:
1. The site conditions are:
    a. -15°C to 40°C maximum ambient.
    b. 5,480 feet altitude.

1.04 SUBMITTALS

A. The following submittals shall be provided in accordance with the requirements of Section 01 33 00.

B. Action Submittals – Shop Drawings:
1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections,

along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

2. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
3. A copy of the Contract Document Electrical Drawings E-401, E-601 and E-602, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. A copy of the Contract Document Process and Instrumentation Diagram I-605 with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "NO CHANGES REQUIRED." Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Manufacturer and manufacturer's type designation.
6. Manufacturer's catalog and/or other data confirming conformance to specific design, material and equipment requirements including:
    a. Engine:
        1) Type, aspiration, compression ratio, and combustion cycle.
        2) Bore, stroke, displacement, and number of cylinders.
        3) Rotational speed, rpm.
        4) Engine lubricating oil capacity.
        5) Engine coolant capacity without radiator.
        6) Engine coolant capacity with radiator.
        7) Coolant pump external resistance (maximum).
        8) Coolant pump flow at maximum external resistance.
        9) Exhaust back-pressure (maximum allowable pressure).
        10) Combustion air inlet flow rate.
        11) Exhaust gas, flow rate, stack temperature.
        12) Exhaust system back pressure (maximum).
        13) Heat rejection to:
            a) Coolant.
            b) Aftercooler.
            c) Lube oil.
            d) Exhaust.
            e) Atmosphere.
        14) Fuel consumption:
            a) 50% load.
            b) 75% load.
            c) 100% load.

15) Fuel supply system, including belly tank and level alarm device.

b. Generator:
   1) Model.
   2) Frame.
   3) Voltage.
   4) kW.
   5) Power factor.
   6) Frequency.
   7) Insulation class.
   8) Number of leads.
   9) Weight, total.
   10) Weight, rotor.

c. Efficiency at Rated Voltage:
   1) Efficiency at 0.95 power factor for 50% load.
   2) Efficiency at 0.95 power factor for 75% load.
   3) Efficiency at 0.95 power factor for 100% load.

d. Radiator:
   1) Model.
   2) Type.
   3) Heat rejection.
   4) BTU/hour.
   5) Fan drive ratio.
   6) Coolant capacity, radiator.
   7) Coolant capacity, radiator and engine.

e. GenSet with Enclosure Dimensions:
   1) Dimensions.
   2) Length, width, height.
   3) Weight.
   4) Dry and wet.
   5) Vibration isolators.

f. Power Rating

g. Nominal full-capacity standby kW at 0.95 power factor and corresponding kVA rating.

7. Drawings:
   a. General dimensions drawings showing overall GenSet measurements, mounting location, and interconnection points for load leads, fuel, exhaust, cooling and drain lines.
   b. General dimension drawings for fuel supply and storage system including interconnection points, fuel and drain lines, and level and leak-detection equipment, terminal boxes and panels.

8. Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council format for controls and switchgear showing interconnected points and logic diagrams for use by Contractor and Owner.

9. Generator manufacturer sizing calculations and signed certification that the generator will consistently start three booster pumps while operating all other power loads specified.

C. Action Submittals – Structural Bracing:
   1. Provide submittal separately from and after review of the Shop Drawings submittal. Provide the following per the requirements of Structural Drawings.
   2. A copy of this Section and related Structural Drawings, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
   4. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
   5. Weight for each complete equipment assembly.
   6. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Action Submittals – Contractor-Applied Coatings:
   1. Exterior paint color chip for enclosure per paragraph 3.01.

E. Informational Submittals – Final Structural Bracing Certification:
   1. Provide the final reviewed complete Structural Bracing submittal, including review comments for review by the Owner's Authority Having Jurisdiction.

F. Informational Submittals – Test Results:
   1. Factory test reports per Part 3.
   2. Field test reports as specified.

G. Closeout Submittal – Operation and Maintenance (O&M):
   1. O&M information as specified in Section 01 78 23. In addition to the following:
      a. Operating instructions with description and illustration of engine and generator controls and monitors.
      b. Manuals that illustrate and list assemblies, subassemblies and components, except the standard fastening hardware.

c. Preventative maintenance instructions for daily, weekly, monthly, biannual, and annual maintenance requirements. Include a lubrication chart for all components.
d. Routine test procedures for electronic and electrical circuits, including the generator.
e. Troubleshooting chart covering the complete GenSet with a description of trouble, probable cause, and suggested remedy.
f. Recommended spare parts' list showing consumables anticipated during routine maintenance and test.
g. Wiring diagrams and schematics showing function of electrical components.
h. Complete final reviewed submittals, including As-Built Drawings.
i. Manuals and books described above shall be contained in rigid plastic pouches.
j. Warranty verification statements published by manufacturer.
k. Location and description of supplier's parts and service facility, including parts inventory and number of qualified GenSet service personnel.

H. Closeout Submittal – Training:
1. Training certification Section 43 05 11-Form B specified in paragraph 3.03.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this Section. The manufacturer shall have a dealer located within 25 miles of the site.

B. The candidate manufacturers include the following:

Equipment/Manufacturer/Supplier	Engine-Generator
Caterpillar	Caterpillar/Caterpillar

2.02 ENGINE EQUIPMENT

A. General:
1. The engine shall be a single, stationary, liquid-cooled, 1,800 rpm, four-cycle design, direct-injection engine with forged-steel crankshaft and connecting rods. Systems with dual-engine generators in one enclosure will not be permitted.
2. The engine cylinder block shall be cast-iron, with replaceable wet liners with four valves per cylinder. Provide 6-, 12-, or 16-cylinder engine with turbocharger and after-cool, as required by the GenSet manufacturer.
3. The GenSet engine shall not be manufactured with any Class I ozone-depleting substances as defined by Federal Register Vol. 57 No. 86. The GenSet shall be pre-certified EPA Tier-1 emission requirements.

B. Structural Steel Frame:
   1. The generator, radiator, and engine shall be securely mounted on a heavy welded steel frame structure that is stiffened and cross-braced to provide a rigid mounting base.

C. Engine Equipment:
   1. The engine shall be equipped with manufacturers standard air filters, fuel filters, pressure gauges, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing, when applicable.

D. Engine Fuel System:
   1. Fuel/Water Separator:
      a. A fuel/water separator shall be provided to protect the fuel system from water damage.
   2. Fuel Lines:
      a. Flexible fuel lines between engine and fuel supply shall be provided to isolate vibration.
   3. Fuel System Maintenance:
      a. The fuel transfer pump, injection pumps, rack-and-pinion assembly, and timing mechanism shall be maintenance- and adjustment-free for the life of the equipment. The fuel filter shall not require changing more frequently than once per year or every 250 hours. Provide a fuel filter with spill containment and catch pan for about 3 gallons of fuel.

E. Governor:
   1. General:
      a. The engine governor shall control engine speed and transient load response. The governor shall be selected, installed, and tested by the GenSet manufacturer.
   2. Speed Control:
      a. The engine governor shall be an electronic speed-control actuator. Speed droop shall be 0 (isochronous) from no-load to full-rated load.
   3. Frequency Regulation:
      a. The steady-state frequency regulation shall be within +/- 0.2 Hz. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear.
   4. Remote Speed Control:
      a. A provision for remote speed adjustment shall be provided.
   5. Actuator:
      a. The forward-acting actuator shall move to the minimum fuel position in the event of a DC power loss.

F. Cooling System:
   1. General:
      a. The engine jacket water cooling system shall be a closed-circuit design with provision for filling, expansion, and de-aeration.

1) The cooling pump shall be driven by the engine. Auxiliary coolant pumps required for heat exchangers or separate circuit after-cooling shall be engine-driven.
2) The cooling system shall tolerate at least 172 kPa (25 psi) static head. Coolant temperature shall be internally regulated to disconnect external cooling systems until operating temperature is achieved.

2. Engine-Mounted Radiator:
   a. Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close-coupled radiator.
3. Coolant:
   a. The unit shall have an antifreeze/coolant mixture. The radiator shall cool the jacket water while the engine is operating at full site capability and 0.062 kPa (1/4-inch water column) external air restrictions.
      1) Additional restriction affecting airflow shall not limit the radiator's capability to adequately cool at maximum site temperature. Provide air flow to meet ambient conditions at specified ratings at 100% rated connected load.
4. Fan and Belt Guarding:
   a. The fan, fan drive, and fan belts shall be covered with 14-gauge punched steel mesh guarding for personnel protection. The guarding shall conform to Independent Electrical Contractors (IEC) 34-5, International Organization for Standardization (ISO) and Occupational Safety and Health Administration (OSHA) standards.
5. Radiator Fan:
   a. The radiator-cooling fan shall be a propeller type driven from the engine with the air drawn from the engine side and exhausted through the radiator core.
6. Inlet Air System:
   a. The engine air cleaner shall be engine-mounted with maintenance access. The maximum restriction to the combustion air inlet shall not exceed engine manufacturer requirements where external ducting is provided.

G. Exhaust System:
   1. General:
      a. The engine exhaust system shall discharge combustion gases safely and without leakage with minimum restriction. The critical sound silencer shall be designed for minimum restriction without excessive back-pressure.
         1) Engine exhaust piping shall be carbon steel, with long-radius, 90-degree bends. Piping shall be installed with 9-inch minimum clearance from combustible material or incorporate appropriate insulation and shielding, as appropriate for personnel safety. Provide a stainless steel flexible connection between the engine and exhaust piping.
         2) Exhaust piping shall be supported and anchored to prevent weight or thermal growth being transferred to the engine. Flexible expansion fittings provided to accommodate thermal growth. Support dampers and spring isolators provided to isolate vibration.
         3) Long runs of exhaust piping shall be pitched away from the engine and water traps installed at the lowest point. Provide a 1-inch diameter capped sample

port for emissions testing. Provide ports 90 degrees apart on a straight section of exhaust piping.

4) Exhaust stacks shall be extended to avoid fumes and odors inside enclosure and installed to minimize noise.

2. Silencer-Critical:
   a. The silencer shall be residential-quality.

H. Structural Bracing:
   1. Generator assembly shall be braced by the manufacturer per the Structural Drawings. Submit bracing information.

2.03 THERMAL INSULATION WRAP

A. General:
   1. Provide thermal insulation wrap or other acceptable method for insulating the hot surfaces on generator engines for personnel and structure safety.

B. Surfaces:
   1. Hot surfaces within the enclosure to protect personnel and structure, as recommended by the manufacturer.

C. Execution:
   1. Provide thermal insulation blanket that is easily removed without damaging the blanket during maintenance or repair of the engine.
   2. Stainless steel removable lacing shall be provided. The use of "hot rings" for binding edges or securing blankets is unacceptable.

2.04 GENERATOR SYSTEM

A. Generator:
   1. The generator shall be synchronous, four-pole, revolving-field, pre-lubricated bearing, air-cooled by a direct-drive centrifugal blower fan, and directly coupled to the engine with flexible-drive discs.
   2. The armature shall have skewed laminations of insulated electrical-grade steel, two-thirds pitch windings. The rotor shall have amortissuer damper windings of layer-wound, mechanically-wedged winding construction. The rotor shall be dynamically balanced.
   3. Insulation system components shall meet National Electrical Manufacturers Association (NEMA) MG1 temperature limits for a Class H insulation system. Actual temperature rise measured by resistance method shall not exceed 105°C for rotor and stator to provide additional allowance for internal hot spots.
   4. The generator insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other airborne contaminants.

B. Exciter:
   1. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear loads on the generator.

2. The PMG shall sustain field-excitation power for optimum motor starting and shall sustain short circuit current for selective operation and coordination of system overcurrent devices.
3. The PMG exciter insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other airborne contaminants.

C. Voltage Regulator:
1. The automatic voltage regulator shall be temperature-compensated, digitally-controlled pulse, width-modulated, solid-state design, and include over-voltage and over-current protection functions.
2. Over-voltage protection shall sense generator output voltage, In the event of regulator failure or loss of reference, the regulator shall shut down its output on a sustained over-voltage of 1-second duration.
3. Over-excitation protection shall sense regulator output and shut down its output if overload exceeds 10-second duration. Both over-voltage and over-excitation protection shall be latched, requiring the generator to be stopped for reset.
4. Generator output voltage shall be maintained within 1% of rated value for any load variation between no-load and full-load and drift no more than within 1/2% of rated value at constant temperature.

D. Circuit Breaker:
1. The generator-mounted circuit breaker shall be mounted and connected in a guarded, drip-proof, freestanding enclosure meeting IEC 144 requirements and provided with adequate space for customer power-cable lug connections. Provide cable lugs by supplier; refer to the Electrical Drawings for circuit conductor sizes and numbers.
2. Provide the following:
a. Molded-case circuit breaker rated for 100% current, three-pole, single-throw, stationary-mounted with manual operating handle, overload and short circuit trips, complete with cable lugs.
b. Circuit breaker shall be Underwriters Laboratories (UL) labeled and rated for 600-volt circuits and provided with a solid-state over-current trip device.
c. A circuit breaker with a 24-Vdc shunt-trip unit wired to terminal board.
d. Three current transformers with 5-ampere secondary windings for the ammeter display, as needed.
e. NEC required working access space around the circuit-breaker enclosure.
f. Provide lugs to accommodate cable size and quantity shown.

2.05 ENGINE GENERATOR SYSTEMS

A. Engine-Starting System:
1. The engine-starting system shall include 24-Vdc starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement.
2. Required cables furnished and sized for power feeder circuit requirements and capable of starting the specified engine within 10 seconds at the elevation and ambient environmental conditions specified herein.

B. Water Jacket Heater:

1. Jacket water heater(s) shall be provided to maintain coolant temperature of 37.8°C (100°F) while the engine is not running. Heaters shall accept 240-Vac, single-phase power and include thermostatic controls.

C. Batteries:

1. Batteries for GenSet starting and control shall be selected and supplied by the GenSet manufacturer. Battery warranty shall be the responsibility of the GenSet manufacturer. Batteries shall be protected from engine fuel leaks.
2. Batteries shall be maintenance-free starting, lighting and ignition (SLI) lead acid type with through-partition connectors and mounted near the starting motor. Batteries shall be mounted on a corrosion-resistant or coated steel battery rack as close to the starting motor as practical and allow personnel access for inspection and maintenance.
3. Starting batteries shall be rated 24-Vdc with ampere-hour and ampacity sizing to allow for engine oil viscosity, ambient starting temperature, project elevation, and accessories.

D. Alternator:

1. An engine-mounted, belt-driven battery-charging alternator shall be installed with an automatic voltage regulator. Alternator and regulator suitable for the application with a rating of 24-Vdc output.

E. Battery Charger:

1. A dual-rated, 10-ampere battery charger shall be provided that shall accept 120-Vac single-phase input to provide 24-Vdc output.
2. The battery charger shall be fused on the AC input and DC output and incorporate current-limiting circuitry to avoid the need for a crank disconnect relay. The charger shall be rated for operation at plus 50°C ambient temperature. Charger voltage regulator shall be temperature-compensated.
3. A voltage power switch shall be mounted on the face of the charger and shielded from accidental switching. The charger shall include an AC ammeter and voltmeter, a failure malfunction alarm switch, and be housed in an enclosure suitable for mounting inside the outdoor enclosure.

2.06 FUEL STORAGE SYSTEM

A. Provide 24-hour rated belly fuel tank, fuel-level indication, and diesel-fuel flowmeter indicating flow rate and flow total. Tank shall have UL 142 secondary containment with leak detector. The tank shall be manufactured by the same manufacturer as the generator.

B. Provide low-fuel level and tank-leak alarms.

2.07 OUTDOOR ENCLOSURE

A. General:

1. The acoustical enclosure shall house the engine generator and the auxiliary equipment required for the electric power generating system. The enclosure shall be

a weather-protected, sound-attenuated enclosure complete with AC and DC lighting, convenience outlet, field electrical connection provisions, and the following modification and features:

a. Sound-Attenuation Enclosure:

1) The acoustical enclosure shall be constructed of 14-gauge minimum galvanized steel modular panel construction with 4-inch acoustic insulation and perforated liner. The enclosure shall be designed for a minimum wind load of 100 mph, roof load of 50 pounds per square foot, and floor load of 200 pounds per square foot if equipped with a floor.

2. Galvanized perimeter frame structure bracing shall allow the enclosure to be removed as a unit without disassembly. Provide crane-lifting eyes where required to move enclosure. Provide peaked roof for rain run-off.
3. Provide fixed-vane weatherproof acoustic intake louvers sized per the engine's cooling and combustion airflow requirements.
4. Provide NEC-required 3-foot clear workspace in front of the generator circuit breaker and generator control panel.

B. Doors:

1. Enclosure shall contain four personnel outside-entrance double-gasketed doors for entering the engine/generator compartment. Doors shall be fabricated from 14-gauge galvaneal with heavy-duty continuous stainless steel piano hinge with stainless steel fasteners and pins.
2. Outside door-latch mechanism shall be flush-mounted and lockable. No hardware shall protrude beyond the perimeter of the enclosure to facilitate normal handling and shipping aboard container ships or by highway semi-tractor trailer.

C. Surface Preparation and Painting:

1. Surface preparation and painting for the enclosure by the container manufacture shall be as follows:
   a. Steel sheeting shall be galvanized steel.
   b. Steel components shall be force-dried and painted with a two-part epoxy primer and high-gloss finish polyurethane topcoat.
   c. Caulk open seams with a sealant to prevent rust seepage after painting.

D. Exterior Color:

1. The enclosure exterior shall be painted per manufacturer's standard, with Contractor-applied coatings per Section 09 90 00.
2. Submit exterior paint color chip for approval and provide one gallon of the same paint for touch up purposes to the Owner.

E. Not Used.

F. Not Used.

G. Not Used.

H. Electrical Connections:

1. The generator main circuit breaker shall be housed in a NEMA-12 gasketed metal enclosure installed within the enclosure. Provide a NEMA-12 gasketed terminal box for control and instrumentation wiring, separated from power connections, and show terminal box location in the submittal documentation.

I. Ventilation:
   1. Fixed-vane intake louvers sized per the engine's cooling and combustion airflow requirements. Separate the intake louver from the exhaust louver.
   2. Orient each louver to minimize superheating of the intake air. Use air directional acoustic barrier plates to mitigate sound escaping from the enclosure while not impeding airflow necessary for combustion and cooling. Install water separator to catch and drain of standing water on the louvers.
   3. A sound-insulated baffle shall be installed 6 inches below the opening of the fan and shall extend 12 inches beyond the fan opening.

J. Sound Attenuation:
   1. The enclosure shall be sound-attenuated with composite sandwich construction of perforated metal enclosure, either non-flammable mineral fiber or fiberglass. The interior wall surface shall be 20-gauge perforated aluminum metal construction.

2.08 CONTROLS

A. Engine Generator Control Panel:
   1. The control panel shall be designed and built by the engine generator manufacturer and mounted near the generator with vibration-dampening mounting devices.
   2. Provide a 100%, solid-state, microprocessor-based control circuitry, sealed dust-tight, watertight modular components, and digital instrumentation. Provide IEC-IP52 or NEMA-12 enclosure ratings. Comply with IEC 60529 or NEMA standards for enclosure protection. Label the control panel with ISO symbols.
   3. Display critical parameters such as operating hours, engine rpm, battery DC volts, oil pressure, jacket water temperature, including the specified engine and electrical parameters.

B. Engine-Monitoring Devices:
   1. Engine-monitoring signals provided by engine-mounted lubricating oil pressure and coolant temperature transducers shall communicate over a serial data link through a Data Sending Unit (DSU) to the control panel receiving module. The safety logic shall shut the engine down if the serial data link is lost.

C. Control Functions:
   1. Provide control panel front-mounted devices such as generator voltage control device, ammeter/voltmeter phase-selector switch, control selector switches, and pushbuttons. Provide control and monitor devices identified and labeled with ISO symbols.
   2. Provide start-stop logic for cycle-cranking and cool-down operation and red-mushroom head emergency-stop maintained pushbutton.

D. Control Wiring:
   1. GenSet control wiring:
      a. Number 16 AWG (American Wire Gauge) stranded wire and control panel ground wire.
      b. Number 12 AWG with green and yellow striped insulation rated. Conductors shall be rated 90°C, 600-Vac insulation with UL listing.
      c. Provide wire identification on the conductor 6 inches from the terminal and protect wire from sharp bends and metal edges.
      d. Provide four sets of Form C dry contacts rated at 2-amps for remote customer alarming:
         1) Run Status.
         2) Trouble (pre-alarm) alarm.
         3) Shutdown (fail) alarm.
         4) Low-Fuel alarm.
         5) Fuel-leak alarm.

E. Alarm and Shutdown Conditions:
   1. Indicate the following alarm and shutdown conditions and provide a RESET device to clear fault:
      a. Low oil pressure: pre-alarm.
      b. High engine temperature: pre-alarm.
      c. Low engine temperature: pre-alarm.
      d. Low fuel: pre-alarm.
      e. Low-battery DC voltage: pre-alarm.
      f. Generator output circuit breaker (trip or off): alarm.
      g. Generator overload: alarm.
      h. Low oil pressure: shutdown.
      i. High engine temperature: shutdown.
      j. Low coolant level: shutdown.
      k. Over-crank: shutdown.
      l. Over-speed: shutdown.
      m. Over-voltage: shutdown.
      n. Under-voltage: shutdown.
      o. Under-frequency: shutdown.
      p. High-battery voltage alarm.
      q. Low-battery voltage alarm.
      r. Normal battery voltage indication
      s. Battery charger malfunction alarm.
      t. Spare (2): alarm and shutdown.

F. Metering:
   1. Provide digital metering with 1/20% accuracy. Provide true root-mean-square indication that includes the total harmonic voltage and current content:

a. Voltmeter.
b. Ammeter.
c. Frequency meter.
d. Phase select switch.
e. Running time.

G. Alarm Module:
1. Provide integral digital alarm annunciator for indication and audible alarm per NFPA Standard 110 on the engine-generator control panel. Provide lamp test switches, alarm horn silence-button, and first-out alarm detection.

2.09 SPARE PARTS

A. Spare parts are not required as they shall be normally stocked locally by the manufacturer's local dealer.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. The GenSet shall be installed and connected in accordance with manufacturer's recommendations and the installation shall be certified on Form 43 05 11-A as specified in Section 01 99 90.
2. Verify the equipment pad is sized for the GenSet size per submittal information, level, with ground pad installed.

B. Signs:
1. Provide NEMA MG1-22.61 GenSet nameplate. Provide laminated equipment, device, and panel nameplates per Section 26 05 00.
2. Contractor shall provide one nameplate with minimum 1/2-inch lettering per NEC 701.7 for Contractor installation on the Service Entrance Equipment: "Standby Generator located West of this Service Entrance."

C. Conduit Transitions at Slab:
1. Connection from underground conduits to GenSet equipment shall transition via polyvinyl chlorinated coated, flexible-steel conduits. Loose or open cabling will not be permitted.

D. Not Used.

E. Intrusion Switches:
1. Provide intrusion switch for each enclosure doorway. Switches shall be NEMA 4, with Form C contacts.

F. Exterior Color:
1. Contractor-applied coatings per Section 09 90 00.
2. Submit exterior paint color chip for approval and provide one gallon of the same paint for touch-up purposes to the Owner.

3.02 FIELD INSPECTION AND TESTING

A. Not Used.

B. Pre-Delivery Testing:
   1. Prior to delivery of the GenSet to the project site, test the GenSet to verify it is free of defects, starts automatically, and carries a full load. Test shall be performed at the factory.
   2. The testing shall be done on dry-type, resistive-load banks capable of precise incremental loading.
   3. Provide separate test grade instrumentation to monitor the GenSet using the load bank. The GenSet monitoring instruments shall be read and compared to the amperage and voltage on each phase. Both readings shall be recorded and compared in the test report.

C. Not Used.

D. On-Site Post-Installation Testing:
   1. Following installation, the following tests shall be performed by the system manufacturer's qualified representative in the presence of the Owner's Representative.
   2. Pre-start checks:
      a. Oil level.
      b. Water level.
      c. Fuel level.
      d. Battery connection and charge condition.
      e. Engine to control interconnects.
      f. GenSet intake/exhaust obstructions.
      g. Removal of all packing materials.

E. Field Tests:
   1. The GenSet field test shall be performed by factory-trained technicians at the project site with test equipment, facilities, and consumables, including lubricants provided by the supplier.
   2. The Contractor shall provide a full tank of diesel fuel when the testing is completed and the GenSet is available for operation.
   3. Owner’s Representative shall witness the field tests. Contractor shall provide to the Construction Manager written notice of the date field testing will commence a minimum of 2 weeks prior to that date.
   4. The following field tests shall be conducted:
      a. Check electrical exhaust, fuel and water connections for proper size, continuity and tightness of fittings.
      b. Check fluids for appropriate levels and jacket water heater operation.
      c. Start up engine and make initial start-up check of operational equipment.
      d. Upon completion of initial start-up and system checkout, schedule the witnessed field test to demonstrate load-carrying capability, stability, voltage and frequency.

e. Operate the GenSet for 1 hour for proper engine break-in and record water temperature, fuel pressure, oil pressure, ambient air temperature, voltage, amperage, frequency, kilowatts, and power factor.
f. Operate a minimum of 4 hours under full load with consumables necessary for testing furnished by the bidder.
g. Return to normal power source and test the automatic transfer station (ATS) transfer from normal power to standby power and the ATS monitoring functions by simulating the loss of normal power source.
h. Test the ATS-initiated "GenSet Start" condition with the load bank.
i. Run the generator for test duration; monitor the oil and water temperatures and record readings every 15 minutes.
j. Test the GenSet safety devices using methods recommended by the manufacturer.
k. Set up the unloaded run at the conclusion of the test and the retransfer to normal power to allow engine to cool before engine shutdown.
l. Notify the Owner's Representative of problems and the mitigation plan.
m. Submit the formal Test Results Report for approval.

F. Demonstration:
1. Demonstrate proper operation of generator, transfer switch, switchboard, and programmable logic controller to the Construction Manager. Demonstration to include simulation of power failure with three booster pumps running; generator start and pump restart; restoration of power failure; pump transfer to normal power and restart; and generator stop.

3.03 TRAINING

A. The Contractor shall contract with the GenSet manufacturer to provide 4 hours of training. Arrange and schedule the training with the Owner.

B. Training shall include the requirements of Section 01 79 00 and the following:
1. Operational information for the specific equipment provided:
a. Operation of the equipment in automatic and manual modes.
2. Troubleshooting.
3. Routine maintenance.

C. Training shall be certified on Form 43 05 11-B as specified in Section 01 99 90.

END OF SECTION

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SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies automatic transfer switches (ATS) rated 600-volts and less for lighting, heating, ventilation and air conditioning (HVAC), and motor loads with rating as indicated on the Drawings.

B. The ATS shall use electrically-operated, mechanically-held, power-rated, electrical contractors to provide double-throw switching action with the number of poles as shown or specified.

C. Refer to the standby engine-generator interface and interlock requirements in Section 26 32 13.13.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE Standard 446	Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
NEC Article 701 and 702	National Electric Code: Legally Required or Optional Standby Systems
NFPA 70 - NEC	National Electric Code
NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA Standard ICS10	AC Automatic Transfer Switches
NFPA 110	Emergency and Standby Power Systems
UL 508	Industrial Control Equipment
UL 1008	Standard for Automatic Transfer Switches

B. Listing:
   1. The ATS shall be Underwriters Laboratory (UL) listed in accordance with UL 1008.

1.03 SUBMITTALS:

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A copy of the Contract Document Electrical Drawings E-401, E-601, and E-602, with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. A copy of the Contract Document Process and Instrumentation Diagram I-605 with addendum updates included, marked to show deviations. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   4. Arrangement drawings of the transfer switch enclosure indicating the front door and rear panel equipment arrangement and dimensions.
   5. List of materials and components shall accompany the arrangement drawing.
   6. Elementary and internal connection diagrams.
   7. Manufacturer's data marked to indicate momentary, interrupting, and continuous current ratings of all relevant equipment, components, and devices.

C. Action Submittals – Structural Bracing:
   1. Manufacturer shall provide this submittal separately from and after review of the shop drawings submittal. Provide the following per the requirements of Structural Drawings.
   2. A copy of this section and related Structural Drawings, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a

whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
4. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
5. Weight for each complete equipment assembly.
6. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the manufacturer.

D. Informational Submittals – Final Structural Bracing Certification:
   1. Provide the final reviewed complete Structural Bracing submittal, including review comments for review by the Owner's Authority Having Jurisdiction.

E. Closeout Submittals – Operation and Maintenance (O&M).
   1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
      a. O&M information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01 78 23, whichever is the earlier.
      b. Full-size drawings shall be reduced to 11 x 17 inches.
   2. Include the following in each O&M manual:
      a. Final reviewed submittals, including revised As-Built Drawings.
      b. Manufacturer's O&M instructions, edited for this project.
      c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters per Part 3.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this section.

B. Candidate manufacturers include ASCO, Cummins, Caterpillar-Zenith, or equal.

2.02 RATING

A. The voltage, current, frequency and number of poles shall be as specified and shown. The ATS shall be rated 480-Vac and rated to close onto and withstand a fault, with the withstand closing rating (WCR) of 65,000 symmetrical amperes.

B. The ATS shall be labeled with ratings. Series rating components are not acceptable.

2.03 FACTORY TEST

A. The ATS shall be factory-tested to ensure proper operation

2.04 CONTROL AND MONITORING

A. The switch shall contain the following devices in the control circuit:
   1. Voltage pickup relay: adjustable 85 to 100%.
   2. Frequency pickup relay: adjustable 90 to 100%.
   3. Time-delay relay for open transition from normal to emergency (TDNE): adjustable from 0.2 to 50 seconds, initially set at 1.0 seconds.
   4. Time-delay relay for open transition from emergency to normal (TDEN): adjustable from 0 to 30 minutes, initially set at 30 minutes.
   5. Time-delay for open transition to allow motor-load electromagnetic field (EMF) decay: adjustable from 1 to 10 second, initially set at 20 seconds.
   6. Engine cool-down timer: 0-60 minutes, initially set at 5 minutes.
   7. ATS transfer test switch mounted on equipment cover or door.
   8. Switch position indicating lights:
      a. Green light for normal source and red light for emergency source.
   9. Generator Start Command:
      a. Output relay.
   10. Engine Generator Exerciser:
      a. Adjustable exerciser with no-load or load transfer, start time, duration, retransfer, and cool-down time.
   11. Monitoring:
      a. Event logging with data, time, and reason.
   12. Output status and alarm dry contacts:
      a. Normal Position status (2-sets Form-C).
      b. Standby Position status (2-sets Form-C).
      c. Trouble alarm (2-sets Form-C).

2.05 TERMINATIONS

A. Arrange internal equipment items for power cable bottom entry and bottom exit.

B. Provide oversized termination lugs as required for the size and quantity of conductors shown. Provide copper bus, terminations and connections.

2.06 ENCLOSURE

A. The enclosure shall be floor-mounted and shall be suitable for locations as indicated on the Drawings and as described below:
   1. National Electrical Manufacturers Association (NEMA) 12 dust-tight enclosures intended for indoor use primarily to provide protection against circulating dust, falling dirt, and dripping non-corrosive liquids.

B. Structural Bracing:
   1. Assembly shall be braced by the manufacturer per the seismic requirements of Structural Drawings and Specifications. Submit bracing information.

2.07 NAMEPLATES

A. The switch shall be identified as indicated on the Drawings and nameplates shall be provided in accordance with the requirements of Section 26 05 00.

B. Provide black nameplate with white lettering on front of ATS:
   1. Engraving: “AUTOMATIC TRANSFER SWITCH/480 VAC POWER FROM STANDBY GENERATOR LOCATED NORTH AND SES LOCATED WEST OF THIS ATS.”

PART 3 EXECUTION

3.01 FIELD ADJUSTMENTS

A. The time-delay relays shall be adjusted to the following values:
   1. Normal to emergency time delay: 5 minutes.
   2. Emergency to normal time delay: 20 minutes.
   3. Open Position time delay: 3 seconds.
   4. Voltage pickup: 90%.
   5. Frequency pickup: 95%.

3.02 FIELD TESTS

A. The following tests shall be performed on the equipment provided under this section. Tests shall be in accordance with the latest version of UL and NEMA standards.
   1. Electrical insulation check to verify the integrity and continuity of the system.
   2. Visual inspection to ensure that the switch matches the Specification requirements and to verify fit and finish meet quality standards.
   3. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances.
   4. Test the ATS using engine-generator set per Section 26 32 13.13.

B. The ATS shall be acceptance field tested in accordance with Section 26 08 00.

C. Configure the ATS for scheduled operation in accordance with Owner’s test schedule:
   1. Example:
      a. Wednesday at 10 AM, the plant load transfer from the power utility to the GenSet in accordance with the following to verify that the GenSet and transfer scheme is

operational. Provide settings for the automatic test using the ATS transfer timer schedule: Plant load for 2 hours then retransfer to power utility.

END OF SECTION

SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide the lightning protection system (LPS) design by a qualified LPS firm registered to design lightning protection systems.
   2. Contractor shall furnish and install a complete LPS for the following facilities and structures:
      a. Mingus Pump Station.
      b. Mingus Tank.
   3. Contractor shall test and certify that the LPS design, installation, and testing to comply with the lightning protection industry standards as applied to the project facilities and structures.
   4. Contractor shall provide the LPS firm with the plant or facilities drawings that indicate the equipment, buildings, structures, and heating, ventilation, and air conditioning (HVAC) equipment as the basis for its design work.
   5. Contractor shall submit the design drawing to the Design Review Agency for approval and to the Engineer for reference.

B. Coordination:
   1. LPS design shall be arranged in accordance with the class of structure to be protected.
   2. Coordinate arrangement and connections with roof system proposed for use and roof-mounted equipment. Refer to the structural and architectural drawings provided by the Contractor.

1.02 QUALITY ASSURANCE

A. Quality Control:
   1. LPS materials shall be the standard product of a manufacturer regularly engaged in the production of LPSs.
   2. Materials shall comply in weight, size, and composition for the class of structure to be protected.
   3. LPS shall be installed under the direct supervision of a Lighting Protection System Certified Master Installer.

B. Certification Requirements:
   1. Provide and submit Master Installer Certified forms for the following:
      a. Form LP1-175A - Jobsite Witness of Grounding Connections.
      b. Form LP1-175B - Post-Installation Inspection.
      c. Underwriters Laboratories (UL) Master Label C.

C. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/IEEE C62.1	Surge Arresters for AC Power Circuits
ANSI/IEEE C62.11 LP1-174	Metal-Oxide Surge Arresters for Alternating Current Power Circuits Lightning Protection Institute Installation Code
LP1-175	Lightning Protection Institute Standard of Practice
NEC	National Electric Code (NEC): Article 230 – Services Article 250 – Grounding Article 280 – Surge Arrestors Article 501 – Class I Locations Article 502 – Class II Locations Article 800 – Communications Circuits
NFPA 780	Lightning Protection Systems
UL Standard No. 96	Lightning Protection Components
UL Standard No. 96A	Master Label Provisions

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner's Representative shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with

the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Plan Drawings E-101, E-401, and E-411, with addendum updates included, check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification.
3. Manufacturers technical information for materials proposed for use.
4. Complete scaled drawings identifying the system arrangement and equipment connections for each building.
5. Drawings shall include equipment connection details, down-lead details, routing of system conductors, and locations of air terminals and ground rods.
6. Submit certificate for UL Master Label C.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials:
   1. General:
      a. System materials shall be copper and high copper-content bronze castings.
         1) Fittings, except cable holders, shall be heavy-duty type made from bronze castings.
         2) Terminal rods, bolts, screws, and related type hardware shall be copper-clad steel or brass to prevent galvanic corrosion.
   2. Components:
      a. The system shall consist of the necessary equipment as required to provide a complete and coordinated system. Cable and air terminals used shall bear the UL label. The components shall consist of, but not be limited to, the following:
         1) Cables.
         2) Air terminals.
         3) Mounting bases.
         4) Fittings.
         5) Couplings.
         6) Connectors.
         7) Fasteners.
         8) Conduit.
         9) Pitch pads and weatherproof seals.

2.02 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate firms are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this section.

B. The candidate detailed design, product manufacturer, and installation firm shall be one of the following or accepted equal:
   1. Thompson Lightning Protection Inc.
   2. AC Lightning Security.
   3. Heary Bros. Lightning Protection Co., Inc.

C. Early Streamer Emission (ESE) is a prohibited product system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Verify field measurements as indicated on the drawings and as specified elsewhere herein.

B. Conceal system conductors where practical and main down-leads and roof risers shall be concealed within the building walls or columns.

C. Allow 6-foot minimum clearances as required by the NEC from:
   1. Lightning rod conductors to non-current-carrying metal parts of electrical equipment unless they are bonded to the rods;
   2. Lightning conductors to open conductors of communications systems;
   3. Lightning protection grounding electrodes to electrodes of other grounding systems.

D. Do not use lightning protection rods and electrodes in place of the grounding electrodes for electrical equipment.

E. Run leads in 1-inch Schedule-80 polyvinyl chloride (PVC) plastic conduit.

F. Terminate upper end above floor ceiling, and utilize through-roof connectors for cable roof penetrations. Conduit terminations at lower end to be 6 inches above finished ground level to pinpoint locations during future inspections.

G. Bond metallic objects and systems at roof level.

H. Primary bonds using appropriate fittings and full-size conductor:
   1. Roof intake and exhaust fans, HVAC units, ductwork, piping, ladders, skylights, stacks, vents, etc.
   2. Down-leads to steel column or major framing member at every down-lead position.

I. Secondary bond using secondary cable and fittings:
   1. Metal bodies of inductance located within 6 feet of a conductor
   2. Equipment with primary bond.

J. Connect to structure ground grid system using exothermic welds.

K. Insure installation of air terminals to withstand wind force equivalent to 100 miles per hour with a gust factor of 1.3 without structural damage and without damage to the integrity of the LPS.

L. Interconnect the LPS to the building grounding grid at one location.

END OF SECTION

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SECTION 26 43 13

TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.01 DESCRIPTION

A. Surge protective devices (SPD) replace the transient voltage surge suppressors (TVSS) based on the National Electric Code (NEC) requirements.

B. Scope:
   1. Provide SPD with electrical characteristics and ratings for service entrance equipment, switchboards, and panelboards specified in the Division 26 electrical distribution equipment Specification sections or as indicated on the Drawings. Provide SPD with the same voltage, phase, 3- or 4-wire system as the host electrical equipment.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/Underwriters Laboratories 1449 4th Edition	Surge Protective Devices
Underwriters Laboratories 1283 3rd Edition	Electromagnetic Interference Filter for Noise Attenuation
MIL STD 220A, Rev A, Change Notice #2	Method of Insertion Loss Measurement
National Electrical Code 2008 Article 285	Surge-Protective Devices (SPDs), 1 kV or Less
NEMA LS-1	National Electrical Manufacturers Association: Low Voltage Surge Protective Devices
C-UL	Canadian Underwriters Laboratories
ANSI/IEEE C62.41	American National Standards Institute/Institute of Electrical and Electronic Engineering Inc.

B. Qualifications:
   1. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
   2. The manufacturer shall be International Organization for Standardization (ISO) 9001 or ISO 9002 certified for the equipment specified herein.
   3. The manufacturer shall have produced similar electrical equipment for a minimum period of 5 years.

1.03 SUBMITTALS

A. Submittals and transmittal procedures for submittals are defined in Section 01 33 00.

B. Action Submittals – Shop Drawings and Product Literature.
   1. The following information shall be submitted under Sections 26 21 16, 26 24 13, and/or 26 24 16 as applicable.
   2. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review."
   4. Provide verification that the SPD complies with the required American National Standards Institute/Underwriters Laboratories (ANSI/UL) 1449 4th Edition listing by UL or other Nationally Recognized Testing Laboratory (NRTL).
   5. Compliance: File number verified on UL's website or other NRTL's website, with the following information:
      a. Model number.
      b. SPD type.
      c. System voltage, phases.
      d. Protection modes.
      e. Voltage protection rating (VPR).
      f. Nominal discharge current (In).

6. Drawings showing unit dimensions, weights, installation instruction details, and wiring configuration for sidemount SPD mounted external to electrical assembly.

C. Closeout Submittals – Operation and Maintenance (O&M).
   1. Applicable O&M information on an item-by-item basis in accordance with Section 01 78 23.
      a. Final reviewed submittals, including revised As-Built Drawings.
      b. Manufacturer's O&M instructions, edited for this project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The listing of manufacturers does not imply acceptance of products that do not meet the specified ratings, features, and functions. Manufacturers listed shall meet the specifications in their entirety.

B. Products in compliance with the Specification and manufactured by others not named will be considered if pre-approved by the Engineer 10 days prior to bid date.
   1. Eaton Cutler-Hammer.
   2. General Electric.
   3. Square D.
   4. Accepted equal.

2.02 SURGE PROTECTIVE DEVICES

A. Electrical Requirements:
   1. Refer to Drawings for operating voltage and unit configuration.
   2. Maximum Continuous Operating Voltage (MCOV):
      a. Not be less than 125% of the nominal system operating voltage.
   3. SPD suppression system includes thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and other distribution levels.
   4. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may lead to system upset or create environmental hazards.
   5. SPD shall protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Protection Modes

Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

6. Nominal Discharge Current (In):
    a. SPDs applied to the distribution system shall have a 20-kA In rating that includes Types 1 and 2 or operating voltage. SPD's with "In" that is less than 20-kA, shall be rejected.
7. VPR: The maximum VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design:
1. SPD's containing replaceable modules, replaceable fuses, replaceable batteries, requiring maintenance, or requiring diagnostic test kit shall not be accepted.
2. Balanced Suppression Platform:
    a. The surge current shall be equally distributed to MOV components for equal stressing with equal impedance paths to each matched MOV.
3. Electrical Noise Filter:
    a. EMI/RFI noise rejection filter for noise attenuation of line noise of 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
4. Internal Connections:
    a. Plug-in component modules or printed circuit boards shall not be used as surge current conductors. Components shall be soldered, hardwired with connections utilizing low-impedance conductors.
5. Monitoring Diagnostics:
    a. SPD Monitoring:
        1) Status:
            a) Green/red solid-state indicator light for status of the protection on each phase.
                (1) For WYE configured units, provide indicator lights for status of protection elements and circuitry in the L-N and L-G modes and in the N-G mode.
                (2) For delta configured units, provide indicator lights status of protection elements and circuitry in the L-G and L-L modes.
                (3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode.
                (4) Status indicators indicate the protection on each phase or mode. If power is removed from any one phase, the indicator lights shall indicate the status of the protection on other phases and protection modes.
            b) Remote Alarm:
                (1) Provide Form C dry contacts (one NO and one NC) for remote annunciation. Both contacts change state under fault condition.
            c) Audible Alarm and Silence Button:
                (1) Audible alarm activates upon fault conditions. Alarm silence button silences the audible alarm.

d) Surge Counter:

(1) LCD display indicates number of surges and trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton allows the surge counter to be zeroed and contains a mechanism to prevent accidental resetting of the counter.

2) Overcurrent Protection:

a) A circuit breaker shall disconnect the MOV(s) from the system during a thermal runaway condition.

3) Design:

a) SPD's components and diagnostics shall be contained within one discrete assembly.

4) Safety Requirements:

a) SPD shall minimize potential arc flash hazards by containing no user serviceable/replaceable parts.

b) SPD's designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit and required conductors shall be factory-installed.

c) Sidemount SPD's shall be factory-sealed in order to prevent access to the inside of the unit.

2.03 SYSTEM APPLICATION

A. SPD's include distribution and branch panel locations, MCCs, switchgear, and switchboard assemblies tested and demonstrate suitability for application within ANSI/IEEE (Institute of Electrical and Electronics Engineers) C62.41 Category C, B, and A environments.

B. The minimum surge current capacity:

Minimum Surge Current Capacity Based on ANSI/IEEE C62.41 Location Category

Category	Application	Per Phase	Per Mode
C	Service Entrance Locations, Switchboards, Switchgear, MCC, Main Entrance	250 kA	125 kA
A	Branch Locations: Panelboards, MCCs, Busway	120 kA	60 kA

C. SPD's installed on the load side of the service entrance disconnect:

1. Type 1.

D. Switchboard Requirements:

1. SPD located at service entrances shall be tested within ANSI/IEEE C62.41 Category C environments.
2. SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway.
3. SPD shall be factory-installed inside the switchboard at the assembly point by the original equipment manufacturer.
4. Locate SPD on the load side of the main disconnect device, close to the phase conductors and the ground/neutral bar.

5. SPD connected through a disconnect (30A circuit breaker) located in immediate proximity to SPD. Connection shall be made via bus, conductors, or other connections and shall be as short as possible.
6. Monitoring and diagnostic features shall be visible on the front of equipment.

E. SPD application includes lighting and distribution panelboards, tested for application within ANSI/IEEE C62.41 Category B environments.
1. SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
2. SPD shall be mounted within the panelboard by the manufacturer.
3. SPD shall be of the same manufacturer as the panelboard.
4. Panelboard including the SPD shall be UL 67 listed.

2.04 ENCLOSURES

A. Enclosed equipment shall have enclosures:
1. NEMA 1 Gasketed:
a. Constructed of polymer for units integrated within electrical assemblies or steel for sidemount units for indoor use that provide protection against the ingress of solid foreign objects and falling dirt.

PART 3 EXECUTION

3.01 GENERAL

A. Host equipment manufacturer's representative shall visit the site, verify installation and testing, and verify that the SPD equipment and SPD installation meets intent of the Contract Documents and manufacturer's warranties and that the guarantees are in effect.

3.02 INSTALLATION

A. Install according to manufacturer's recommendations.

B. Lead lengths shall not exceed manufacturer's recommendation.

C. Electrical equipment manufacturer shall authorize and perform bus-tap connections, as necessary.

3.03 TRAINING

A. Provide a minimum of 1 hour of training for SPD systems and conforming to the requirements of Section 01 79 00. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies luminaries (lighting fixtures) features and installation.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at bid time. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS:

A. Refer to Section 01 33 00.

B. Action Submittals – Product Literature:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification

requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Contract Document Drawings E-402, E-411, and E-602 with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required". Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Marked product literature for luminaires.
4. Polar plots on 8-1/2 x 11-inch paper providing candlepower vs. angle and foot lamberts (brightness) vs. angle for longitudinal and transverse axis.
5. Catalog information describing fixture make, materials, and dimensions.

1.04 WARRANTY

A. Emergency Lighting Unit Batteries Warranty:
   1. Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period: 2 years from date of Substantial Completion. Provide full warranty for first year and prorated warranty for the remaining warranty period.

B. In addition to the warranty in General Conditions, provide 5-year warranty for LED fixtures.

1.05 EXTRA MATERIALS:

A. None.

PART 2 PRODUCTS

2.01 FIXTURES

A. LED:
   1. Total harmonic distortion less than 15%.
   2. In-line fuse.

2.02 LAMPS

A. LED:
   1. Life expectancy of 50,000 hours minimum as tested per Illuminating Engineering Society (IES) LM-79-08.
   2. Lumen depreciation shall be less than 30% at end of life, as tested per IES LM-80-08.
   3. Temperature range of 4,000 to 5,000 degrees Kelvin.
   4. Field-replaceable without requiring soldering.

2.03 SITE JUNCTION BOXES

A. Junction boxes for the distribution of outdoor lighting circuits shall be precast concrete and set flush with the ground. Nominal size shall be approximately 10.5 x 17.25 x 12 inches deep. Lid shall be cast-iron with cast inscription: "LIGHTING." Rated H20 in traffic areas.

B. Boxes Manufacturer:

1. Brooks Products, Christy Concrete Products, Forni Corporation, Utility Vault Company or equal. Example: Brooks catalog No. 3-1/2PB.

PART 3 EXECUTION

3.01 GENERAL

A. The location and type of luminaries, associated poles, fixtures, and receptacles are as specified on the Drawings.

B. Labels and marks, except the Underwriters Laboratories (UL) label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance. Photoelectric cells shall be oriented toward the north.

C. Raceways, wire, or cable shall be provided in accordance with Division 26. Raceways and wire shall be provided from the fixtures, switches and receptacles to the lighting panel in accordance with the National Electrical Code (NEC). Underground and outdoor wire splices shall be in accordance with Section 26 05 19.

D. Fixtures labeled to require conductors with a temperature rating exceeding 75°C shall be spliced to circuit conductors in a separately mounted junction box. Fixture wire shall meet UL and NEC requirements. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

E. Fixtures shall be aligned and directed to illuminate an area as specified. Fixtures shall be directly and rigidly mounted on their supporting structures. The conduit system shall not be used to support fixtures.

F. Fixture supports that are welded to steel members shall be treated with rust-resistant primer and finish paint where brackets or supports for lighting fixtures.

G. Provide manufacturer’s recommended mounting hardware and brackets.

3.02 WIRE CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values or use torque values specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage, then replace damaged fixtures and components. Verify normal operation of each fixture after installation.

B. Test for Emergency Lighting:
   1. Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. Retest to demonstrate compliance with Specification requirements where adjustments are made.

D. Replace fixtures with damage or corrosion during warranty period.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material.

PART 2 PRODUCTS

2.01 GENERAL

A. Excavation and fill shall be per the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details (USSD), the City of Prescott Supplement to the MAG USSD, and these Special Provisions contained in these Contract Documents, except as revised herein.

2.02 FOUNDATION MATERIAL TREATMENT

A. All foundations shall be seated in firm, native, granular soils and/or compacted and tested fill.

B. At the Mingus (Zone 41) Pump Station, the upper soil layer consists of high-plasticity, expansive clay fill. This fill should be removed to a minimum depth of 3 feet below the Pump Station or to the depth of the finished grade pad, whichever is deeper. The area of fill removal shall extend at least 5 feet outside of the building footprint. The removed soil may be replaced with other on-site cut material where firm, low-plasticity, granular soil is encountered.

PART 3 EXECUTION

3.01 GENERAL

A. Execution of excavation and fill shall be per the MAG USSD, the City of Prescott Supplement to the MAG USSD, and these Special Provisions contained in these Contract Documents.

END OF SECTION

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SECTION 33 16 13.13

STEEL, ABOVE-GROUND, WATER-UTILITY, STORAGE TANKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies a welded steel water reservoir including designing, furnishing, constructing, testing, and disinfecting a welded steel tank and accessories for the storage of potable water.
2. Tank shall be a welded steel water storage tank and shall be provided with foundation, tank structure, and tank appurtenances as shown on the Contract Drawings and described herein.
3. All required labor, materials and equipment shall be included.
4. Coating systems shall be as required as specified in Section 09 97 13.33.

B. Tank Design Standards

1. The materials, design, fabrication and erection of the bolt together tank shall conform to the American Waterworks Association (AWWA) Standard for "Welded Carbon Steel Tanks for Water Storage" – ANSI (American National Standards Institution)/AWWA D100, latest revision.
2. Tank disinfection shall be as required by ANSI/AWWA C652, Disinfection of Water-Storage Facilities, latest revision.
3. All materials furnished by the tank manufacturer which are in contact with the stored water shall be certified and listed by the National Sanitation Foundations (NSF) to meet NSF/ANSI Additives Standard 61.

C. Reservoir Design:

1. The tank shall be designed in accordance with AWWA D100, latest revision, requirements and all other pertinent local, state and federal standards. The tank shall also be designed in accordance with the recommendations of the Geotechnical Report. Note, an additional geotechnical boring will be taken after the demolition of the existing tanks. The recommendations for this area will be updated at that time.
2. Reservoir dimensions shall be as specified. Unless otherwise specified, reservoir shall be a ground-supported flat-bottom welded steel tank. It shall have a supported conical roof . Design of the tank shall comply with AWWA D100 and recommendations of the Geotechnical Report contained in the Contract Documents.
3. The effects of an oscillating water surface in the tank shall also be taken into account. The drawings of the steel reservoir are intended to define general dimensional requirements and tank configuration. Inlet, outlet, and overflow configuration shall be as specified and shown in Contract Documents.
4. The Contractor shall design the reservoir and all required structural supports and stiffeners in accordance with AWWA D100 and the requirements contained herein. The overflow pipe shall be designed to accommodate full uplift. Design calculations shall be provided in sufficient detail to indicate the procedures used, signed by a structural engineer licensed to practice in the State of Arizona.

5. The tank foundation shall be a ringwall as required by AWWA D100. The design of the foundation shall be provided by the Tank Supplier.

D. Design Criteria:

Tank	
• Nominal capacity, gal	793,000
• Diameter, feet	66
• Sidewall Height, feet	32
• Minimum Freeboard (bottom of rafter to overflow), feet	2 feet or sloshing wave height, whichever is greater
Roof Load	
• Snow load, psf	30
• Live load, psf	15
Design wind speed, mph	105
Lowest, one-day mean ambient temperature, degrees F	20
Allowable Bearing Pressure, psf[1]	2,500
Notes: *[1]Includes direct, wind or seismic, and overturning* *gal = gallons* *psf = pounds per square feet*	

1. Roof shall be a cone roof with a slope of 1 inch in 12 inches.
2. Annular bottom plates shall be butt welded with a radial width providing at least 24 inches between the inside of the shell and any lap-welded joint in the remainder of the bottom.
3. Tank shall support all mechanical components as provided in Contract Documents.

E. Seismic Design:
1. General:

S_S: 0.35
S_1: 0.10
Use Group: Group III
Site Class: B

F. Tank Sliding: Positive anchorage to ringwall footing shall be provided where frictional resistance alone is inadequate. Design shall use a coefficient of friction of and include the area under the tank bottom crown for friction resistance area. Two loading cases shall be considered:
1. Horizontal shear at maximum lateral acceleration and sliding resistance at 0.3 times maximum vertical acceleration.
2. Horizontal shear at 0.3 times maximum lateral acceleration and sliding resistance at maximum vertical acceleration.

G. Hydrodynamic Seismic Hoop Tension shall be per AWWA D100.

H. Column Lateral Loads: Design roof columns for lateral forces in addition to vertical loads. Compute equivalent static lateral loads by multiplying column weight by acceleration. Also include lateral force from sloshing water which may be assumed to be 10 pounds per square foot over the projected area of the column. Combine lateral loads with vertical

weight of roof structure and live load increased by vertical component of acceleration. Design connections for 1.5 times the calculated forces to provide ductile behavior.

I. Thermal Movement: Design connections of roof rafters to provide for thermal expansion and contraction for a temperature range of 20 to 100 degrees F.

1.02 QUALIFICATIONS OF TANK SUPPLIER

A. The Engineer's selection of a welded tank reservoir for this facility has been predicated upon specific criteria, construction methods, and an optimum coating for resistance to internal and external tank corrosion. Deviations from the specified design, construction or coating details, will not be permitted.

B. The tank supplier shall submit with its proposal a drawing showing major dimensions and plate thickness upon which the bid is based and a site-specific foundation design based on the soils report showing preliminary dimensions and approximate quantities of concrete and reinforcing steel. The tank and foundation drawings shall be electronically stamped by an Arizona licensed professional. This information will be required at the time of bid opening as part of the sealed bid process.

C. The tank supplier shall be experienced in the construction of the specified tank and shall be certified by the manufacturer as an authorized builder. The Tank Constructor shall have built at least five tanks of similar type and capacity within the last five years and will submit this installation list with bid.

1.03 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISI	Pocketbook of AISI Standard Steels
ASTM A36/A36M	Structural Steel
ASTM A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars

Reference	Title
ASTM D1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction
AWWA B300	Hypochlorites
AWWA B301	Liquid Chlorine
AWWA C504	Rubber Seated Butterfly Valves
AWWA C652	Disinfection of Water Storage Facilities
AWWA D103	Factory-Coated Bolted Steel Tanks for Water Storage
ISO	International Standards Organization
UL 96A	Installation Requirements for Lightning Protection Systems, Ninth Edition

1.04 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. The tank supplier is required to furnish, for the approval of the Engineer and at no added cost, five sets of structural calculations and plans for the tank structure and site-specific foundation. All such submissions shall be stamped by a Professional Engineer (PE) licensed in the state of Arizona.
3. Dimensional drawing(s).
4. The approval by the Engineer of the Tank Supplier's drawings shall be an approval relating only to their general conformity with the bid drawings and Specifications and shall not guarantee detail dimensions and quantities, which remains the Contractor's responsibility.
5. Accessory list with fabrication detail.
6. Catalog cuts, and descriptions of standard manufactured items.
7. Cathodic protection design per Section 26 42 00 and plan of penetrations for the cathodic protection facilities.
8. The tank manufacturer's warranty as required by paragraph 3.06 herein shall be included with submittal information.
9. Welder qualifications according to AWWA D100.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, materials and construction shall conform to AWWA D100.

2.02 SHELL

A. Shell plates shall be cold rolled to the tank radius prior to the removal of mill scale. Horizontal and vertical joints shall be butt welded on each side with full penetration. If structural bracing of the shell is required, these members shall only be placed on the inside of the shell. Shell plates shall include all vertical plates.

2.03 ROOF, ROOF COLUMNS, RAFTERS, AND GIRDERS

A. Roof shall be a cone roof with a slope of 1 inch in 12 inches. Roof plates shall be lap jointed. Roof shall not be self-supporting. Roof plates shall only be welded to the tank at the center and the roof edges.

B. Roof support system members shall be provided whose slope and layout facilitates cleaning and preparation for application of protective coatings.

C. Columns shall be circular with section properties not less than those of a 6-inch-diameter standard pipe section. The column baseplate shall not be welded to the floor plates but held in position by angles or other stops welded only to the floor plates at ends of a plate diagonal. Shims shall be provided under baseplate to provide uniform bearing where column baseplate overlaps a lap seam in the floor plates. Column footing shall be provided. If footing is required, it shall be 12-inch minimum thickness reinforced concrete as designed by Tank Supplier.

2.04 ACCESSORIES

A. Shell Manholes and Handholes:

1. Shell manholes shall be 30 inches in diameter and shall be hinged to the shell. Manholes shall be gasketed and watertight. Handholes for cathodic protection system shall be drilled anode holes in the roof capped with neoprene-gasketed screwed covers. Two manholes shall be provided.

B. Pipe Connections:

1. All pipe and pipe connections shall be constructed to the limits specified. Pipe connections shall be provided in the tank bottom per AWWA D100, and as shown in the Contract Documents.
2. Penetrations of shell shall not be less than 12 inches clear above bottom. Steel pipe supports for submerged inlet inside the tank shall be provided per pipe length and shall be constructed as recommended by the tank manufacturer. Steel pipe shall be fusion epoxy lined and coated.
3. All pipe connection sizing and orientation shall be as shown on the Plans.
4. Water supply, overflow and drain piping connections to the tank shall be field located, saw-cut with interior and exterior flange assemblies welded to the tank where applicable.

5. Pipe material shall be compliant with AWWA D100. Isolation gaskets shall be between pipes of dissimilar materials and as indicated by the Contract Drawings.
6. Pipe connections shall be designed for the test pressures indicated in Section 40 05 02.23.

C. Overflow:
1. The tank shall have an overflow as shown in the Contract Drawings.

D. Internal and External Ladder:
1. The tank shall have one internal and one external ladder. Internal ladder shall be accessible from the interior tank floor and shall extend to the roof manway. An anchorage system shall be provided for use with a personal fall arrest or restraint system and shall conform to the requirements of the Occupational Safety and Health Administration (OSHA). Anchorages used for attachment of personal fall arrest equipment shall be independent of any anchorage being used to support or suspend platforms and capable of supporting at least 5,000 pounds (22.2 kN) per employee attached. The exterior ladder shall be provided with an anti-climb device.
2. The external ladder shall be constructed of galvanized steel. The interior ladder shall be constructed of American Iron and Steel Institute (AISI) Type 304 or 316 stainless steel.

E. Roof Hatch:
1. Access roof hatches shall measure 36-inch x 36-inch. Each roof hatch shall be minimum 11 gauge aluminum with hinges and locking hasps. Hatch openings shall have a 4-inch high curb and the hatch cover shall lap the curb by 2 inches. One roof hatch shall be located over the interior ladder.
2. Overflow roof hatch shall measure 24-inch x 24-inch. The hatch opening shall have a 4-inch high curb and the hatch cover shall lap the curb by 2 inches.
3. Hatches shall be located to enable a person standing on the step-off platform to safely open it.
4. Hatches shall have a locking feature.
5. Hatches manufacturer shall be Bilco, or equal

F. Roof Vent:
1. A tank vent shall be provided in the roof center. Tank vent shall be Newlin 24-inch pressure vacuum vent or equal. Tank manufacturer shall verify the size of the vent.
2. The vent shall be so designed in construction as to prevent the entrance of birds and/or animals by including an expanded aluminum or stainless steel screen (1/2-inch) opening. A stainless steel mesh insect screen shall be provided and designed to open should the screen become plugged by ice formation.
3. A properly-sized vent assembly in accordance with AWWA D100 shall be furnished and installed above the maximum water level of sufficient capacity so that at maximum design rate of water fill or withdrawal, the resulting interior pressure or vacuum will not exceed 1/2-inch water column.
4. The overflow pipe shall not be considered as a tank vent.

G. Observation Platform:
1. The reservoir shall have an observation platform with grating and handrails.

2. Handrails shall be designed per OSHA regulations and must resist simultaneous vertical and horizontal loads of 50 lb/ft applied to the top of the rail, and also resist a single concentrated load of 200 lb applied in any direction along the top of the handrail. Additional loading requirements shall be per AWWA D100.
3. Provide a 3-foot x 3-foot galvanized steel platform as shown in Contract Drawings.

H. Gage Board:
1. The reservoir shall have a float and gage board assembly. Gage board assembly shall be a target-reading type liquid level indicator. Gage board assembly shall have an accuracy of plus or minus 1/10 foot.
2. The indicator shall have an anodized aluminum gage board graduated in feet and tenths and shall extend from the base of the reservoir to the top of the reservoir wall. Gage board shall have black numbers and marks on a white background. The pointer shall be cast iron, colored red, and shall travel in the same direction as the liquid in the reservoir. Pointer shall have two guide wires. Assembly shall have a guided float with two top and bottom anchors, sheave elbows, guides, clamps, and other appurtenances. Sheave anchors shall have a steel housing, adjustable spring rod with cadmium-plated steel spring. Bottom anchor shall be steel. Float and guide wires, pointer guide wires, and wire fasteners shall be 316 stainless steel. Pipe between elbow sheaves and the tank and indicator board shall be 1-1/2-inch galvanized steel. Top of the indicator board shall have an iron cap with a drilled brass bolt guide for guiding the pointer wire. Brackets shall be steel. Indicator shall be equipped with a Type 304 stainless steel pull chain. Gage board shall be Varec 6700 series, or equal.

I. Expansion Joint Filler:
1. Reformed expansion joint filler shall be ASTM D1751, nonextruding, resilient bituminous type, except strips utilizing cork shall not be used. Cane or other cellular fibers uniformly saturated with asphalts shall be provided.

J. Bituminous Mastic:
1. Bituminous sealant shall consist of Henry's 204 as manufactured by Henry Company, APCO 100, Marvin, or equal.

K. Access Doors:
1. Two bottom access doors shall be provided as shown on the Contract Drawings in accordance with AWWA D100.
2. The manhole openings shall be a minimum of 30 inches in diameter; the access door (shell manhole) and the tank shell reinforcing shall comply with AWWA D100.

L. Identification Plate: A manufacturer’s nameplate shall list the tank diameter, height and maximum design capacity. The nameplate shall be affixed to the tank exterior sidewall at a location approximately 5 feet from grade elevation in a position of unobstructed view.

M. Lightning Protection Systems:
1. Air terminals, ground connections, and a grounding system shall be provided. It shall comply with UL 96A, and upon completion of the work, the Owner shall be provided with a Master Label issued by UL.
2. A buried No. 4/0 bare copper wire counterpoise shall be provided along the tank foundation periphery, and a 3/8-inch-diameter 10-foot-long copper-clad grounding

rod shall be provided at each down conductor location. The connection of the down conductor, ground rod, and the counterpoise shall be protected in a concrete box with a removable cast iron cover plate marked "GROUNDING ELECTRODE." Crushed rock shall be provided in the bottom of the box for drainage to a depth of 18 inches.

3. Exothermic welds shall be used for wire splicing and bonding of the tank.

2.05 FOUNDATION

A. The reservoir foundation shall consist of a compacted fill with an oiled sand cushion, and a reinforced concrete ringwall footing in accordance with AWWA D100, Type 1.
   1. Sand shall be thoroughly mixed with liquid asphalt prior to placement within the concrete ringwall. Asphalt content of the mix shall be 6 to 7 percent by weight. Sand shall be placed and compacted by rolling with pneumatic tired rollers so finished surface is true to grade and the edge is approximately 1/4 inch above concrete ringwall. Asphalt shall be sloped at a minimum of 1% from the center of the tank to the outer edge of the tank.

B. Joint Filler, Tank Reservoir Bottom to Ringwall:
   1. Preformed expansion joint filler shall be placed on top of the ringwall and pipe encasements under the tank bottom sketch plate. The exposed edge of the strips shall be cut to a radius 1 inch greater than the sketch plate and adjacent strips butted together. After the tank shell has been constructed and painted, exposed expansion joint filler between the sketch plate and the top of the ringwall shall be sealed with bituminous mastic.

2.06 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Structural calculations of the reservoir and accessory items.
   2. Welding data tabulation and details of welded joints.
   3. Erection drawings.
   4. Mill test reports of all steel materials with a certification of which ASTM or other AWWA D100 required specification each meets.
   5. Report of initial radiographs and evaluation for each weld as specified in paragraph 3.02 Spot Radiographs.
   6. Report certifying the inspection per Section 11.2, AWWA D100 at the conclusion of the work.
   7. Underwriters Laboratories Inc. Master Label for lightning protection system.
   8. Certificate of compliance with AWWA D100.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. General:
   1. Unless otherwise specified, construction shall conform to AWWA D100.

B. Foundation:
   1. The tank foundation is a part of this Contract and shall be installed by the Authorized Distributor or approved subcontractor.
   2. A site-specific foundation design shall be stamped by a civil engineer with a professional engineer (PE) license for the State of Arizona.
   3. Tank footing design shall be based on the soil-bearing capacity as previously determined by the Owner's geotechnical engineer. Copies of the analysis completed by a consultant to the Owner are bound in these Specifications.

C. Welding:
   1. Unless otherwise specified, all welding shall comply with AWWA D100, Section 8.
   2. Contractor-certified qualification records of the welders employed for erection shall be reviewed with the Construction Manager at the start of erection and each time a new welder is employed. The record for each welder shall indicate:
      a. Date and result of qualification test.
      b. Contractor conducting tests.
      c. Identifying mark of welder.
   3. All butt joints shall be provided with complete joint penetration welds.
   4. Welding is not permitted when the temperature is less than 32 degrees F, nor during rain, snow, high winds, or when ice is on the metal. For plate thicknesses in excess of 1-1/2 inches, preheating is required when the metal temperature is less than 70 degrees F.

D. Bottom:
   1. The reservoir bottom shall be assembled by the lap joint method of construction as specified in Section 8 of AWWA D100.

3.02 WELD TESTING

A. Weld testing shall be provided in accordance with AWWA D100, Section 11.

B. Weld testing reports shall be provided.

C. Vacuum Test:
   1. Welded seams of the tank bottom shall be tested for porosity by observation for any bubbles in a soap solution coating with a glass top metal testing box connected to equipment that produces a vacuum of at least 2 psi. Deficient welds shall be corrected.

D. Shell to floor connection welds shall be tested using either vacuum or dye penetration methods.

3.03 TEMPORARY CLOSURE OF TANK OPENINGS

A. Tank openings that are not fitted with valves, hatches, or manhole covers at the completion of erection shall be provided with temporary covers of metal, 10-gage minimum, or plywood, concrete-form quality, cut to fit. Covers shall be installed using three or more bolts. The covers are intended to exclude dust, animals, and intruders before and after painting and after disinfection.

3.04 DISINFECTION

A. The tank shall be cleaned and disinfected in accordance with AWWA C652, unless otherwise specified. Water for disinfection will be provided by the Owner. The Contractor shall schedule disinfection of the tank to coincide with water availability.

B. Disinfection shall not take place until tank coating is fully cured.

C. Prior to disinfection, all interior surfaces shall be washed with clean water using a high-pressure water blaster. All water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the tank.

D. Acceptable forms of chlorine for disinfection shall be:
   1. Liquid chlorine as specified in AWWA C652.
   2. Sodium hypochlorite as specified in AWWA C652.

E. Acceptable methods of chlorination shall be:
   1. Chlorination method 1, 2, and 3 as outlined in AWWA C652.

F. Disposal of chlorinated water shall be coordinated with the Owner.

G. After filling tank but prior to placing tank in service, two samples shall be collected and delivered to a certified laboratory within 6 hours to obtain a bacteriological quality test to demonstrate the absence of coliform organisms. If the initial disinfection fails, water in tank shall be chlorinated and re-tested until satisfactory results are obtained. Retesting shall be at the Contractor's expense. The Contractor shall provide Construction Manager with written test results for submission to the State of Arizona. All costs for testing shall be paid for by the Contractor.

3.05 TESTING FOR VOLATILE ORGANIC COMPOUNDS

A. Following disinfection of the tank, but prior to filling the tank for bacteriological testing, a 5-day soak test shall be completed to determine the presence of any volatile organic compounds (VOCs). The water shall be analyzed by a certified laboratory approved by the State of Arizona, and the test reports shall be provided to the Owner. The test results shall be approved by the Construction Manager prior to final acceptance of the project by the Owner. If the VOC test fails, the Contractor shall repeat the test until obtaining an passing result. After passing the VOC test, bacteriological testing can be completed using the water in the tank. All costs for testing, including re-testing if required, shall be paid for by the Contractor.

B. Testing for VOCs shall be as follows:
   1. Contractor shall fill the tank to the overflow level. Potable water for the first test will be provided by the Owner at no cost to the Contractor.
   2. Water shall be allowed to stand for a 5-day soaking period.
   3. The Owner will engage the services of a testing laboratory approved by the State of Arizona to perform a total organic scan.
   4. The Construction Manager will obtain a water sample from the tank in accordance with the latest State of Arizona procedures and forward the sample to the laboratory for analysis.

3.06 TANK MANUFACTURER'S WARRANTY

The tank structure is warranted to be free from defects due to faulty workmanship or materials, under normal and proper use, maintenance and operation, during the period expiring on the earlier of (i) 1 year after liquid is first introduced to the tank or (ii) 14 calendar months after shipment from the factory.

END OF SECTION

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SECTION 40 05 01

PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the general requirements for selection and supply of pipe materials, fittings, appurtenances, expansion control, supports, and seismic restraints for process, mechanical, plumbing, utility, odor control ducts, and heating, ventilation, and air conditioning (HVAC) piping systems. Installation, inspection, and testing are also specified in this section.

B. Use the general requirements specified in this section with the more specific requirements listed in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and other referenced sections. Except where referenced specification sections specify alternate provisions, the requirements of this section apply to all piping systems listed in Section 40 05 02.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 66 00 – Product Storage and Handling Requirements

C. Section 03 30 00 – Cast-in-Place Concrete

D. Section 40 05 02 – Piping System Schedules

E. Section 40 05 06.16 – Piping Connections

F. Section 40 05 07 – Hangers and Supports for Process Piping

G. Section 40 05 45 – Piping System Identification

H. Maricopa Association of Governments (MAG) Standard Specifications for Public Works Construction (current addition)

I. City of Prescott Supplement to the MAG Uniform Standard Specifications and Details for Public Works Construction

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges

Reference	Title
ANSI B31.1	Power Piping
ANSI B31.3	Process Piping
ANSI B31.9	Building Services Piping
ANSI Z223.1	National Fuel Gas Code
ANSI/ISA-S70.01	Quality Standard for Instrument Air
ASME B1.1	Unified Inch Screw Threads
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM F37	Sealability of Gasket Materials
ASTM F104	Nonmetallic Gasket Materials
ASTM F152	Tension Testing of Nonmetallic Gasket Materials
AWWA C651	Disinfecting Water Mains
CAN/CGA B149.6	Code for Digester Gas and Landfill Gas Installations
EJMA	Expansion Joint Manufacturer's Association
UPC	Uniform Plumbing Code

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Maximum pressure: The greatest continual pressure at which the piping system is designed to operate.
   2. Test pressure: The hydrostatic, air, or gas pressure used to determine system compliance.
   3. Take-down coupling: Pipe couplings that facilitate disassembly of piping systems without damage or demolition of piping system components.
   4. Embedded/Encased piping: Piping enveloped in reinforced concrete, typically under structures and under roadways, where specified on the Drawings.
   5. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

B. Piping System Identification:
   1. Process, mechanical, plumbing, utility, and HVAC piping system piping is identified by a two-component alpha-numeric code, (Line Label) as follows:
      a. The first component of the code indicates the nominal line size.
      b. The second component of the code identifies the process service or fluid being conveyed in the piping system.
   2. Process service identifiers for pipelines are specified on the Drawings. The Process service is defined for each process service identifier in Section 40 05 02.
   3. Detailed specifications for each process service are scheduled in Section 40 05 02.00 through 40 05 02.99.
   4. Mark and label piping systems as specified in Section 40 05 45.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.

2. A copy of this Specification section, along with Sections 01 73 24 and 40 05 07, as applicable, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. For each piping system (refer to Piping System Schedules in Section 40 05 02.00 through 40 05 02.99), submit document listing pipe, fittings, linings, coatings, valves, flexible connectors, expansion joints, couplings, bolts, gaskets, restraints, and other items provided for each applicable pipe size and category.
4. Welding: Prior to commencing any welding of steel or stainless steel pipe, supports, and/or structural attachments, provide a written description of welding techniques including, but not limited to, materials, methods, and quality control. Identify differences in shop and field techniques. Indicate in the submittal that the welding technique has been reviewed for each piping service and certify that the technique is acceptable for the intended service condition (piping service defined in Section 40 05 02 and area exposure designation specified in Section 01 61 45). Written procedures to be stamped and sealed by a Professional Engineer registered in the State of Arizona and qualified for welding design.
5. Submit piping layout drawings by area for all piping systems, including raceway, duct and other specified systems support. Indicate assembly details, location and placement of field welds, unions and flanges, fittings, valves, flushing connections, drains, sample taps, cathodic protection, seismic restraint system, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details and appurtenances for all piping, including wall and floor penetrations, where applicable, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.). Include details of connections to new and existing equipment, piping and structures. Submit original layouts by the Contractor; photocopies of Contract Drawings are not acceptable. Identify the invert elevation of buried pipe at changes in slope, pipe crossings, and connections to structures on piping layout drawings in addition to providing coordinates for locating changes in horizontal alignment of buried pipe.
    a. Product Samples: Where specified or when directed by the Construction Manager, provide mill test results or product samples.
    b. Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.
    c. Safety plans for pneumatic pressure testing.

1.06 QUALITY ASSURANCE

A. Review the Drawings prior to installation of piping, conduit services, and fixtures. Identify any conflicts and cooperate with the Construction Manager to determine the adjustments necessary to resolve conflicts.

B. Confirm the routing of each section of pipeline with other services prior to commencement of installation. Advise the Construction Manager of any conflicts with existing services or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict and confirm with the Construction Manager.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

B. Deliver pipe, fittings, and specials to site using loading methods which do not damage pipe or linings, or coatings.

C. Piping materials delivered to site will be clearly marked to indicate size, type, class/schedule and coatings.

D. Until ready for incorporation in the work, store on site as recommended by the piping materials' manufacturer to prevent damage, undue stresses, or weathering.

E. Store materials at least 8 inches above ground. Provide sufficient supports to prevent undue bending.

F. Protect non-UV light inhibited plastic from sunlight.

G. Maintain refrigerant piping factory seals until ready for incorporation into the work.

H. Cover openings in piping, and temporarily seal to protect from contamination.

I. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water by elevating above floor or surrounding grade.

J. Protect unfinished work at end of each workday from damage, contamination and moisture by use of plugs, caps or covers.

K. Protect piping and valves from damage pending performance of system tests.

L. Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe, linings, and coatings.

M. Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings or linings.

N. Prevent entry of foreign matter during handling, assembling, and installation. Use compressed air, wire brush, solvent and other acceptable means to remove all foreign matter from inside of pipe prior to installation. Remove residual scale, dirt and other foreign matter from interior of piping before final connections are made.

1.08 NOT USED

1.09 COORDINATION

A. Refer to Section 40 05 45 for process piping identification requirements.

B. Pipe Sleeves: Coordinate placement of sleeves and penetrations in cast-in-place concrete with raceway, duct, and pipe penetrations prior to concrete placement. Coordinate placement of sleeves and wall penetration prior to construction of masonry building elements.

PART 2 PRODUCTS

2.01 PIPE MATERIALS - GENERAL

A. All pipe materials to be new, free from defects, and conforming to the requirements and standards identified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and related sections.

B. New and existing piping is designated by process service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Investigate connections to existing piping and provide suitable connections, including electrical isolation, as necessary.

C. Fittings and Coupling Compatibility: To assure uniformity and compatibility of piping components, furnish fittings and couplings for grooved-end or shouldered-end piping systems from the same manufacturer.

D. Buried Piping: Size temporary and/or permanent thrust restraints. Design restraint systems to allow complete piping system disassembly without destruction of any portion of the piping system.

2.02 MATERIAL FOR PIPING SUPPORT, SEISMIC RESTRAINTS AND PIPE ANCHORS

A. This paragraph specifies materials for pipe supports, seismic restraints, pipe anchors, certain expansion control elements, and all associated appurtenances. Section 01 61 45 defines environmental exposures by physical location. pipe support, seismic bracing, and pipe anchor materials are specified based on the environmental exposure specified in Section 01 61 45. Provide pipe support, seismic bracing and pipe anchor components fabricated from materials as specified in the following table:

Environmental Exposure or Pipe Material	Materials[1]	Nuts, Bolts, Washers and Fasteners
Outdoor	Steel, hot-dip galvanized after fabrication	Type 304/316 stainless steel
Indoor, Dry	Steel, hot-dip galvanized after fabrication	Steel, zinc-plated or hot-dip galvanized after fabrication
Indoor, Wet	Type 316 stainless steel or FRP (fiberglass reinforced plastic)	Type 316 stainless steel
Chemical Corrosive	Fiberglass (FRP)	Type 316 stainless steel
Head Space	Type 316 stainless steel or FRP	Type 316 stainless steel
Submerged	Type 316 stainless steel or FRP	Type 316 stainless steel

Environmental Exposure or Pipe Material	Materials[1]	Nuts, Bolts, Washers and Fasteners
Undefined	Type 316 stainless steel or FRP	Type 316 stainless steel
Stainless steel piping	Same type of stainless steel as the pipe or FRP	(per area as defined in this table)

Notes:

[1]Where materials as designated in Drawing details or indicated in other Specification sections, those requirements govern over the provisions of this table.

2.03 PIPE AND VALVE COMPATIBILITY

A. Coordinate the selection of pipe materials, linings, and end connections so that valves operate properly over their entire range (e.g., sufficient disk clearance for butterfly valves). Support wafer-style valves or spectacle flanges between flanges of equal inside diameter.

2.04 NOT USED

2.05 JOINTS – GENERAL

A. Provide joints for disassembly within 3 feet of any connection to equipment, on both sides of structural penetrations, and within 2 feet of all threaded end valves.

B. Unless otherwise specified on the Drawings or in equipment specifications, adapt all equipment connections to a flanged connection compatible with the connected piping system.

C. Flexible Joints at Structural Joint Crossings: Provide a flexible joint (or joints) on all piping crossing structural joints.

2.06 FLANGES AND OTHER COUPLINGS

A. Pipe connections are specified in the Piping System Schedules in Sections 40 05 02.00 through 40 05 02.99

B. General requirements for flanges are as follows:
   1. Where raised-face and flat flanges are provided for connection, reface the raised-face flanges. Flange face to be flush with flat-faced companion flanges on flat-faced valve or equipment flanges.
   2. Provide flat-faced flanges on each side of butterfly valves.
   3. For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

C. Slip-on flanges that are attached to a pipe by means of set screws and gaskets (uni-flange, etc.) are not acceptable.

2.07 FITTINGS – GENERAL

A. Fittings are specified in the Piping System Schedules.

B. Provide eccentric reducers in horizontal lines with the flat side on top, unless specified otherwise on the Drawings (e.g., flow meters in horizontal runs requiring submergence).

C. Provide concentric reducers in vertical lines, unless otherwise specified on the Drawings.

D. Provide reducers upstream and downstream of flow measurement devices to adapt line size to the specified flow-measurement device dimension. Coordinate with the specific instrument requirements.

E. Provide long-radius (greater than or equal to 1.5 x nominal diameter) elbows unless otherwise specified on the Drawings.

2.08 GASKET MATERIALS

A. For flat-faced flanges, use full-face gaskets. For raised-face flanges, use ring-type gaskets. Conform to American National Standards Institute (ANSI) B16.21.

B. Refer to the Piping System Schedule for the specified gasket material. Material designations used in the detailed pipe specification sheets are as follows:
   1. EPDM: ethylene-propylene-diene-terpolymer 70 durometer
   2. Neoprene: neoprene (black) 70 durometer
   3. Nitrile: nitrile (Buna N)
   4. SBR: Styrene-butadiene (red)
   5. Natural rubber: natural rubber
   6. Compressed Synthetic Fibers (Kevlar): American Society for Testing and Materials (ASTM) F104 (F712400) and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37)
   7. Compressed Synthetic Fibers (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152), 0.1 mL/h Leakage Fuel A (ASTM F37)
   8. Gylon – Type 1: Garlock Style 3500: 1.35 MPa (ASTM F152), 0.22 mL/h Leakage Fuel A (ASTM F37)
   9. Gylon – Type 2: Garlock Style 3510: 1.35 MPa (ASTM F152), 0.04 mL/h Leakage Fuel A (ASTM F37)
   10. CPE – Chlorinated polyethylene
   11. Spiral-wound: Flexitallic SS316L, graphite impregnated per ASME B16.20
   12. PTFE bonded EPDM, full-face gaskets
   13. Viton/FKM – Fluoroelastomer, 75 Durometer

2.09 DISSIMILAR METAL CONNECTIONS

A. Where dissimilar metals are to be connected, provide dielectric fittings and/or isolating flanges, including bolt sleeves and washers, according to Section 40 05 06.16.

2.10 CATHODIC PROTECTION

A. Provide cathodic protection of piping, pipe fittings, and appurtenances where specified on the Drawings or Specifications.

2.11 STRUCTURAL ELEMENT PENETRATIONS

A. Penetrations through structural elements are referenced to a custom detail or Standard Detail. Where a penetration detail is not specified, conform to the Standard Detail relevant to the type of structure, exposure, and type of pipe.

B. Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during block work erection.

2.12 PIPE MARKERS, DETECABLE WARNING TAPE, AND TRACER WIRE

A. Pipe marker, detectable warning tape, and tracer wire materials per Section 40 05 45.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation, inspect, and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

B. Pothole existing pipe at connections to new pipe to confirm material and joints prior to submittal of pipe layout drawings.

C. The Drawings are, in part, diagrammatic, make all minor modifications to suit installed equipment and structural element locations and elevations and coordinate with electrical construction.

D. Provide details of connections to new and existing equipment, piping, and structures in piping layout drawing submittals. Unless otherwise specified on Drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

E. Piping arrangements indicated on the Drawings have been estimated from the approximate configuration of the type of equipment listed in the equipment specifications. If the equipment to be provided does not have the same configuration, modify the piping arrangement as necessary. Include any piping modifications in shop drawings submitted prior to fabrication or installation.

3.02 PIPE SUPPORT, ANCHORAGE, AND SEISMIC BRACING

A. Support piping with anchor brackets, guides, saddles, or hangers. Provide supports on each run at each change of direction.

B. Do not use existing pipes and supports to support new piping.

C. Install expansion loops, anchors, expansion joints, and guides where specified on the Drawings.

3.03 PIPING CONNECTIONS TO MACHINES

A. Align piping at machine connections in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come-a-longs or other mechanical means to align field piping with the connections at the machines.

B. Do not force bolts into mating flange bolt holes. Align flange bolt holes to permit insertion of bolts by hand (without tools, hammering, or prying).

C. Use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections are strictly prohibited.

D. Provide equipment connection fittings per Section 40 05 06.16, as specified on the Drawings.

3.04 JOINT AND COUPLING OPTIONS

A. Provide pipe connection (joint and coupling) options as specified in the Piping System Schedule.

B. If a Piping System Schedule lists several connection options, then any of the listed options may be used for a particular pipe material, but the selected option shall be used consistently. For example, if flanged or grooved connections are specified and grooved are represented on the Drawings, then flanged may be installed in lieu of the grooved couplings specified on the Drawings.

C. Connecting straight runs of pipe by welding is acceptable only where the individual Piping System Schedule allows welding as a connection option.

D. Where connections other than those indicated on the Piping System Schedule are specified on the Drawings, locate the connection specified on the Drawing at the specific location indicated on the Drawing.

E. Provide rigid, non-rotating connections at all valves and equipment.

3.05 SMALL BORE UTILITY PIPING

A. Field-route small-bore (generally less than 3-inch) diameter branch piping for utility services.

B. In general, small-bore utility branch piping is not specified on the Drawings unless a specific pipe routing or configuration is to be provided or where necessary to show valves or instrumentation requiring electrical connections.

C. Distribution lines for small-bore utility piping are specified on the Drawings along with service connection routes to locations that require utility service piping.

D. Install small-bore utility piping that must be drained to provide freeze protection with a continuous slope down to the drain.

3.06 NOT USED

3.07 SEWER AND DRAIN PIPING

A. Run horizontal drainage piping as straight as practicable and at uniform pitch.

B. Install pipe 3-inch or less in diameter with slope of not less than 2 percent, unless otherwise specified on the Drawings.

C. Install pipe larger than 3-inch diameter with slope of not less than 1 percent, unless otherwise specified on the Drawings or required by the UPC.

3.08 SLEEVES

A. Unless otherwise noted in the specified pipe penetration details or otherwise approved by the Construction Manager, provide sleeves where piping passes through a wall, floor, or ceiling.

B. Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

3.09 PIPE JOINTS AND CONNECTIONS

A. Field cuts for glass-lined pipe are not permitted.

B. Cut pipe with appropriate tool and deburr.

C. Make joints tight. Test and remake leaking joints with new materials. Do not use thread cement or caulking to remake joints.

D. Do not use sharp-toothed wrench in making up brass pipe, or chrome-plated items.

E. Provide thread forms and length in accordance with American Society of Mechanical Engineers (ASME) standards. Use lubricant or sealant on male threads suitable for proposed pipe service.

F. Clean joints before soldering. Use flux and alloy appropriate for specified operating temperature and pressure.

G. Welding procedures, welder certification/qualification, and weld testing per ASME Section IX, Boiler and Pressure Vessel Code. Make welds per the specified standard when ASME B31.1 or ASME B31.3 are specified for a piping system in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).

H. Coat gasket with gasket manufacturer's recommended lubricant between flange faces.

3.10 NOT USED

3.11 INSTALLATION OF BURIED PIPE AND PIPE BELOW STRUCTURES

A. Trenching and Backfill for Buried Pipe: Conform to MAG and City of Prescott Supplement to MAG.

B. Pipe Laying and Bedding: Conform to MAG and City of Prescott Supplement to MAG.

C. Restrain all plugs, caps, tees and bends in buried pressure piping systems by means of restrained joints as specified in the respective Piping System Schedule.

D. In accordance with Section 40 05 06.16, and where specified on the Drawings, provide flexibility per specified details where buried pipe passes under, through, or is connected

to structures. Provide restrained joint connections or provide restraints across each un-restrained joints.

E. Install Pipe in straight alignment. Do not exceed 3/8-inch variance over 30 feet from the true alignment in any direction.

F. Slope gravity lines uniformly from point of origin to discharge.

G. Ensure the pipe alignment stays true during and after placement of concrete encasement.

H. Ensure that the method used to prevent pipe uplift during placement of concrete encasement results in an invert and crown true to intended grade.

I. Maintain circular cross section of pipe.

J. Provide lean concrete below the underside of the slab or footing for backfill over pipe laid below structures when pipe is less than 6 inches below the underside of the slab or footing, unless specified otherwise. Place concrete in accordance with Section 03 30 00.

K. Provide heat-shrinkable cross-linked polyolefin coating or tape-wrap coating on all flanged, grooved, and welded joints that are buried or below structures.

L. Provide petrolatum tape wrap on all valves and mechanical pipe couplings that are buried or below structures. Install per manufacturer's recommendations. Candidate manufacturers:
   1. Denso Densyl Tape
   2. #1 Wax Tape
   3. Approved Equal

M. Use anti-seize compound with all stainless steel nuts and bolts.

N. Provide detectable warning tape for all buried pipe. Provide tracer (locate) wire as specified in Section 40 05 45.

3.12 EXPOSED INSTALLATION

A. Fabricate and install domestic hot- and cold-water piping, sanitary piping and storm drainage piping in accordance with the UPC.

B. Provide pipe system layout in accordance with the following criteria:
   1. Drawings show general layout of piping. Exact dimensions determined by Contractor.
   2. Maintain minimum clear areas through tunnels and principal access aisles as specified in this section.
   3. Expanding or swaging of tubing to fit IPS (iron pipe size) fitting sockets is not permitted.
   4. Use reducing fittings where change in pipe size occurs.
   5. Use couplings only where pipe runs are longer than standard supplied pipe lengths.
   6. Make exposed polished or enameled connections to fixtures or equipment with special care to avoid damage to finished surfaces.

7. Make changes in direction only with fittings.
8. Install piping with not less than minimum slope to ensure adequate drainage and venting.
9. Maintain clear areas around equipment to allow adequate access for maintenance as specified in this section.
10. Ensure valve operators are accessible from floor level. Provide chain-wheel operators for valves with centerline elevations of 7 feet or above.
11. Ensure piping ancillaries and in-pipe instrumentation is installed in accessible locations which do not create problems for traffic in the clear areas.

C. Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage.

D. Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag or stress.

E. Install expansion joints where specified on the Drawings or where required by the Design Professional, to allow for piping expansion and contraction.

F. Install expansion loops or bends where specified, or required by the Design Professional, to allow for proper pipe expansion. Construct expansion loops with long-radius welded bends.

G. Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves or pipe.

H. Accurately cut all piping for fabrication to field measurements.

I. Install pipes in straight alignment and parallel to wall. Do not exceed 3/8-inch variance over 30 feet from the true alignment, in any direction.

J. Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. Unless stipulated by the Design Professional to address significant thermal strain, and accepted by the Construction Manager, the "springing" of pipe and fittings to ensure alignment is not permitted. Undo and subsequently remake all pipework connections where so instructed by the Construction Manager to ensure that unintended springing does not occur. Take care not to damage equipment, valves, or flanges.

K. Slope instrument air piping to condensate traps.

L. Do not cut or weaken the building structure to facilitate installation of piping.

M. In parallel pipe runs, offset flanges and/or grooved joint fittings by a minimum of 8 inches longitudinally to allow for proper access.

N. In vertical pipe runs of pipe diameter greater than 10 inches, provide 8-inch long spool piece on lower side of each valve.

O. Do not install water piping over electric switchboards, transformers, cable tray or electric motor starters.

P. Provide pipe markers for all exposed pipe.

3.13 THREADED JOINTS

A. Conform to the requirement of ANSI B31.1.

B. Ream the end of all pipes to remove all burrs and cuttings when fabricating threaded joints.

C. Clean out pipe and repair linings and coatings prior to joining.

D. Apply Teflon tape to male threads and join pipe. Use both Teflon tape and Teflon sealing compound on stainless steel pipe threads. Do not apply extra tape to make up for slack in the joint.

3.14 FLANGED JOINTS

A. Maintain consistent flange bolt hole positions along the entire length or run of the pipe.

B. For pipe installed with a horizontal axis, position flange bolt holes so that the vertical centerline of the flange face bisects the arc between flange bolt holes (“Two-Holed”).

C. For pipe installed with a vertical axis, position flange bolt holes so that the horizontal centerline of the flange face bisects the arc between flange bolt holes and is perpendicular to the closest structural wall (“Two-Holed”).

D. Clean flanges and gaskets prior to connection.

E. Lubricate gaskets with gasket manufacturer’s recommended lubricant and apply anti-seize compound to all bolts.

F. Bring flanges into close parallel and lateral alignment.

G. Tighten bolts progressively. Proceed from side to side of the flange.

H. Use proper length bolts for each size flange on flanged connections. Washers may not be used to take up excess bolt length. Provide approximately two full threads bolt projection beyond nuts. Bolts with excessive length of exposed threads will not be permitted. All-thread rod is not acceptable for bolting flanges. All bolts shall face the same direction.

I. When joining steel to cast-iron flanges, take care to avoid damage to the cast-iron flange. Ensure both flanges are flat-faced and use full-face gaskets.

J. Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place strain on the equipment.

K. Allow a minimum of 6 inches’ clearance to face or 8 inches to edge of flange to wall, floor, or ceiling unless otherwise specified.

3.15 INSULATION

A. Insulate piping systems in accordance with the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).

3.16 FLEXIBLE HOSE CONNECTORS

A. Accurately align pipelines to receive flexible connectors before installing the connectors. Do not stretch, compress, misalign or offset the connectors.

B. Align and install each flexible connector in accordance with the manufacturer's instructions.

C. Support, anchor and guide the piping so that the flexible hose connectors are not required to absorb any axial compression or elongation.

D. Do not torque or twist the flexible connectors.

E. Check bolt tightness and tighten where necessary a maximum of 1 week after commissioning and periodically thereafter.

3.17 EXPANSION JOINTS

A. Accurately align pipelines to receive expansion joints before installing the joint. Do not stretch, compress or offset the joint to fit the piping. Install expansion joints in accordance with manufacturer’s instructions prior to releasing preload.

B. Align and install each expansion joint in accordance with Expansion Joint Manufacturers Association (EJMA) standards and with the manufacturer's written instruction; properly guide and anchor all expansion joints. No lateral movement is permitted on compensator- type expansion joints.

C. On rubber expansion joints, check bolt tightness, and tighten where necessary 1 week after commissioning is completed.

3.18 REPAIR/RESTORATION

A. Repair pipe with damaged shop-applied protective linings in accordance with specified standard (e.g., American Water Works Association (AWWA) C210) or in accordance with the lining manufacturer's directions, if no standard is cited.

B. Damaged glass lining cannot be repaired. Replace piping with damaged glass lining.

C. Patching inserts, overlays, or pounding out of dents is not be permitted.

D. Repair pipe with damaged protective coatings and holdback areas for welding and other field fabrication, as follows:
   1. For shop-applied coatings, not subject to Section 09 90 00 requirements, in accordance with specified standard (e.g., AWWA C210) or in accordance with the coating manufacturer's directions, if no standard is cited.
   2. For coatings applied pursuant to Section 09 90 00 requirements, apply repair coatings in conformance with the applicable Section 09 90 00 coating system,

including thickness and stipulated preparation of the lowest full-thickness coating layer (i.e., exposed metal would require full profile preparation and specified multi-layer coating restoration).

3. Prepare areas to be repaired not less than 2 inches beyond damaged areas and feather repair coating into adjacent areas.
4. Repair to provide equivalent protection to undamaged coatings and a uniform appearance when judged from 4 feet away.

E. Other requirements may be stipulated in related piping sections.

3.19 NOT USED

3.20 TESTING

A. Provide 24-hour notice prior to testing.

B. Do not insulate or conceal work until piping systems are tested and have met all required criteria.

C. Complete any required weld tests.

D. Supply all water, air, and inert gases required for pressure testing.

E. Supply all pumps, compressors, gauges, etc. required for testing.

F. Install air threadolets, air-relief valves, and line-fitting valves as necessary to complete testing. Remove after testing and plug threadolets.

G. Cap or plug all lines which are normally open-ended. Remove on completion of testing.

H. Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

I. Test all underground lines prior to backfilling. Do not place concrete encasement until lines are tested and have met all required criteria.

J. Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the Construction Manager of such failure.

K. Isolate all pumps and low-pressure equipment and appurtenances during testing so as not to place any excess pressure or thrust forces on the equipment.

L. Where defective material or equipment is identified, repair or replace using new material.

M. Flush and drain liquid pipes after pressure tests. Purge all gas pipes after pressure tests using inert gas.

N. Dispose of flushing water in manner approved by the Construction Manager, which causes no damage to buildings or siteworks.

3.21 HYDROSTATIC PRESSURE TESTING OF LIQUID LINES

A. Hydrostatically test all lines normally used for the conveyance of liquids using water as the test medium, unless otherwise specified in this section.

B. Test pressures and durations as specified in the Piping System Schedules.

C. Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

D. Lined Pipelines: Allow filled pipeline or section thereof to stand under a slight pressure for at least 8 hours (24 hours for cement mortar lining) to allow the lining to absorb water and to allow the escape of air from air pockets.

E. Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

F. Show evidence of leakage rates below 0.02 gallons per hour per inch pipe diameter per 100 feet of pipe length for buried piping, unless otherwise specified.

G. Test drains in accordance with the UPC.

H. For hydraulic and lube oil systems, test using the medium of service. Provide zero loss of pressure throughout the specified test period.

3.22 PNEUMATIC PRESSURE TESTING

A. Use nitrogen gas or oil free dry air to test piping systems where nitrogen or air is the specified testing medium in the Piping System Schedule.

B. Submit a testing plan and a safety plan for each piping system that will be pressure-tested with nitrogen gas or oil-free dry air. Do not perform pressure testing with air or nitrogen until a favorable review of the safety plan and testing plan for the piping system has been returned from the Construction Manager. Comply with all workplace safety and pressure-vessel safety codes and guidelines.

C. Provide a separate pressure-relief valve for pneumatic pressure testing.

D. Locate pressure-relief valve within visual range of the test gauge and with exhaust to a safe location.

E. Set relief valve at not more than full-test pressure plus 10 percent.

F. Continuously monitor and control testing to assure personnel safety and piping integrity.

G. Remove all personnel from areas where piping will be subjected to pressure tests and prevent entry into testing areas until test pressure has been relieved.

H. Protect installed work from potential damage from pressure-testing failures. The Contractor is responsible for any damage or injury resulting from failed pressure testing with air or nitrogen.

I. When using nitrogen or air to test steel or stainless steel pipelines, gradually introduce the test gas up to a pressure of 45 psig or 1/3 of specified test pressure, whichever is less.

J. While maintaining this pressure, test lines for leaks using soapy water.

K. When the line is free from leaks at this pressure, increase by increments of 50 psig or 1/3 of specified test pressure (whichever is less) to the specified test pressure.

L. After each increment, retest using soapy water; take corrective action as necessary.

M. When the system is free from leaks at the test pressure, depressurize the system slowly.

N. To prevent the entrance of water or moisture into the medium source, disconnect the test source from the system and cap.

O. Where specified, maintain nitrogen pad after testing until the line is put into service. Label any piping for which a pad is provided and maintained.

P. Provide high-purity nitrogen gas used for testing, in cylinders fitted with pressure regulators for 0 to 300 psig and all necessary fittings and adaptors necessary to complete the connection between the source and the system header. Provide self-relieving type pressure regulator that vents to the atmosphere and include a throttling valve.

Q. Provide oil-free air with a relative humidity of zero for testing. Provide all fittings, adaptors, accessories, and the pressure regulator and throttling valve that are suitable for pressure testing with air and rated for 300-psig service.

3.23 PRESSURE TESTING OF GAS, AIR, AND VAPOR LINES

A. Hydrostatically or pneumatically pressure test, as specified in the Piping System Schedules, all lines normally used for the conveyance of gas, air, and/or vapor in accordance with ASME procedures for testing pressure piping and CAN/CGA B149.6 for buried digester gas piping. Pneumatically test all instrument air lines in accordance with International Standard Atmosphere ISA-S7.0.01 and digester gas piping in accordance with CAN/CGA B149.6.

B. For gas and air lines to be hydrostatically tested, check support system to ensure it is capable of withstanding loads imparted by test method. Provide any additional supports necessary in a manner acceptable to the Construction Manager. At the Construction Manager's request, provide calculations indicating design of temporary support system.

C. Test pressures are identified in the Piping System Schedule.

D. Zero leakage rate for insulated systems, and systems tested with water is required at the specified test pressure through the test period. Prior to commencing test using air, ensure air will be at ambient temperature and specified test pressure.

E. Do not exceed the maximum specified leakage rate during the test period for all other systems tested with air.

F. Remake all joints which display leakage and retest.

3.24 NOT USED

3.25 CLEANING AND FLUSHING

A. After installation and prior to testing, perform initial cleaning of process and utility lines. Clean piping greater than 6 inches and less than 24 inches by passing a tightly fitting cleaning ball or swab through the pipeline, unless specified otherwise. Lines greater than 24 inches may be cleaned manually or with a cleaning ball or swab. Give lines smaller or equal to 6 inches an initial flush or purge.

B. After initial cleaning, connect the piping systems to related process and mechanical equipment. Insert temporary screens, provided with visible locator tabs, in the suction of pumps and compressors in accordance with the following table:

Suction Size, in.	Maximum Screen Opening, in.
0 – 1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

C. Maintain the screens during testing, flushing/purging, initial startup, and the initial operating phases of the commissioning process. In special cases and with the Construction Manager's acceptance, screens may be removed for performance tests. Install screens for clear-water testing and initial operation on liquid-systems handling solids. Initial operation on solids systems following clear-water testing may be without screens.

D. Unless specified otherwise, flush liquid systems after testing, with clean water and screens in place. Maintain flushing for a minimum period of 15 minutes and until no debris is collected in the screens.

E. Remove the screens and make the final connections after the screens have remained clean for a minimum of 24 consecutive hours of operation. Keep screens in place for 24 hours of clean-water operation on solids-handling systems; remove prior to placing the system into solids-handling service.

F. In air or gas systems with pipe sizes less than or equal to 6 inches, purge with air and/or inert gases before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream. Satisfy ANSI/ISA-S7.0.01 standards for instrument air systems.

G. Purge digester gas, natural gas, and propane systems with nitrogen gas and provide a nitrogen pad maintained at 10 psig until put in service. Purge and dry digester gas systems in accordance with CGA B149.6.

H. Clean and flush piping connecting to HVAC equipment in accordance with Division 23.

3.26 DISINFECTION

A. Flush and disinfect lines intended for potable water service after testing in accordance with AWWA C651, MAG and City of Prescott Supplement to MAG.

END OF SECTION

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SECTION 40 05 02

PIPING SYSTEM SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies a Piping System Schedule for each Process Service. Each Piping System Schedule specifies piping system materials for groups of similar process piping services.

B. The table in paragraph 1.01C lists process services and the corresponding Piping System Schedule that specifies piping system material requirements for the associated process piping service. See Part 4 for Piping System Schedules that define materials for piping services.

C. Piping System Schedule assignments are listed in the following table:

Process Service Identifier	Process Service	Piping System Schedule	Fluid Category	Pipe Marker Background Color
D	Drain	40 05 02.89	Drain/Vent	Green
SD	Storm Drain	40 05 02.89	Drain/Vent	Green
W	Potable Water (City Water)	40 05 02.23	Water	Blue

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250
ASME B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded
ASME B16.12	Cast Iron Threaded Drainage Fittings
ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	Power Piping
ASME B31.3	Process Piping

Reference	Title
ASME B31.9	Building Services Piping
ASME B32	Solder Metal
ASME B36.10	Welded and Seamless Wrought Steel Pipe
ASME B36.19	Stainless Steel Pipe
ASME B1.1	Unified Inch Screw Threads
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High Temperature Service
ASTM A126	Grey-Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A135	Electric-Resistance-Welded Steel Pipe
ASTM A139	Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)
ASTM A167	Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate
ASTM A181/181M	Forgings, Carbon Steel, for General Purpose Piping
ASTM A182/182M	Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/193M	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service High Pressure Service and Other Special Purpose Applications
ASTM A194/194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service or High Temperature Service, or Both
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A240	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
ASTM A269	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A307	Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
ASTM A312/312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A320/320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A536	Ductile Iron Castings
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM A1011/A1011M	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B75	Seamless Copper Tube

Reference	Title
ASTM B88	Seamless Copper Water Tube
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C361	Reinforced Concrete Low-Head Pressure Pipe
ASTM C443	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	Circular Precast Reinforced Concrete Manhole Sections
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D792	Test Method for Specific Gravity and Density of Plastics by Displacement
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings
ASTM D3350	Polyethylene Plastics Pipe and Fittings Materials
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM D4894	Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials
ASTM D4895	Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
AWWA C104	Cement–Mortar Lining for Ductile-Iron Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
AWWA C153	Ductile-Iron Compact Fittings
AWWA C200	Steel Water Pipe, 6 Inches and Larger

Reference	Title
AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches through 144 Inches
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
AWWA C301	Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
AWWA C303	Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and their Appurtenances
AWWA C606	Grooved and Shouldered Joints
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe - A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 6
FSA	Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division
FEDSPEC, L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-S-8660C	Silicone Compound
MIL-STD-810C	Environmental Test Methods
MSS SP-25	Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-43	Wrought Stainless Steel Butt Welding Fittings
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends
MSS SP-114	Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000
NSF/ANSI 61:	Drinking Water System Components – Health Effects
SSPC	Society for Protective Coatings
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
International Plumbing Code, 2018 Edition	International Plumbing Code

1.03 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:

B. Pipe Connections and Joints:
   1. BABS – Bell and Ball Spigot
   2. BAS – Bell and Spigot
   3. BFW – Butt Fusion Weld
   4. BSS – Bolted Split Sleeve Coupling
   5. BW – Butt Weld
   6. BSW – Butt-Strap Weld
   7. CGRV – Cut (or Cast) Grooved End Coupling
   8. CPLG – Coupling
   9. CPO – Compression Type Push-On
   10. CPRSN – Compression
   11. DLW – Double Lap Weld (Bell and Spigot)
   12. EFSW - Electro-Fusion Socket Weld
   13. FLG – Flanged
   14. FLRD – Flared
   15. FP – Full Penetration
   16. FSW – Fusion Socket Weld
   17. HAS – Hub and Spigot, Compression (Cast Iron Soil Pipe)
   18. HBLS - Shielded Hubless (Cast Iron Soil Pipe)
   19. HGRV – HDPE Groove Coupling
   20. HLF CPLG – Half Coupling
   21. HPEG – HDPE Plain End with Gripping Teeth
   22. HXGT - HDPE by Grooved End Transition
   23. LR ELL – Long Radius Elbow
   24. MJ – Mechanical Joint
   25. PGRV - Proprietary Groove Coupling
   26. PO – Push-On
   27. RBAS – Restrained (Lap Welded) Bell and Spigot with O-ring rubber gasket
   28. RGRV – Rolled Grooved End Coupling
   29. RJC – Ring Joint Coupling
   30. RMJ – Restrained Mechanical Joint
   31. RPO – Restrained Push-On Joint
   32. SLV – Solvent Weld
   33. SLDR – Solder or Brazing
   34. SLW – Single Lap Weld (Bell and Spigot)
   35. SR ELL – Short Radius Elbow
   36. SW – Socket Weld
   37. THD – Threaded
   38. UN – Union

C. Flanges:
   1. FF – Full Face

2. LF – Loose Flange
3. LJ – Lap Joint
4. LWN – Long Weld Neck
5. RF – Raised Face
6. SO – Slip-On
7. THD – Threaded
8. WN – Weld Neck

D. Materials:
1. DI – Ductile Iron
2. RCP – Reinforced Concrete Pipe
3. RCP-LHP – Reinforced Concrete Low Head Pressure Pipe
4. SS – Stainless Steel
5. SV – Service (Cast Iron Soil Pipe available with SV rating or XH, extra heavy, rating)

E. Welding:
1. FP – Full Penetration
2. SML – Seamless
3. WLD – Welded

F. Other:
1. CFT - Cured Film Thickness
2. DFT – Dry Film Thickness
3. Dim – Dimensions
4. M or E Pipe – Matches or exceeds rating of connecting pipe
5. Thk – Thickness
6. Sch – Schedule
7. Std – Standard
8. STD – Standard Weight or Standard

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe size (nominal diameter) and the process service identifier for the contents of the pipeline are specified in pipe line labels on the Drawings.

B. Provide piping system materials and components per the Piping System Schedule assigned for the specified process service and pipe size.

C. The Rating column in the Piping System Schedule specifies the minimum acceptable pressure rating or wall thickness for the component of the piping system.

PART 3 NOT USED

PART 4 SCHEDULES

4.01 PIPESPEC SYSTEM SHEETS/DETAILED PIPING SPECIFICATION SHEETS.

A. Piping System Schedules follow this section. Piping System Schedules are assigned a section number in the range from 40 05 02.00 through 40 05 02.99 as applicable.

END OF SECTION

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Schedule 40 05 02.23 – Potable Water

Process Service	Potable Water				
Process Service Identifier	W				

Test Conditions

Pressure (psig)	Duration (min.)	Medium
150 psig	Per MAG 611 and Supplement to MAG	Per MAG 611 and Supplement to MAG

General Requirements

1. Full-faced flanges mated with raised-face flanges are not permitted.
2. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.
3. Threads per ASME B1.20.1.
4. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g., Do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)
5. Solvent welding of PVC piping performed with Weld-On 724 (ASTM F 493, NSF/ANSI 14, NSF/ANSI 61) or Approved Equal. Universal plastic pipe solvent is not acceptable. Prior to solvent welding, clean pipe joints to remove all loose debris and prime with a compatible primer. Primer shall stain piping.
6. Potable water pipe construction shall be per MAG 610 and the Supplement to MAG 610. Testing and disinfection shall be per MAG 611 and Supplement to MAG 611.
7. All piping, fittings, valves and material that come in contact with potable water shall comply with NSF Standards 60 and 61.
8. Copper tubing or fittings in contact with dissimilar metal piping, reinforcing steel, or other dissimilar metal at any location is not permitted. Electrical checks shall be made to assure no contact is made between copper tubing and ferrous elements. Wherever electrical contact is demonstrated by such tests, provide dielectric protection as specified in Technical Specification Section 40 05 06.16.

Notes:

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long-Radius Elbows. Provide full-flow fittings. Segmentally welded fittings are not acceptable.
3. Provide long-radius, five-cut, mitered elbows for segmentally welded fittings.
4. Install lining and coating prior to welding threadolet or half coupling.
5. Except at flanged connections at valves, flanged connections/joints not permitted on buried ductile iron pipe.
6. FNPT tap at factory-installed tapping boss. Taps at other locations on pipe and fittings are not permitted.
7. Bolts and nuts with metallurgy specified in AWWA C111.
8. BW (butt weld) connections/joints not permitted for 14-inch through 24-inch pipe.
9. Provide square nut operator, extension stem, and valve box for buried valves.
10. Hard, drawn, furnished in straight lengths.
11. Provide annealed tube for flared fittings. Furnished in straight lengths or coils.

Schedule 40 05 02.23 – Potable Water

Process Service	Potable Water				
Process Service Identifier	W				

12. 3/8-inch thick wall required for installation of CGRV on 24-inch pipe.

Indoor Dry, Indoor Wet, Outdoor - Exposed

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	3 and smaller	Type L	SLDR	Copper Tube: ASTM B88, Drawn	MAG 754	
	Ductile Iron, 4 and Larger	Class 53	FLG	Ductile Iron: AWWA C151	MAG 750	5
Lining for Pipe & Fittings	3 and smaller	—	—	None	—	
	Ductile Iron	Thk. per Std.	—	Cement Mortar: Factory Applied, AWWA C104, NSF 61 certified	MAG 750	
External Coating	Ductile Iron	—	—	Epoxy	09 91 00	
	Valves	—	—	Epoxy	09 91 00	
Fittings	Copper, 3 and Smaller	—	SLDR THD or FLG adapters for valves	Wrought Copper and Copper Alloy (Brass or Bronze): Materials and Dim. per ASME B16.22	MAG 754	
	4 and Larger	—	FLG	Ductile Iron: AWWA C110 or C153	MAG 750	2
Flanges	4 thru 24	—	—	Ductile Iron: AWWA C115 or C110	MAG 750	
FLG Bolts, Nuts and Hardware	All	All	—	Alloy Steel Bolts: ASTM A193-Gr B7 with Carbon Steel Nuts: ASTM A194-Gr 2H heavy hex	—	1
Gaskets	All	All	All	SBR	—	
Valves	3 and Smaller		THD	Ball: Bronze Body/Ball; Nibco T-585-70, Apollo 700-100 Series or equal	—	
	4 thru 16		FLG	Gate: AWWA C509	MAG 630 and Supplement to MAG 630	
	4 thru 16		FLG	Swing Check: Lever Arm and Spring	40 05 65.23	
Insulation (Outdoor – Exposed only)	1/4 thru 8	1 in. Thk		Cellular Elastomeric: ASTM C534-Type I Grade 1, Low Temperature Range, Freeze Protection, PVC Jacket/Covers	—	
	10 thru 24	1 in. Thk		Cellular Elastomeric: ASTM C534-Type II Grade 1, Low Temperature Range, Freeze Protection, PVC Jacket/Covers	—	

Schedule 40 05 02.23 – Potable Water

Process Service	Potable Water				
Process Service Identifier	W				

Buried (Includes Embedded and Encased)

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	3 and Smaller	Type K	SLDR	Copper Tube: ASTM B88	MAG 754	
	4 thru 24	Pr. Class 350	RMJ, RPO, FLG	Ductile Iron: AWWA C151	MAG 750	5
Lining for Pipe and Fittings	1/2 thru 3	—	—	None	—	
	4 thru 48	—	—	Cement-Mortar: AWWA C104, NSF 61 certified	MAG 750	
External Coating	PVC, 1/2 thru 3	—	—	None	—	
	Copper, 1/2 thru 3	2 wraps /layers	—	Pipe Wrap Tape: Polyethylene or PVC tape, Shop or Field Applied	—	
	4 thru 24	Thk. per Std —	—	Asphaltic: Manufacturer's Standard, AWWA C151, Factory Applied Polyethylene Encasement: AWWA C105, Field Installed	MAG 750 MAG 610	
	Valves	—	—	Epoxy: AWWA C550	—	
Fittings	3 and Smaller	—	SLDR	Wrought Copper and Copper Alloy (Brass or Bronze): Materials and Dim. per ASME B16.22	MAG 754	—
	4 thru 24	250 psi	RMJ, FLG, RPO	Ductile Iron: AWWA C110 or AWWA C153	MAG 750	5
Flanges	1/2 thru 3	—	—	None	—	
	4 thru 24	250 psig	FLG	Ductile iron: AWWA C115 for pipe, AWWA C110 for fittings, Dim. per ASME B16.1-Class 125	MAG 750	5
FLG Bolts, Nuts and Hardware	All	—	—	Non-Corrosive, High-Strength, Low-Alloy Steel Bolts: ASTM A 449- Gr 3, Class C or Class D with	—	1, 9
Gaskets	All	—	—	SBR		
Valves	3 and Smaller		THD	Ball: Bronze Body/Ball; Nibco T-585-70, Apollo 700-100 Series or equal	—	
	4 thru 16		FLG	Gate: AWWA C509	MAG 630 and Supplement to MAG 630	11
Insulation	All	—	—	None	—	

Schedule 40 05 02.23 – Potable Water

Process Service	Potable Water				
Process Service Identifier	W				

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Schedule 40 05 02.89 – Building Mechanical Drainage

Piping Service	Drain	Storm Drain			
Piping Service Abbreviation	D	SD			

Test Conditions

Piping Service	Pressure (psig)	Duration (min.)	Medium
D	4.3 (10-ft WC)	15	Water
SD	Per MAG Section 618		

General Requirements

1. Minimum test conditions specified above. Comply with applicable local plumbing code.
2. Sleeve drain, waste and vent piping through structural concrete and masonry.
3. Piping under structures, concrete-encased pipe from the structure, and piping extended from the structure through the interface between piped commodities common to process/mechanical and yard piping shall be either CISP or DIP, as specified.
4. Not used.
5. Provide copper tube for outdoor HVAC equipment condensate drains.
6. Pipe threads per ASME B1.20.1.

Notes:

1. Provide cast-iron soil pipe for buried pipe within 5 feet of building perimeter. Pipe materials transition to be at least 6 inches above slab or 6 inches inside building perimeter wall.
2. Provide long-radius elbows.
3. Provide magnetic tracer tape,
4. Not used.
5. Pipe tape wrap is not required for pipe installed in Indoor Dry, Indoor Wet, and Outdoor Area Exposures.
6. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse-thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
7. Provide non-corrosive, high-strength, low-allow steel bolts or fluoropolymer-coated carbon steel bolts for flanges installed in Buried Area Exposure.
8. Not used.
9. Fabricated (miter-cut pipe) PVC fittings are not acceptable.
10. Not used.
11. Bolts and nuts with metallurgy specified in AWWA C111.
12. Install per Cast Iron Soil Pipe Institute recommended practice specified in Cast Iron Soil Pipe and Fittings Handbook.
13. Provide polyethylene encasement: per AWWA C105, field-applied, for buried pipe under buildings and within 5 feet of building perimeter.

Schedule 40 05 02.89 – Building Mechanical Drainage

Piping Service	Drain	Storm Drain			
Piping Service Abbreviation	D	SD			

Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, and Headspace – Exposed and Buried (Includes Embedded and Encased) Under Buildings and within 5 feet of Building Perimeter

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	2 thru 12	SV	HAS, HBLS	Cast Iron (CISP): ASTM A74 or ASTM A888	—	1, 12
Lining for Pipe and Fittings	Cast Iron, All	—	—	Asphaltic: Manufacturer's Standard, Factory-Applied	—	
External Coating	Cast Iron, All	—	—	Asphaltic: Manufacturer's Standard, Factory-Applied	—	13
Fittings	Cast Iron, All	SV	HAS, HBLS	Cast Iron (CISP): ASTM A74 or ASTM A888	—	2, 5, 12
Taps	All	—	—	None:		
FLG Bolts, Nuts, and Hardware	All	—	—	Carbon Steel Bolts: ASTM A307-Gr A with Carbon Steel Nuts: ASTM A563-Gr A, 1/4" thru 1-1/2" use Gr A hex nuts, 1-5/8" thru 3" use Gr A heavy hex nuts	—	6, 7
		—	—	Non-Corrosive, High-Strength, Low-Alloy Steel Bolts: ASTM A 449- Gr 3, Class C or Class D with Carbon Steel Nuts: ASTM A563-Gr C3, Class C or Class D	—	6, 7, 11
		—	—	Carbon Steel Bolts: ASTM A307-B with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal with Carbon Steel Nuts: ASTM A563-A with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal		6, 7
Compression and Push-On Gasket	2 thru 12	—	HAS, HBLS	Neoprene or Nitrile	40 05 01	
Valves	All	—	—	None	—	

Schedule 40 05 02.89 – Building Mechanical Drainage

Piping Service	Drain	Storm Drain			
Piping Service Abbreviation	D	SD			

Buried (Includes Encased and Embedded) 5 feet Beyond Building Perimeter – Yard Piping

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1-1/4 thru 12	Sch. 40	SLV	PVC: ASTM D1784-Class 12454-B or ASTM D2665-Class 12454-B, NSF 61 certified, Dim. Per ASTM D1785	40 05 31.17	3
	2 thru 12	SV	HAS, HBLS	Cast Iron (CISP): ASTM A74 or ASTM A888	—	12
	3 thru 15	DR 35	PO	PVC: ASTM D1784-Class 12454-B, Dim. Per ASTM D3034	40 05 31.17	3
	18 thru 24	Class IV	BAS	Reinforced Concrete Pipe: ASTM C76, Joints per ASTM C443 or ASTM C1628	MAG Section 735	3
Lining for Pipe and Fittings	PVC, All	—	—	None	—	
	Cast Iron, All	—	—	Asphaltic: Manufacturer's Standard, Factory Applied	—	
	RCP, All	—	—	None	—	
External Coating	PVC, All	—	—	None	—	
	Cast Iron, All	—	—	Asphaltic: Manufacturer's Standard, Factory Applied Polyethylene Encasement: per AWWA C105, Field Applied	—	
	RCP, All	—	—	None	—	
Fittings	1-1/4 thru 12	Sch. 40	SLV	PVC: ASTM D2665-Class 12454-B, NSF 61 certified, Dim. Per ASTM D3311	40 05 31.17	2
	Cast Iron, All	SV	HAS, HBLS	Cast Iron (CISP): ASTM A74 or ASTM A888	—	2, 5, 12
	PVC, 3 thru 15	SDR 35	PO	Molded PVC: ASTM D1784-Class 12454-B, Dim. Per ASTM D3034	40 05 31.17	2, 9
Taps	All	—	—	None	—	
Grooved Coupling	All	—	—	None	—	
Flanges	All	—	—	None	—	
FLG Bolts, Nuts, and Hardware	All	—	—	None	—	
Flange Gaskets	All	—	—	None	—	
Mechanical Coupling Gaskets	All	—		None	—	
Compression and Push-On Gasket	PVC, All	—	PO	Oil-Resistant gasket: ASTM F477	—	
	Cast Iron, All	—	HAS, HBLS	Neoprene or Nitrile	40 05 01	
	RCP, All	—	BAS	Oil-Resistant gasket: ASTM C1619, Class B	—	
Valves	All	—	—	None	—	
Insulation	All	—	—	None	—	

Schedule 40 05 02.89 – Building Mechanical Drainage

Piping Service	Drain	Storm Drain			
Piping Service Abbreviation	D	SD			

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SECTION 40 05 06.16

PIPING CONNECTIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe

Reference	Title
AWWA C207	Steel Pipe Flanges for Waterworks Service – Size 4-in. through 144-in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components – Health Effects

1.03 SUBMITTALS

A. In addition to the material listed in the detailed specification, the following submittals shall be provided in accordance with Section 01 33 00:
   1. For equipment connection fittings used in pumping applications, submit thrust rod stretch calculations in accordance with paragraph 2.02 and dimensional layout data.

PART 2 PRODUCTS

2.01 FLANGE ASSEMBLIES

A. Flanges:
   1. General: Flanges shall either be flat flanges or convoluted-ring flanges as specified in the following paragraphs.
   2. Flat flanges: Cast-iron flanges shall be faced in accordance with American National Standards Institute (ANSI) B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised-face, conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain-face, conforming to American Water Works Association (AWWA) C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain-faced flanges shall not be bolted to raised-face flanges.

B. Gaskets:
   1. Gasket material shall be as specified in paragraph 2.03.
   2. Gaskets for plain-faced flanges shall be the full-face type. Thickness shall be 1/16-inch for pipe 10 inches and less in diameter and 1/8-inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised-face flanges shall match the raised face and shall be 1/16-inch thick for pipe 3-1/2 inches and less in diameter and 1/8-inch thick for pipe 4 inches and larger.

C. Bolts:
   1. Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI Bl.1, standard coarse-thread series; bolts shall be Class 2A and nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.
   2. Unless otherwise specified, bolts shall be carbon-steel machined bolts with hot-pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with American Society for Testing and Materials (ASTM) F593, marking F593F. Nuts for submerged service shall be made of copper-

silicon alloy bronze, conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:

1. Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Romac 501, Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal. Couplings shall be restrained where noted on the drawings.
2. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, markingF593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.
3. Gaskets shall be as specified in paragraph 2.03 and AWWA C111.

B. Plain-End Couplings:

1. Plain-end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain-end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.
2. Gaskets shall be as specified in paragraph 2.03 and AWWA C606.

C. Grooved-End Couplings:

1. Grooved-end, flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved-end, rigid-type couplings shall be Gustin-Bacon 120 Rigi-Grip, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted, tunnel-piping applications; and for grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved-end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint, grooved-end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or lightwall pipe.
2. Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy

C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 2.03 and AWWA C 606.

D. Equipment Connection Fittings

1. Equipment connection fittings join flanged pipe ends with both lateral and angular misalignment adjustment between the axes of the pipes. In addition, equipment connection fittings provide full-pressure thrust restraint between the field piping connection and equipment connection flanges.
   a. Equipment connection fittings consist of two flanged coupling adapters, a plain-end section of pipe and thrust-restraint tie rods and associated fittings designed to transmit thrust without transmitting shear to the thrust-restraint rods and without compromising provisions for accommodating angular and parallel misalignment.
   b. Materials and features are to conform to the requirements established in this section. Standard “dismantling joints” incorporate only one flanged coupling adapter and are not acceptable substitutes.
   c. Candidate manufacturers:
      1) Romac ECF Series;
      2) Baker Coupling Company, Los Angeles; and
      3) Approved equal.
2. Single sleeve of plain-end piping conforming to the Piping System Schedule for the specified process service and of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with sleeve-type, flange-coupling adapters at each end.
3. Provide thrust restraint by means of all-thread rod spanning between flanges and male rod nuts and spherical washers to provide a ball-joint type self-aligning feature. Project the all-thread restraint rod through the flange and mating flange coupling adapter bolt holes or through holes in the restraint lug plates that extend above the flanges. Secure all thread-restraint rods to the flanges with a minimum of two flange bolts.
4. Where the all-thread rods project through the flange bolt holes, provide ball-joint type nut and washer combinations with lock washers at each face and at each end. Where restraint lug plates are employed, provide ball-joint type nuts and washers only on the outside faces of the plates with nuts that have a self-locking feature that prevents nut movement due to vibration or other operational or environmental causes. Double-nutting with non-locking nuts is not an acceptable method of providing a self-locking feature.
5. Select thrust-rod diameter and material to provide sufficient freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full development of thrust restraint at all thrust rod tension take-ups.
6. Design equipment connection fittings per the requirements of AWWA C219.

7. Provide ASTM A193 grade B7, B8, or B8M thrust rods, ASTM A194 grade 2H, 8, or 8M nuts, with matching washers and lock washers to develop full-rated piping system pressure thrust forces. For pump applications, select thrust-rod quantities and diameters such that the thrust-rod stretch under the piping system's operating pressure does not exceed 2.0 mils.
8. Factory apply dry film molybdenum disulfide anti-galling compound to ends of thrust rods, covering all threads subject to nut travel and tightening.
9. Gaskets:
    a. Flange gaskets: Match gasket material specified for flange gaskets in the Piping System Schedule for the associated process service.
    b. Follower gaskets – compression-wedge. Match gasket material specified for mechanical coupling gaskets in the Piping System Schedule for the associated process service.
10. Provide Schedule 40, ASTM A53, Grade B pipe sleeves with ASTM A536, Grade 65-45-12 or ASTM A36 flange bodies and end rings. The pressure ratings of the flange adapters are to meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of equipment connection fittings, with the exception of 316 stainless steel components, with fusion-bonded epoxy conforming to AWWA C550 and NSF 61.

E. Dismantling Joints:
1. Dismantling joints may be used as takedown couplings in accordance with paragraph 3.03. Dismantling joints shall be fully restrained, double-flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. Dismantling joints shall be Romac DJ-400, or approved equal.

F. Sleeve-Band Couplings:
1. Sleeve-band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered, high-deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve-band couplings are acceptable wherever sleeve-type couplings are used (paragraph 2.02).

G. Flexijoint:
1. Where specified flexijoint couplings shall be flanged Romac flexijoint couplings. The flexijoint is a flexible, ductile-iron joint that can accommodate expansion, contraction, rotation and bending and is rated at 350-psi working pressure. The joint can accommodate 15- to 20-degree deflection, depending on size. Body shall be ductile-iron, lock rings Type 410 stainless steel, and ring gasket, casing, ball and cover shall be ethylene propylene diene monomer (EPDM) molded watertight construction. All metal portions of flexijoint coupling, including the stainless steel lock rings, shall be

coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. For buried installations, install with polyethylene baggy cover in accordance with the manufacturer's instructions.

2.03 GASKETS

A. Gaskets designated in Section 40 05 01 shall be as follows:
   1. EPDM: ethylene-propylene-diene-terpolymer.
   2. Neoprene: neoprene.
   3. Nitrile: nitrile (Buna N).
   4. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500-psi (ASTM F152), 0.2 ml/hr/ Leakage Fuel A (ASTM F37).
   5. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).
   6. Gylon gasketing, Garlock Style 3500, 2000-psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).
   7. Gylon gasketing, Garlock Style 3510, 2000-psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).
   8. Gylon gasketing, Garlock Style 3504, 2000-psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).
   9. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.
   10. PTFE bonded EPDM: PTFE (polytetrafluoroethylene) bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

2.04 THREAD

A. Pipe thread dimensions and size limits shall conform to ANSI Bl.20.1.

2.05 DIELECTRIC UNIONS

A. Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

A. Unless otherwise specified, flange assemblies and mechanical-type couplings for buried installation shall be field-coated with System M-1 as specified in Section 09 90 00.

2.07 PRODUCT DATA

A. In accordance with Section 01 33 00, the Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3 EXECUTION

3.01 PIPE CUTTING, THREADING AND JOINTING

A. Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

A. Pipe shall be welded by American Society of Mechanical Engineers (ASME) certified welders using shielded-metal arc, gas-shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 40 05 01. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 40 05 01.

B. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

A. Takedown couplings shall be screw unions, flanged or grooved-end mechanical coupling type joints and shall be provided as specified. Flanged or grooved-end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within 3 feet of the wall, unless specified otherwise.

B. A union or flanged connection shall be provided within 2 feet of each threaded end valve.

3.04 FLEXIBILITY

A. Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single flexijoint) as specified on the buried pipe within 2 feet of the structure for 2-inch through 6-inch diameter pipe; within 3 feet of the structure for 8-inch through 24-inch diameter pipe; and within one and one-half pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

3.05 DIELECTRIC CONNECTIONS

A. Where a copper pipe is connected to steel or cast-iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

3.06 EQUIPMENT CONNECTION FITTINGS

A. Where shown, equipment connection fittings shall be provided between field piping systems and equipment inlet and outlet connections.

END OF SECTION

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SECTION 40 05 06.33

PIPING APPURTENANCES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies pipeline thermometers, flow and level gages, pressure gages, strainers, steam traps, vents and drains.

B. Exclusions:
   1. Temperature, pressure and flow-measuring devices used for instrumentation are specified in Division 40. Instruments specified in Section 40 71 00 are identified in Section 40 06 70-3.03 – Instrument Index.

PART 2 PRODUCTS

2.01 NOT USED

2.02 NOT USED

2.03 PRESSURE DEVICES

A. Gage Cocks:
   1. Unless otherwise specified, gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

B. Pressure Gages:
   1. Unless otherwise specified, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale.
   2. Pressure gages for air, gas, and low-pressure services (0 to 10 feet) shall be premium-grade, heavy-duty, bourdon-tube units (bellow-type for vacuum) with Delrin bushings and pinion, and stainless steel sector.
   3. Gages on liquid service shall be as noted above, except they shall be provided with an internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill. Snubbers or orifices shall not be utilized.
   4. See Section 40 73 00 for pressure gauge product requirements.

C. Diaphragm Seals:
   1. Unless otherwise specified, seals shall be diaphragm-type with 1/4-inch flushing connection, Type 316 stainless steel body and Type 316L diaphragm. Fill fluid shall be Silicone DC200 unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

D. Pressure Sensors
   1. Unless otherwise specified, pressure sensors (tubular chemical seals) shall be the in-line, full-stream captive-sensing, liquid type. Wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N, unless otherwise specified. Seals shall be

rated for 200-psi with 5-inch SC hysteresis. Seals shall be Ronningen-Petter, Red Valve, or equal.

2. Fill fluid shall be rated for a temperature range of -20° F to 200° F. Capillary tubing shall be armored stainless steel. Fittings shall be provided for vacuum filling of system. Systems that are not factory-filled shall be vacuum-filled in the field. Filling connections shall be soldered shut after vacuum evacuation and filling.

2.04 NOT USED

2.05 NOT USED

2.06 PRODUCT DATA

A. Manufacturer's product data shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 NOT USED

3.02 GAGE TAPS

A. Gage taps shall be provided on the suction and discharge of pumps, fans, compressors, vacuum pumps and blowers. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

3.03 VENTS AND DRAINS

A. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted 4 feet above the floor. Vents in piping systems for fluids containing solids shall be 1-inch nonlubricated eccentric plug valves fitted with quick couplers.

B. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted 4 feet above the floor. Drain valves shall be threaded-end gate valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

END OF SECTION

SECTION 40 05 07

HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies hangers and supports for all piping systems specified in Section 40 05 01. This section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.

B. Operating Conditions:
   1. The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
      a. Ambient Systems:
         1) B. 60°F to 119°F
      b. Cold Systems
         1) C - 1. 33°F to 59°F
         2) C - 2. -20°F to 32°F

C. Hanger and Support Selection:
   1. The Contractor shall select pipe hangers and supports as specified in this section when not specified on the drawings. This specification section also provides additional information for support types used on the Contract Drawings. In the event of a conflict between the Contract Specifications and Contract Drawings, the Contractor shall adhere to the requirements of the Drawings first.
   2. Support selections shall be based upon the pipe support classifications specified in this section and any special requirements which may be specified in the Contract Documents.
   3. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.
   4. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:
      a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.
      b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
      c. Reaction forces due to the operation of safety or relief valves.
      d. Wind, snow or ice loadings on outdoor piping.
   5. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing or, where specified, the outside diameter of insulation.

6. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.
7. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.
8. The supporting systems shall provide for and control the free or intended movement of the piping, including its movement in relation to that of connected equipment.
9. Where there is horizontal movement at a suspended-type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.
10. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic- or vinyl-coated, or stainless steel hanger and support components.
11. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
12. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
13. Stock hanger and support components shall be used wherever practical.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Ed.
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e. Pipe support materials shall conform to the requirements of MSS SP-58. Metal framing system components shall conform to the Metal Framing Manufacturers Association Standard MFMA-2.

2.02 MATERIALS

A. General:
   1. Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot-dip or mechanically galvanized after fabrication. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in Section 26 05 00-1.05 Corrosive Areas, which shall be type 304 stainless steel.

B. Pipe Hangers and Supports:
   1. Type 7 – U-BOLT: U-bolts shall be carbon steel with configuration equivalent to MSS and FEDSPEC Type 24.
      a. Steel pipe (uninsulated) – Shall be Grinnell Fig. 137, B-Line B3188, or equal.
      b. Steel pipe (insulated) – Shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.
      c. Cast and ductile iron pipe – Shall be Grinnell Fig. 137, B-Line B3188, or equal.
      d. Copper pipe (uninsulated) – Shall be Carpenter & Patterson Fig. 222 CT, B-Line B3501 CT, Grinnell Fig. 137C, or equal.
      e. Copper pipe (insulated) – Shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.
      f. Plastic pipe – Shall be Grinnell Fig. 137C, Michigan model 151, B-Line B3188 C, or equal.
   2. Type 10 - Pipe Stanchion Saddle: Saddles and yokes shall be carbon steel and comply with MSS Type 37 and FEDSPEC Type 38.
      a. Steel pipe (insulated) – Shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.
      b. Steel pipe (uninsulated) – Shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.
      c. Cast and ductile iron pipe – Shall be Carpenter & Patterson Fig. 125, B-Line B3090 NS, or equal.
      d. Copper pipe (uninsulated) – Shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield or lined with dielectric material.
      e. Copper pipe (insulated) – Shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.
      f. Plastic pipe – Shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

3. Type 11 – Offset Pipe Clamp: Pipe clamp shall be carbon steel with configuration and components as specified and shall be of standard design manufactured by a pipe hanger component manufacturer.
    a. Steel pipe (insulated) – Shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.
    b. Steel pipe (uninsulated) – Shall be B-Line B3148, Grinnell Fig. 103, or equal.
    c. Cast and ductile iron pipe – Shall be B-Line B3148 NS, Grinnell Fig. 103, or equal.
    d. Copper pipe (insulated) – Shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.
    e. Copper pipe (uninsulated) – Shall be B-Line B3148, Grinnell Fig. 103, or equal, lined with dielectric material.
    f. Plastic pipe – Shall be B-Line B3148, Grinnell Fig. 103, or equal.
    g. Vertical pipe support applications shall be as specified above, except that insulation shields shall not be used for insulated pipe.

C. NOT USED

D. Structural Attachments:
1. Type B – Side Beam Bracket: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B-Line B3062, or equal.
2. Type H – Cast Iron Bracket: Bracket shall be cast-iron, Carpenter & Patterson Fig. 340, or equal.
3. Type J – Adjustable Beam Attachment: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or equal.
4. Type N – Pipe Stanchion Floor Attachment: Baseplate shall be carbon steel with 1/2-inch minimum thickness. Anchor bolt holes shall be 1/16-inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.

E. Accessories:
1. Hanger Rods: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.

2.03 NOT USED

2.04 PRODUCT DATA

A. Hanger and support locations and components shall be indicated on the piping layout drawings required by Section 40 05 01-2.04.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

A. The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the Contract Documents to support continuous pipeline runs unaffected by concentrated loads.

B. At least one hanger or support shall be located within 2 feet from a pipe change in direction.

C. The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

D. Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

E. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

A. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the American Institution of Steel Construction (AISC) Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.

B. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

C. The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

D. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

E. The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

I. Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

J. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

A. The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

END OF SECTION

SECTION 40 05 31.17

PVC DRAIN WASTE AND VENT PIPE AND FITTINGS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies polyvinylchloride material for DWV (storm drain, drain, waste and vent) pipe, fittings and joints.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 09 90 00 – Painting and Coating Systems
   4. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2321	Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic
ASTM F679	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F1970	Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. PVC: polyvinylchloride.
   2. DWV: storm drain, drain, waste and vent

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Specification section with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks denote full compliance with a paragraph as a whole. Underline deviations and denote each deviation with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification section along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturer's product data, catalog cuts, typical installation details, and dimensions. Indicate each Piping System Schedule where the product will be used.

1.06 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide PVC piping system materials as specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) for the specified Process Service.

2.02 COMPONENTS

A. PVC Solvent Weld Cement:
   1. Pipe and fittings 12-inch diameter and smaller: IPS 711 Weld-on Cement or approved equal.
   2. Universal plastic pipe solvent is not acceptable.

B. Primer:
   1. Staining solvent conforming to standard ASTM F656.
   2. Manufactured by solvent weld cement manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. DWV Pipe

1. Join by means of socket fittings and solvent cement welding in conformance with ASTM D2855 and ASTM F402.
2. Make solvent-cemented joints in compliance with the manufacturer's/supplier's instructions and recommended procedures.
3. Connections:
   a. Connect to different pipe materials by means of flanges, specified adapters, or transition fittings.
   b. Foreign material to be removed from the pipe interior prior to assembly.
4. Bedding and Backfill: Conform to Maricopa Association of Governments (MAG) and City of Prescott Supplement to MAG. Blocking under pipe is not permitted.

B. Not Used.

3.02 FIELD QUALITY CONTROL

A. Conduct tests in accordance with Section 40 05 01.

END OF SECTION

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SECTION 40 05 45

PIPING SYSTEM IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the supply and installation of permanent identification labels and markers for piping systems.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. References:
   1. This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ASME A13.1	Scheme for the Identification of Piping Systems
ANSI Z535.1	Safety Colors/APWA Uniform Color Code for Marking Underground Utilities

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Embedded/Encased Piping: Piping enveloped in concrete, typically under structures or under roadways.
   2. Exposed: All area exposures, other than buried, submerged, or encased/embedded.
   3. Buried: Below-grade walls or roofs; locations covered and in contact with earth/soil.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Provide a full-line product brochure showing available Piping System Marker and Caution Tape standard text and color options. Submit all text and colors proposed for use.
   3. Provide manufacturer's recommended installation instructions for Caution Tape.
   4. Provide product brochures and data sheets for tracer wire and splice kits. Submit all wire insulation colors proposed for use.
   5. Submit proposed tracer wire access box(es) for test leads. Submit electrical continuity test results upon completion.
   6. A copy of this section, addendum updates included, with each paragraph check-marked (✓) to indicate compliance or marked to indicate requested deviations from section requirements.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Electrical continuity test results.

PART 2 PRODUCTS

2.01 PIPING SYSTEM MARKERS FOR EXPOSED PIPE

A. Identify material contained in exposed piping systems using a colored plastic marker legend system conforming to American Society of Mechanical Engineers (ASME) A13.1.

B. For exposed piping, provide pre-coiled, mechanically attached-type, colored markers that are easily removable. Adhesive-type markers are not acceptable.
   1. Resistant to petroleum-based oils and grease and meet criteria for humidity, solar radiation, rain, salt, fog, leakage and fungus specified by MIL-STD-810.
   2. Withstand a continuous operating temperature range of -40°F to 250°F.
   3. Manufactured and applied in one continuous length of plastic, including directional arrows. Markers comprised of letters and directional arrows individually applied to the maker are not acceptable. Legends and arrows printed on polyester subsurface and over-laminated with Tedlar.
   4. Text size per ASME A13.1.
   5. Marking Services Style MS-995, Brady Style B-689, or approved equal.

C. Each Piping System Marker to be color-coded for identification and labelled with the Process Service Identifier and directional flow arrows indicating the direction of flow in the pipe. Piping System Marker background colors are specified in Section 40 05 02 for each Process Service. Except for Piping System Markers with an orange, yellow or white background color, provide white text and directional arrows for all Piping System Markers. Provide black text and directional arrows for pipe markers with an orange, yellow or white background.

2.02 CAUTION TAPE AND TRACER WIRE FOR BURIED PIPE

A. Provide Caution Tape and Tracer Wire per City of Prescott Standard Details 200Q-1 and 319Q-1.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM MARKERS

A. Provide Piping System Markers and direction arrows at locations conforming to ASME A13.1 and at the following locations:
   1. Apply intermittent markings on straight pipe runs, close to all valves, fittings, and adjacent to all changes in direction.
   2. Where pipes pass through walls, partitions, and floors, apply markings on both sides of walls, partitions, and floors.
   3. At point of entry and leaving each pipe chase and/or confined space, and piping accessible at each access opening.
   4. Adjacent to valves and where valves are in series at intervals of no more than 6 feet.
   5. At least once in each room and at maximum spacing of 40 feet. Exception: gas piping to be identified at 6-foot intervals in ceiling plenums.
   6. Spacing for markings not less than 1 foot.
   7. At the beginning and end points of each run, and at each piece of equipment in each run.

B. Visibility:
   1. Place identification on the bottom of the piping system for pipe systems located near ceiling or above the normal line of sight.
   2. Place identification on the side of the piping systems for pipe systems located at the normal line of sight or below.
   3. Place identification at approximate line of sight for vertical pipe systems.

3.02 INSTALLATION OF CAUTION TAPE AND TRACER WIRE

A. Provide Caution Tape and Tracer Wire per City of Prescott Standard Details 200Q-1 and 319Q-1.

3.03 NOT USED

3.04 FIELD QUALITY CONTROL

A. Comply with manufacturer's handling and installation instructions.

B. Provide continuity testing of tracer wire as specified on City of Prescott Standard Details 319Q-1.

END OF SECTION

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SECTION 40 05 61.16

GATE VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies bronze- and iron-body, solid-wedge gate valves. Iron-body valves shall be bronze-mounted.

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C509	Resilient-Seated Gate Valves or Water Supply Service

B. Design Criteria:

1. Gate valves 3 inches through 24 inches in size shall comply with American Water Works Association (AWWA) C509, including applicable hydrostatic testing. Gate valves smaller than 3 inches shall be subject to hydrostatic tests at the test pressure.

1.03 SUBMITTALS

A. Submittals shall be submitted in accordance with Section 01 33 00 and shall include at a minimum the following:

1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks shall denote full compliance with a paragraph as a whole.

   If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of

the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. Equipment literature, cut sheets and data sheets for all equipment supplied under this section.

PART 2 PRODUCTS

2.01 GENERAL

A. Gate valves shall be per the Maricopa Association of Governments (MAG) Uniform Standard Specifications and Details (USSD), the City of Prescott Supplement to the MAG USSD, and these Special Provisions contained in these Contract Documents, except as revised herein.

2.02 MANUFACTURE

A. Manual Operators:
   1. Unless specified otherwise, above-ground valves less than 12-inch size shall be provided with handwheels, and valves 12 inches and larger shall be provided with geared operators. All buried valves shall be provided with wrench nuts.

2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Affidavits of compliance, as required by AWWA C509.
   2. Hydrostatic test results.

PART 3 EXECUTION

3.01 INSTALLATION

A. Gate valves shall be installed in the closed position.

B. After installation and before pressurization of the valve, all pressure-containing bolting (bonnet, seal plate, packing-gland bypass and end connections) shall be inspected by the Contractor and witnessed by the Construction Manager for adequate tightness to prevent leakage. In addition, an inspection shall be made for the adequate tightness of all tapped and plugged openings to the valve interior.

C. On completion of installation of valves associated with the pump station and tank, valve location, size, make, type, date of installation, number of turns to open, direction of opening and other information deemed pertinent shall be entered on Form 01 78 23 C and included in the Operation and Maintenance Manual.

END OF SECTION

SECTION 40 05 65.23

SWING-CHECK VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies spring-loaded swing-check valves.

1.02 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A536	Ductile-Iron Castings
ASTM B148	Aluminum-Bronze Sand Castings
AWWA C508	Swing-Check Valves for Waterworks Service, 2-in. Through 24 In. NPS

1.03 SUBMITTALS

A. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Construction details showing dimensions and materials of construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include Val-matic and APCO, or equal.

2.02 MATERIALS

A. Materials of construction shall be as follows:

Component	Material
Body and Cover	Ductile Iron, ASTM A536, Grade 65-45-12
Gasket	Non-asbestos with Butadiene Rubber Binder
Cover Bolt	316 Stainless Steel, or Steel A449, Grade 5
Body Pipe Plug	Iron, Malleable, ASTM A48, Class 40

B. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 MANUFACTURE

A. Disc, disc arm, shaft, keyways, lever and spring shall be capable of closing within 1/2-second of pump stoppage and fluid moving at velocity of 8 feet per second. Spring tension shall be adjustable. The valve design shall permit mounting levers and springs on either side of the valve. The design of the spring attachment shall permit adjustment of closing force by tensioning the spring or replacement with different active-length springs.

B. Valves shall be provided with a clear opening equal to or greater than the connecting piping, with no raised seating surface. Seats shall be threaded onto the body or fitted with an O-ring seal and locked in place with stainless steel screws or pins and shall be replaceable. Shafts shall be provided with stuffing box and packing or O-ring seals at each end. Seals shall be externally replaceable. Minimum shaft diameters shall be as follows:

Valve Inlet Connection Size, inches	Shaft Diameter, inches
3	0.75
4	0.825
6	1.0
8	1.75
10	2.0
12	2.5
14	2.75
16	3.25
18	3.5
20	3.75
24	3.75

C. The pivot arm shall be secured to the disc with either twin bolted connections with lockwashers or a pinned nut. In either instance, the connection shall be designed to prevent disc movement relative to the arm. Shaft bearings shall extend the entire length of the shaft, other than the section required for the disc arm attachment. Disc and lever arms shall be keyed to the shaft and retained by bushings or pins.

D. Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Operating Pressure, psig	Hydrostatic Test
All	175	350

E. Check valves' wetted parts shall be coated with fusion-bonded epoxy.

2.04 PRODUCT DATA

A. Manufacturer's catalog information, including dimensions, cross-sectional views, details of construction, and materials, shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. Spring-loaded swing-check valves shall be installed in accordance with the manufacturer's recommendations.

B. On completion of installation, pressure-relief valve location, size, make, type, date of installation, number of turns to open, direction of opening, and other pertinent information pertinent shall be entered on Form 01 78 23 B and included in the Operation and Maintenance Manual.

END OF SECTION

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SECTION 40 05 72

SPECIALTY VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies specialty valves which are auxiliary to process piping systems.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME SEC VIII D2	Boiler and Pressure Vessel Code, Pressure Relief Devices
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings

1.03 SUBMITTALS

A. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (√) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. A copy of the Contract Document Process and Instrumentation Diagram, with addendum updates that apply to the equipment in this section, marked to show specific changes

necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required." Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

C. Construction details showing dimensions and materials of construction.

D. Manufacturer's recommended installation instructions.

E. Headloss characteristics.

PART 2 PRODUCTS

2.01 DIFFERENTIAL PRESSURE-SUSTAINING CHECK VALVES

A. Description: Hydraulically operated, diaphragm acutated globe valve, diferential pressure-sustaining control valve that sustains minimum differential pressure between the suction side and discharge side of the pump, regardless of fuctuating flow or varying upstream pressure.

B. Materials:
   1. Body and cover: Ductile iron, in accordance with American Society for Testing and Materials (ASTM) A536.
   2. Bolts, stem, nuts and studs: Type 316 stainless steel
   3. End connections: Flanged, ANSI 16.42 Class 150.
   4. Disc: Buna-N.
   5. Diaphragm: Nylon Refinforced Buna-N Rubber
   6. Main valve trim, stem and seat: Type 316 stainless steel, in accordance with ASTM A743.
   7. Coating: In accordance with Section 09 90 00 for immersed surfaces in contact with potable water.

C. Design Requirements:
   1. Valve size: 4-inch/6-inch
   2. Flow characteristics:
      a. Design flow: 420 gpm/970 gpm
      b. Minimum flow: 180 gpm/360 gpm
      c. Max pressure differential across valve: 4.4 psi/4.9 psi
      d. Minimum Cv value: 200/440
   3. Function:
      a. Pressure-sustaining regulator.
      b. Independent check valve feature.
      c. Flow-limiting V-port throttling valve.
      d. Opening rate adjustable over a minimum range of 15 seconds to 2 minutes. Initial setting: 15 seconds.
   4. Do not use diaphragm as seating surface.
   5. Assemble all control features and hardware on basic valve at factory.

6. Use corrosion-resistant metal for all exposed portions of the pilot system.
7. Provide a built-in type check to prevent pressure reversal.

D. Manufacturer:
1. Cla-Val Hytrol
2. Or approved equal.

2.02 PRESSURE-RELIEF VALVES

A. Pressure-relief valve (PRV) shall be hydraulically-operated, single-diaphragm, globe pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearings installed, and the diaphragm assembly. No separate chambers shall be allowed between the main valve cover and body.

B. Valve material of construction shall be as follows:

Body	Ductile Iron
Cover	Ductile Iron
Rubber Material	Buna-N
Shaft	Type 303 Stainless Steel
Diaphragm	Nylon Reinforced Buna-N
Bearing	Brass
Trim	Bronze or Stainless Steel

PRV shall be Cla-Val Model 50-01 modified as necessary to provide the specified features and to meet specified operating conditions. Size PRV per the Drawings and the manufacturer's recommendation.

C. Valves shall be NSF 61 epoxy-lined and coated.

D. Provide valve with closed position switch, Form C contacts, NEMA 4 enclosure.

2.03 HOSE VALVES

A. Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, Crane 17, Lunkenheimer 214, Powell 151, or equal with threaded nipple adapter for hose connection.

2.04 FLUSHING COCKS

A. Flushing cocks shall consist of a DeZurik 159/118-S, Keystone Fig 541, or equal, neoprene-faced eccentric plug valve with a hose nipple adapter if required. Unless specified otherwise, flushing cocks shall be 1-inch in diameter.

2.05 QUICK DISCONNECTS

A. Quick disconnects shall not be disconnectable under pressure. Quick disconnects for air service shall be Swagelok, Tomco, or equal, and shall be 1/2-inch, unless otherwise specified. Quick disconnects for water service shall be EverTite Part B, Gate Part B, or equal, and shall be 1-inch, unless specified otherwise.

2.06 STOP AND DRAIN VALVES

A. Stop and drain valves shall be Mueller H-10284, or equal.

2.07 PRODUCT DATA

A. Manufacturer's product data shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. Specialty valves shall be installed in accordance with the manufacturer's recommendations.

B. On completion of installation, PRV location, size, make, type, date of installation, number of turns to open, direction of opening, and other information deemed pertinent shall be entered on Form 01 78 23 B and included in the Operation and Maintenance Manual.

C. Manufacturer’s Representative shall train Owner’s personnel on the operation of PRVs per Section 01 79 00 for a minimum 30-minute training session.

END OF SECTION

SECTION 40 05 78.13

AIR/VACUUM VALVES FOR WATER SERVICE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies air-release valves, air and vacuum valves, and combination air valves for clean-water service, pumping, and storage applications.

B. Types:
   1. Air-Release Valves: Air-release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.
   2. Air and Vacuum Valves: Air and vacuum valves (AVV) shall have a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure. Size and capacity shall be as specified.
   3. Combination Air Valves: Combination air valves (CAV) shall have operating features of both the AVV and the ARV. They include both single- and dual-body construction. Size and capacity shall be as specified.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

1.03 SCHEDULE

Valve size, inches	Type	System press, psi
Per Mechanical Drawings	Per Mechanical Drawings	250

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Air release and vacuum valves shall be A.R.I. Flow Control Accessories, or approved equal, modified to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Component	Material
Body, cover	Cast iron, ASTM A126, Grade B
Float	Type 316 SS, ASTM A240
Seat	Buna-N or Type 316 SS
Trim	Type 316 SS, ASTM A240

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 CONSTRUCTION

A. ARVs shall be float-operated, compound-lever type, except ARVs less than 1-inch may be simple lever-type.

B. AVVs shall be designed to protect the float from direct contact with the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, and shall be easily removed if necessary. The float shall be center- or peripheral-guided for positive-shutoff into the seat.

C. CAVs, unless otherwise specified, shall be single-body construction in sizes 1- through 6-inch and dual-body construction in sizes 8-inch and larger. Single-body construction shall be designed to provide all functions within one housing. The body inlet shall be baffled to protect the float and the large and small orifices shall be designed so that during large orifice closure, the small air-release orifice will open to allow small amounts of air to escape. Dual-body construction shall combine one AVV and one ARV with interconnecting piping and gate valve.

D. NOT USED

E. Valves shall be suitable for pressures up to 150 pounds per square inch (psi).

2.04 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data.
   2. Applicable operation and maintenance instruction manuals per Section 01 78 23.

PART 3 EXECUTION

3.01 INSTALLATION

A. All air, vacuum and combination valves shall be installed in accordance with the manufacturer's recommendations. Unless otherwise specified, isolation valves per Section 40 05 01 shall be provided below each air valve.

END OF SECTION

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SECTION 40 06 70

SCHEDULES FOR INSTRUMENTATION OF PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Instrument Index for instruments furnished or installed under Sections 40 71 00 through 40 74 00.

1.02 QUALITY ASSURANCE

A. Refer to Section 40 61 13.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 61 13.

B. Action Submittal:
   1. Submit updated schedule with field instrumentation submittal defined in Section 40 61 13 to match equipment being provided.

PART 2 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 40 61 13 for requirements.

3.02 FIELD QUALITY CONTROL

A. Refer to Section 40 61 21 for requirements.

B. Maintain a copy of the complete Instrument Index with modifications during construction in Excel format. Provide a copy of the latest version to the Engineer upon request.

3.03 ATTACHMENTS

A. 40 06 70 Attachment A: Instrument Index
   1. Description of headings in Instrument Index.

Instrument Field or Heading	Comment or Description
Site Tag	Per the City
Tag No. Function Abbreviation	Per Drawing I-001
Tag No. Loop Identifier	Per Drawing I-001
Device Function	Provides the functional description of the instrument, analyzer, or device.

Instrument Field or Heading	Comment or Description
Operating Range	
Min Calibration or Setpoint	
Max Calibration or Deadband	
Units	
Comments	
Specification Number	Specification under which device is provided or specified.
P&ID Number	P&ID sheet number

END OF SECTION

SECTION 40 06 70

SCHEDULES FOR INSTRUMENTATION OF PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Instrument Index for instruments furnished or installed under Sections 40 71 00 through 40 74 00.

1.02 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Action Submittal:
   1. Submit updated Instrument Index with Section 40 61 13 field instruments submittal to match equipment being provided.

PART 2 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 40 61 13 for requirements.

3.02 FIELD QUALITY CONTROL

A. Refer to Section 40 61 21 for requirements.

B. Maintain a copy of the complete Instrument Index with modifications during construction in Excel format. Provide a copy of the latest version to the Construction Manager upon request.

3.03 ATTACHMENTS

A. Spec. 40 06 70 Attachment A: INSTRUMENT INDEX
   1. Description of headings in Instrument Index.

Instrument Field or Heading	Comment or Description
Site Tag	Per the City
Tag No. Function Abbreviation	Per Drawing I-001.
Tag No. Loop Identifier	Per Drawing I-001.
Device Function	Provides the functional description of the instrument, analyzer, or device.
Operating Range	25 to 65, -10 to 90, etc.
Min Calibration or Setpoint	0, 24

Instrument Field or Heading	Comment or Description
Max Calibration Or Deadband	20
Units	mgd, kW, psi, etc.
Comments	Provides the features, interlocks, and information applicable to the instrument, analyzer, or device. Describes special installation instructions, area classifications, modifiers to standard instrument specs, Owner-supplied, existing, accessories, signal surge protection, options, etc.
Specification Number	Specification under which device is provided or specified.
P&ID Number	P&ID sheet number

END OF SECTION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.01 SUMMARY

A. Scope:

1. This Section specifies general requirements applicable to Sections 40 06 70 through 40 74 00 of these Specifications for the process control, instrumentation, communication, network, and signal systems. This work shall be provided by a single Systems Integrator (SI) meeting the qualifications section of this Specification.
2. Electrical requirements applicable to this work include those specified in Section 26 05 00 and Section 26 09 16 for electrical control and relays.

B. System Overview:

1. Work Sequence: Refer to Sections 01 12 16 and 26 05 00.
2. Replace the existing Mingus Pump Station (Mingus PS):
    a. Provide replacement pump station with instrumentation, controls, and remote telemetry unit (RTU).
    b. Demolish the existing pump station and controls.
    c. Provide replacement pump station standby generator.
    d. Make replacement Mingus PS RTU communicate with replacement Mingus Tank RTU after tank work below is completed.
    e. Make Mingus Tank RTU communicate with existing City of Prescott master supervisory control and data acquisition (SCADA) system.
3. Replace the existing Mingus Tanks with one tank:
    a. Demolish the Tanks.
        1) Remove and salvage the existing Mingus Tank RTU and antenna for the Mingus PS. No level control signals are now available for the existing Mingus PS operation until tank replacement is complete.
        2) Remove and salvage the existing Mingus Tanks' level transmitters and level switches.
    b. Provide replacement tank.
        1) Provide level instruments.
        2) Provide Mingus Tank RTU and antenna for Mingus PS operation.
        3) Make replacement Mingus Tank RTU communicate with replacement Mingus PS RTU.
4. Removed equipment as part of demolition shall be turned over to the Owner.
5. SCADA Programming: By the SI.
6. RTU Programmable Logic Controller (PLC) Programming: By the SI.
7. Mingus Tank and Mingus PS RTU Fabrication: By the SI.
8. Radio transmission line, antennas, surge protectors, and related components: By the SI.

C. All work covered by Sections 40 06 70 through 40 74 00 shall be the responsibility of a single SI, as defined within this article.

D. The instrumentation and control-system functions are shown on the Drawings and specified in subsequent sections of Division 40. The SI drawings and integration practices shall be as defined in Institute of Electrical and Electronics Engineers (IEEE) 100, Instrumentation, Systems, and Automation Society (ISA) S51.1, and National Electrical Manufacturers Association (NEMA) ICS 1.

E. Demonstrate the overall system performance to the Owner for acceptance.

F. Definitions – Signal Types:
   1. Analog, low level: Signal with full output level of 100 millivolts or less, including thermocouples and resistance-temperature detectors.
   2. Analog, high level: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 mA to 20 mA transmission.
   3. Audio signals, high level: Audio signals exceeding plus 4 dBm, including loudspeaker circuits.
   4. Digital code: Coded information from the output of an analog-to-digital converter or digital transmission terminal.
   5. Discrete control or events: Dry-contact closures and signals monitored by solid-state equipment, relays, or control circuits.
   6. Discrete control or events, low-voltage: Dry-contact closures and signals monitored by solid-state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.
   7. Pulse frequency: Counting pulses emitted from speed or flow transmitters.
   8. Radio frequency (RF) signals: Continuous-wave alternating-current (AC) signals with fundamental frequency greater in a range of 310 kilohertz to 300 gigahertz.

G. Definition – Drawing Types:
   1. Elementary or schematic diagram:
      a. Use graphic symbols to indicate the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing of the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
      b. Indicate connections to internal and external components connected to the panel. Note which devices are external to the panel.
      c. Depicted in ladder logic format.
      d. Indicates contact arrangement of internal and external devices such that circuits are complete and match equipment furnished.
      e. Indicates equipment designations/tag numbers to match Contract Drawings and Process and Instrumentation Diagrams (P&IDs).
   2. Network block diagram:
      a. A diagram of the overall control system, containing annotated boxes showing the primary network components (controllers, hubs, routers, switches, computers, displays).

b. Include annotated interconnecting lines showing the system communication media and communication protocols.
c. Indicate manufacturer and model of the primary network components and software.
d. Indicates functions performed by each device (e.g., historical data server, field controller, database server, operator workstation, etc.)

3. Connection diagram:
   a. Purpose is to show wiring requirements between internal panel components.
   b. Show components of a control panel in an arrangement similar to the actual panel layout.
   c. Indicate internal wiring between components.
   d. Show terminal blocks used for internal wiring and field wiring, with identification as such.
   e. Indicate insulation color code, signal polarities, wire numbers, and terminal block numbers.
4. Arrangement, layout, or outline drawings:
   a. Show the physical space and mounting requirements of a piece of equipment.
   b. Indicate ventilation requirements and space provided for connections or the location to which connections are to be made.
   c. Indicate clearance requirements for ventilation and access.
   d. Show the dimensioned external and interior control panel views with components and Bill of Material.
5. Loop diagrams:
   a. Prepared per ISA S5.4.
   b. Show device element wiring of the system. Indicate device terminations, with terminal numbers.
   c. Show circuits for hardwired device interlocks.
   d. Show circuit cable and wire cable numbers, signal polarities, and terminal block numbers.
   e. Show connection to power supplies. Include AC and direct-current (DC) power supplies and circuit information for instruments furnished under this Contract.
   f. Indicate controller or input/output (I/O) card address/node, rack, slot, and point wiring terminals.
   g. Show power supplies for signal loops. Indicate in which panel components reside and power originates with circuit numbering/name. Where new/modified loops connect to an existing power supply, show the existing power supply name, location, and circuit.
   h. Indicate surge-protection type, manufacturer, and model number (i.e., types include floating ground reference or grounded reference).
   i. Show new and modified terminal blocks with numbering in new and existing panels.
   j. Indicate signal loop grounding terminations.
   k. Indicate loop numbers, wire numbers, and cable numbers used in field wiring and panel wiring.

l. Indicate field element being controlled or monitored (i.e., normally open contact from relay CR19, or FIT 3160).

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.
2. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

B. Coordination:

1. Coordinate the process and instrumentation control system for proper operation with related equipment and systems specified in other Divisions.
2. Integrate equipment in conformance with the Drawings, Specifications, and recommendations of the equipment manufacturer and the related processes equipment manufacturers.
3. Obtain manufacturer's technical information for items of equipment not provided with, but connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between equipment and the control system.
4. Coordinate interface requirements and schedule with other project subcontractors and equipment suppliers.
5. Present to the Construction Manager conflicts between the Plans, Specifications, manufacturer/vendor drawings, and installation instructions, etc. for resolution before proceeding.

C. Pre-submittal Conference: Not Used.

D. Systems Integrator Responsibility:
   1. The specified control system and instrumentation integration, including panel building, software programming, instrument calibration, testing, start-up, operational testing, and training shall be performed by a SI staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.
   2. Equipment shall be integrated, furnished, and installed in conformance with the Drawings, Specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.
   3. SI shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.
   4. SI shall coordinate with project Contractor, subcontractors, and equipment suppliers.
   5. SI shall provide installation supervision for the equipment provided for the Project, a minimum of 4 man-weeks on site.

E. Systems Integrator Qualifications:
   1. The following SI are pre-qualified to perform the work specified in Division 40:
      a. Ripple Industries, LLC.
      b. Alternate Owner pre-qualified firm, if any.

1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00.

B. Action Submittals - General Requirements:
   1. Shop drawings: Prepare drawings in CAD software with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Include a date and description for each revision of a drawing, including the date and description of the revisions. Drawing prints shall be 11-inch by 17-inch with a minimum lettering size of 1/8-inch.
   2. Product literature: Provide manufacturer's specifications, data sheets, and catalog literature for the equipment and components that clearly and unambiguously show what is being provided and that it meets the requirements specified. Indicate provided and available options, materials of construction, environmental characteristics, electrical characteristics, and connection requirements. Include only applicable information.

C. Action Submittals – Field Instruments:
   1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements.

      A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications.

Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Submittal requirements of Section 40 71 00.
3. Submittal requirements of Section 40 72 00.
4. Submittal requirements of Section 40 73 00.
5. Submittal requirements of Section 40 74 00.
6. Updated Instrument Index per Section 40 06 70.

D. Informational Submittals.
   1. Record Documents specified in paragraph 3.03.

E. Closeout Submittals – General Requirements:
   1. Procedures: Section 01 78 23.
   2. Include the following in each operation and maintenance (O&M) manual:
      a. Final reviewed submittals, including revised As-built Record Drawings.
      b. Manufacturer's O&M instructions, edited for this Project.
      c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.
      d. Include list prices for spare parts, expendable supplies, and tools provided.
   3. Include a flash drive at the end of construction that contains the PLC and HMI programming.

F. Closeout Submittals – Field Instruments:
   a. O&M combining the requirements of Sections 40 71 00, 40 72 00, 40 73 00, and 40 74 00.

1.04 ENVIRONMENTAL CONDITIONS

A. Ambient Conditions: Per Section 01 11 80.

B. Corrosive Locations: None.

C. Hazardous (Classified) Areas: None.

D. Seismic:
   1. Brace equipment and supports per requirements of Structural Drawings.

PART 2 PRODUCTS

2.01 EQUIPMENT/MATERIALS

A. General Requirements:

1. New.
2. Free from defects.
3. Rated for the installed environment.

B. Similar control-system components, instrument, instrument accessory, and devices used throughout the work shall be manufactured by one firm, where possible.

C. The components, modules, devices, and control-system equipment shall be recognized industrial-quality products. Recognized commercial- or office-grade products are prohibited.

2.02 ENCLOSURES

A. Table A specifies the instrument and control-panel enclosure material and minimum National Electrical Manufacturers Association (NEMA) rating for the location and application where not identified in other Specification sections.

Table A

Location	Enclosure NEMA Rating
Indoor: Electrical Room	NEMA 12
Indoor: Process Areas	NEMA 4
Outdoor: Non-Corrosive Areas	NEMA 4

2.03 NAMEPLATES

A. Provide nameplates for field-mounted instrument, analyzer, or equipment covered by this section, with the following requirements:
   1. Include the equipment or instrument loop title and the instrument or equipment tag number, where nameplate engraving is not specified or shown.
   2. Machine-engraved black phenolic with white 5/32-inch high lettering, as minimum, unless otherwise specified or shown.

B. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

C. Attach nameplates to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location so the nameplate will remain to identify the service when the device is removed. Attach field instrument nameplates with braided stainless steel straps where not stand-mounted.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Install equipment in locations that are accessible for O&M services.
   2. Installation, calibration, settings, and testing procedures are specified in Sections 01 45 20, 40 61 21, 40 06 70-3.03, and subsequent Sections of Divisions 26 and 40.

B. Field Equipment:

1. Equipment shall be provided with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 48 inches and 60 inches above the floor or permanent work platform. Equipment shall be mounted to avoid shock or vibration that may impair operation. Equipment shall be mounted for unobstructed access and walkways. Equipment support systems shall not be attached to handrails, process piping or mechanical equipment.
2. Space instruments and cabinets from concrete walls by 5/8-inch with framing channel between instrument or cabinet and wall. Add supports to block wall to avoid damage to the wall.
3. Design support systems, including panels, in accordance with requirements on Structural Drawings to prevent deformation greater than 1/8-inch in any direction under the attached equipment load and under an external load of 200 pounds.
4. In wet or outdoor areas, make conduit penetrations into instrument housing or panels through the bottom (preferred) or side of enclosures to minimize water entry from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.
5. Provide nameplates for field-mounted equipment. Attach nameplates in a readily visible location, but such that if the field device is replaced, the nameplate will remain to identify the service.

3.02 FIELD QUALITY CONTROL

A. Delivery Inspection:

1. Notify the Owner's Representative upon arrival of material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner's Representative may inspect such items.

B. Inspection and Installed Tests:

1. Refer to Section 40 61 21.

3.03 RECORD DOCUMENTS

A. Contract Documents shall be maintained and annotated by the Contractor during construction, including the Record Drawings specified in General Conditions and Division 01.

END OF SECTION

SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies testing requirements applicable to Sections 40 06 70 through 40 74 00 of these specifications for the process control, instrumentation, communication, network, and signal systems. This work will be referenced as the Process and Instrumentation Control System (PICS) to be provided by a PICS Testing Manager meeting the Qualifications section of this specification. Section includes:
   1. Testing documentation.
   2. Testing organization and sequencing.
   3. Factory Acceptance Testing (FAT)
   4. Performance testing.
   5. Loop testing.
   6. Functional testing.
   7. Operational testing.

1.02 REFERENCES

A. Definitions:
   1. Refer to Section 40 61 13.

B. References:
   1. Refer to Section 40 61 13.

C. Appoint a startup engineer or qualified specialist as PICS Testing Manager to manage, coordinate, and supervise the testing work.
   1. Definition of process areas and systems, with testing executed on an area-by-area basis, based on the Process and Instrumentation Diagrams (P&IDs).
   2. Testing for each process area executed in sequential tasks.
   3. The PICS Testing Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the testing and startup of similar electrical and instrumentation control systems.
   4. Employ technicians who are qualified by completion and certification from training courses offered by the International Society of Automation (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate testing with Section 01 45 20.
   2. Provide notice to the Construction Manager prior to conducting a test.

3. Provide a detailed step-by-step test procedure, between 60 and 70 days before the commencement of testing activity, complete with forms for the recording of test results, testing equipment used, and a place for identification of the individuals performing and witnessing the test.
4. Provide detail assistance to the Contractor in generating Section 01 45 20-Form A, customized for this project. Submit detailed form prior to testing per the requirements of Section 01 45 20.
5. Equipment and System Performance and Operational Testing: Section 01 45 20 specifies testing of the mechanical, electrical, instrumentation, and HVAC systems. Coordinate, manage, and supervise the work with the quality assurance program including:
    a. Testing plan with the sequence for the test work.
    b. Calibration program for instruments and analyzers.
    c. Documentation program that records tests results.
    d. Performance testing program systems.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Action Submittals:
1. Testing Plan:
    a. Submit detailed testing plan and proposed testing documentation after review of the Quality Assurance submittal showing conformance with Part 2 of this specification. Obtain approved submittal prior to testing. Separate submittals may be provided for each process area or test group:
        1) Control descriptions.
        2) Input/Output (I/O) interface.
        3) Testing status spreadsheets.
        4) Test procedures.
        5) Proposed test forms per this section, detailed for each test for this project.
        6) List of Certified Factory calibrated flow and temperature transmitters.
2. FAT:
    a. FAT schedule and location.
    b. FAT procedures and test forms.

C. Closeout Submittals:
1. Final Test Results.
    a. Test equipment and test equipment calibration date.
    b. Certified factory calibration reports for flow and temperature transmitters.
    c. Performance test results.
    d. Loop test results.
    e. Functional test results.
    f. Operational test results.

PART 2 PRODUCTS

2.01 GENERAL

A. Test forms: Conform to the requirements of Reference Forms 40 61 13-A through 40 61 13-K included in Section 01 99 90. Develop additional or detailed forms as necessary to suit complex instrumentation. Use terms on test forms that comply with ISA S51.1.

B. Project Labeling:
   1. The items specifying project labeling herein include the following as a minimum: Owner's name, facility name, project name, and project number.

2.02 TESTING DOCUMENTATION

A. Documentation Records:
   1. Develop a record-keeping system to document progress and completion for each task in each process area or system. Coordinate overall organization of areas and systems with overall testing required by Section 01 45 20, Equipment and System Performance and Operational Testing.
   2. Always keep documentation current and available for inspection on site in a location designated by the Construction Manager:
      a. Not used.
      b. List of names of Contractor's and System Integrator's personnel associated with final construction and testing, and normal and emergency contact telephone numbers
      c. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.
      d. Testing status specific to pre-loop test and loop testing status spreadsheet to include the I/O list organized by area and system and loop number. Percent complete of the PICS system will be based on percentage of I/O points tested.
      e. Test Report Volumes.

B. Test Report Volumes:
   1. Develop and maintain a testing documentation for each process area or system in separate volumes. Always keep each volume current and available for inspection on site in a location designated by the Construction Manager. Include the following as a minimum:
      a. Three-ring binder with front cover and spine labeled per Paragraph 2.01.
      b. Table of Contents with same labeling as the volume cover with tabs for each section:
      c. Section 1: Control Description
      d. Section 2: I/O Interface
      e. Section 3: Instrument Index
      f. Section 4: Test Procedures and Forms
      g. Section 5: Certified Factory Calibration Reports
      h. Section 6: Test Report

C. Control Description:
   1. Provide a control description outlining operation for each process area's system. The Control Description Specification Section 40 61 96 may be used as a basis.

D. I/O Interface:
   1. Provide I/O spreadsheets for each process area's system. Spreadsheets are to include the following for each I/O point:
      a. Signal number/tag.
      b. Annotation description that may be logically abbreviated and that is subject to approval.
      c. Complete physical I/O channel designation and addressing or communication I/O register designation.
      d. True/false status designations for digital I/O.
      e. Process range; engineering units and multipliers; and raw signal range count for analog I/O.
      f. Signals: Fixed point and scaled at the controller with minimum four significant implied digits of scaling; e.g., 0 to 1,400 at controller for a pH range of 0 to 14 at operator interface.
      g. Provide operator interface scaling to display decimal digits required.
      h. Indicate pass/fail for each point for both pre-loop test and loop tests.
      i. Indicate date of tests and comment for failed points.

E. Instrument Index:
   1. Provide a detailed Instrument Index. The Instrument Index from Section 40 06 70 may be used as a basis. Indicate actual calibration ranges, set points, and deadbands.

F. Field Test Procedure Documentation:
   1. Organize and assemble test procedures for each analog and discrete loop in the process control system in separate volumes for each process area or test group. Organize by I/O point. Submit final test records in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.
   2. Include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.
   3. Include test report forms for each loop, including forms for wiring, piping, and individual component tests, with the test procedure documentation. Record the actual test results on these forms and assemble them into final test reports.
   4. Preprint and populate information in the test report forms to the extent possible prior to commencing testing.
   5. Include on the test report forms:
      a. Project name.
      b. Process area associated with the equipment under test.
      c. Instrument loop description.

d. Instrument loop identification number.
e. Instrument nameplate data.
f. Instrument setup and configuration parameters.
g. Time and date of test.
h. Inspection checklist and results.
i. Reference to applicable test procedure.
j. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
k. Test equipment used.
l. Space for remarks regarding test procedure or results, observations, etc.
m. Name, date, and signature of testing personnel.
n. Test witness's name and signature.

2.03 SOURCE QUALITY CONTROL

A. Factory Acceptance Test (FAT):
1. Provide a FAT and any subsequent retests witnessed by the Construction Manager and Owner.
2. Load software and configuration for control system panels, controllers, network components, operator interfaces, and the programming and graphic configuration application at the control system equipment supplier's factory prior to the FAT.
3. Inspect equipment, panel instruments, panels, or cabinets with factory testing performed.
4. Provide written notice to the Construction Manager 30 working days before the commencement of the FAT activity and include:
a. Schedule for the FAT.
b. Location of the FAT.
c. Testing equipment used.
d. Detailed test procedure with forms for the recording of test results.
e. Sign-off spaces for the individuals performing and witnessing the tests.
5. Network and interwire equipment and panels as applicable. Operate and check out equipment prior to the FAT. Submit certification indicating that the panels are ready for the FAT. Include the following:
a. Visual inspection of equipment, instruments, control panels, and graphic displays.
b. Validation of each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs.
c. Validation includes:
1) Monitoring state changes on operator interface screens based on the inputs state change.
2) Observation of online controller programming application software with the associated outputs state change.
3) Outputs triggered by operator interface software devices (pushbuttons, sliders, manually entered values, etc.)
4) Calibration and operation of instruments on or in the control panels.

d. Repair of loops that do not pass validation.
e. Retest of the FAT at no additional cost.

PART 3 EXECUTION

3.01 GENERAL

A. General Requirements:
1. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein.
2. Inspect materials, equipment, and construction included under this specification in accordance with this section and subsequent sections of this division. Perform testing in accordance with this and subsequent sections of this division.
3. Have a certified instrument technician qualified to calibrate the instrumentation calibrate and set up field instruments and analyzers.

B. Test Equipment and Materials:
1. Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.
2. Provide a calibration sticker on test instruments showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Include certified calibration reports traceable to the National Institute of Standards and Technology with the final test report.
3. Provide a documenting calibration system to conduct process instrumentation calibration activities that consist of a documenting process calibrator and an instrumentation data management software system that captures the calibration results and electronically document instrument data, date of calibration, calibration procedures, and as-found and as-left instrument calibration data.
4. Not used.
5. Not used.
6. Not used.
7. Not used.

C. Performance Deviation Tolerances:
1. Tolerances are specified in individual sections. Where tolerances are not specified, refer to the manufacturer's published performance specifications.
2. Calculate overall accuracy requirements for loops consisting of two or more components, by the root-summation-square (RSS) of the component accuracy specifications. Calculate and record tolerances for each required calibration point on the associated test report form.

D. Witnessing:
1. The Construction Manager reserves the right to observe factory and field instrumentation testing and calibration procedures. Notify the Construction Manager prior to testing, as specified herein.

3.02 TESTING SEQUENCE

A. Perform tests for each area or system in the following sequence:
   1. Performance testing
   2. Loop testing
   3. Functional testing
   4. Operational testing

B. Group equipment and I/O based on the relationship of the equipment to operate safely as specified, including full automatic and manual control and monitoring through the control system. Equipment and I/O in a given area or system shall pass testing prior to proceeding to the next set of tests in the sequence above.

3.03 PERFORMANCE TESTING

A. Perform tests in the order below.

B. Wiring Tests:
   1. Verify that electrical power and signal cable ring-out and resistance testing has been performed as specified in Sections 26 05 00 and 26 08 00. Conduct wiring tests after cables have been properly terminated, tagged, and inspected.
      a. Power and Control: Section 26 08 00.
      b. Signal: Section 40 61 13-Form A.

C. Not used.

D. Not used.

E. Not used.

F. Instrumentation Calibration:
   1. Calibrate instruments and final elements in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.
   2. Complete and document instruments and component inspections to the satisfaction of the Construction Manager prior to individual component calibration and testing.
   3. Calibrate analog instrument at 0, 10, 50, 90, and 100 percent of the specified full-scale range. Adjust each signal sensing trip and process sensing switch to the required setting. Verify instrument readout matches loop signal. Test data recorded on test forms as specified herein.
   4. Test and adjust final element alignment to verify that each final element operates smoothly over the full range in response to the specified process control signals.
   5. Enter test data on the applicable test forms at the time of testing: set alarm trips, control trips, and switches to initial values specified in Section 40 06 70 Instrument Index at this time. Check final elements for range, deadband, and speed of response.
   6. Have any component repaired or replaced by the manufacturer where the component fails to meet the required tolerances. Repeat the specified tests until the component is within tolerance.

7. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.
8. Test forms Section 40 61 13-Form G through I.
9. Certified Test Reports: Field test and inspection activities include verification of instrument parameter setup, verification of instrument zero, and performance at three operating points within the instrument range. Return each instrument that fails to demonstrate proper performance for recalibration or replaced as agreed depending on the impact to the project as determined by the Construction Manager.
    a. Where instrument field calibration is not feasible, certified factory calibration reports may be submitted that include the name and address of the laboratory that conducts the calibration testing. Certified factory test reports may be submitted for the following instrument types in lieu of field calibration:

Table A. Factory Calibration Instrument List

Instrument Identification	Instrument Section	Description
FM	40 71 00	Magnetic flow metering system
TRE	40 74 00	Resistance temperature element, insertion type]

G. Pre-Loop Testing:
1. Test every I/O point from the field device to the termination on the I/O card in the panel.
2. Perform tests with loop wiring complete and terminated for each point being tested between initial field device and I/O termination point.
3. For each discrete I/O point, verify and document contact status value for both the opened and closed positions of the contact.
4. For analog points, verify analog value matches local display. Confirm calibration at 0, 25, 75, and 100 percent of value.

3.04 LOOP TESTING

A. Provide a request to perform loop testing at least 2 weeks prior to the requested loop test date. Include the following with the request:
1. Area/system for which request is being made.
2. Written certification that performance testing has been completed, documented, and passed for the area/system for which loop testing is being requested.
3. Submittal numbers that define the tests and data points for the I/O to be tested. Provide updates to the I/O list or instrument calibration as an outcome of the performance testing.

B. Commence loop testing after the performance testing has been completed and documented to the satisfaction of the Construction Manager.

C. Test each instrument loop as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Inject test signals at the process impulse line

connection where the measuring technique permits, and otherwise at the most primary signal access point.

D. For each discrete I/O point, verify and document field contact status value for both the opened and closed position of the contact.

E. For analog points, verify that analog value matches local display. Confirm calibration at 0, 25, 75, and 100 percent of value.

F. Where loops are interfaced to a controller, verify the controller I/O assignment and operation of the input/output system and processor. Inspect the data table or register in the programmable logic controller (PLC) memory to verify proper operation.

G. If the output control or monitoring device fails to indicate properly, make corrections to the loop circuitry or device. Repeat the test until devices and instruments operate as required.

H. Correct loop circuitry and repeat the test until the instruments operate properly.

I. Test Section 40 61 13-Form J.

3.05 FUNCTIONAL TESTING

A. Process Control Strategy/Functional Testing:
   1. Commence control strategy testing after loop testing has been completed and documented to the satisfaction of the Construction Manager.
   2. Control strategy testing, performed by the Programmer, Si, and Contractor consists of installing and debugging the PLC control logic program, verifying the interface points between the controller I/O cards and field devices and equipment, and exercising the control strategies.
   3. Provide qualified personnel to immediately correct deficiencies in the work that may be encountered during control strategy testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete control strategy testing.

B. Control System Closed-Loop Testing:
   1. Commence closed-loop commissioning after the control strategy testing has been successfully completed and documented to the satisfaction of the Construction Manager.
   2. Demonstrate stable operation of each loop under operating conditions. Adjust loop tuning parameters as part of the test.
   3. Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping, unless otherwise specified.
   4. Provide the loop response to a step disturbance for each loop. Provide two graphs for cascaded control loops, one showing the secondary loop response with its set point in manual, and the second showing overall loop response.
   5. Where a loop is controlled under the direction of a PLC, the Programmer will perform the necessary adjustment of loop tuning parameters and set points, record the loop

response, adjusting final elements, and ensuring total integrated loop performance as specified.

C. Functional Checkout:
   1. Conduct to verify the operation of discrete and hardwired control devices, refer to Section 01 45 20. Exercise the operable devices and energize the control circuit. Operate control element, alarm device, and interlocks to verify that the specified action occurs.

3.06 OPERATIONAL TESTING

A. Perform the System Acceptance Tests (SAT) after component and subsystem tests have been completed. Perform the test of the completed system in full operation and demonstrate that functional requirements of this specification have been met. Demonstrate the following:
   1. Each component of the system operates correctly with other components of the system.
   2. Analog control loops operate in a stable manner.
   3. Hard-wired and software equipment interlocks perform correctly.
   4. Process control sequences perform correctly.
   5. Application program performs monitoring and control functions correctly.
   6. Supervisory Control and Data Acquisition (SCADA) Operator interface graphics represent the monitoring and control functions correctly.

END OF SECTION

SECTION 40 61 96

CONTROL SPECIFICATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section specifies control for programmable logic controller (PLC) based Supervisory Control and Data Acquisition (SCADA) for the Mingus (Zone 41) Pump Station (PS) and Mingus Tank.

B. Control strategies describe sequential and interlocking control functions, analog control functions, and color-graphic video display operator interfaces, including alarm and event logging.

C. The Contractor shall provide the labor and equipment to test the specified control strategies per Section 40 61 21.

D. Programming: Refer to Section 40 61 13.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 INTERLOCKS

A. Interlocks (I) shut down and prevent equipment from operating. Hardwired interlocks are effective whether the PLC system is in operation or not, and in HAND and AUTO modes, unless noted. Software interlocks are provided by the PLC and are usually only effective when the equipment is operating in AUTO mode, unless noted. The following describe general interlock features for all systems.

I1 – MOTOR PROTECTION

Equipment motor protection includes overload and/or variable-frequency drive (VFD) or reduced voltage soft start (RVSS) fault, hardwired only. Manual reset required at the starter, VFD, or RVSS.

I2 – HIGH DISCHARGE PRESSURE

Equipment protection from pressure switch, hardwired only. Time-delayed; no time delay for positive displacement pumps. For protection from a pressure transmitter, refer to Control Strategy 7 High Alarm below, software interlock. Manual reset required at the starter, VFD, or RVSS.

I3 – HIGH MOTOR TEMPERATURE

Equipment motor protection from temperature switch or temperature sensors and switching relay, hardwired only. Typical for large or VFD-driven motors. Manual reset required at the starter, VFD, or RVSS.

I18 – LOW-SUCTION TANK LEVEL

Equipment protection from level switch, hardwired only. For protection from a level transmitter or by SCADA for multiple tanks, refer to Control Strategy 3 Low Alarm below, software interlock. Self-resetting.

I40 – INTRUSION ARM/DISARM

Intrusion alarm disarming is from a keypad located outside the Tank, or inside the PS. Manual reset of the alarm is required at the site keypad.

Upon opening of doors or reservoir hatch, a PLC timer will be initiated. The timer will continue even if the door or hatch is re-closed. The City Operator must enter the disarm code at the keypad within 5 minutes. Otherwise, an intrusion alarm will be indicated when the timer expires by the PLC to SCADA.

After disarming, the PLC will re-arm the alarm timer 1 hour after all doors and the hatch are all closed. If a door or hatch is left opened for more than 8 hours, the PLC will re-arm the alarm as this would likely indicate that work on the site is complete but something was left opened.

3.02 GENERAL CONTROL STRATEGIES

A. Control Strategies (CS) define common equipment operations performed by the PLC and displayed by the SCADA system. Hardwired control strategies are effective for equipment control whether the PLC system is in operation or not, and in HAND and AUTO modes, unless noted.

B. CS' unique to each process system are defined in starting in paragraph 3.03. The following describe general control features for all systems.

CS1 – EQUIPMENT RUN-TIME TOTALIZATION

Equipment run time totalization will be calculated and maintained by the PLC based on equipment run status. Totalize in hours from 0 to 9999.

SCADA: Display total in hours.

CS2 – FLOW TOTALIZATION

Flow totalization will be calculated and maintained by the PLC whenever flow signals exceeds 2-1/2% of full-scale value and analog signal has not failed (refer to CS10). Totalize in gallons times 1,000 (kGal) or gallons times 1,000,000 (MGal) as shown on the piping and instrumentation diagram (P&ID). Totalize from 0 to 9999.

SCADA: Display total in kGal or MGal as shown on P&ID.

Previous 24-hour day flow totalization will also be calculated and maintained by the PLC.

SCADA: Summary display of previous day totals in kGal or MGal as shown on P&ID.

CS3 – PROCESS ALARM(S), SELF-RESETTING

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.
2. Low Alarm: Point value is equal to or less than a predetermined alarm value.
3. High Alarm: Point value is equal to or greater than a predetermined alarm value.

4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until the point value changes by the predetermined deadband value for the point, initial setting of 5% of full-scale range. PLC alarm setpoints are provided in Section 40 06 70-3.03.

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS7 – PROCESS ALARM(S), MANUAL RESET FROM SCADA REQUIRED

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.
2. Low Alarm: Point value is equal to or less than a predetermined alarm value.
3. High Alarm: Point value is equal to or greater than a predetermined alarm value.
4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until reset by the SCADA Operator and the point value changes by the predetermined deadband value for the point, initial setting of 5% of full-scale range.

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary. SCADA allows Operator reset of alarms.

CS9 – DISCRETE POINT STATUS

The status of each discrete input point will be maintained in the PLC.

The status of each logical discrete point will also be maintained in the PLC. Logical points are points which depend upon the status of one or several discrete input points. For example, equipment-failed logical status will result from a loss of ready status when running. Loss of ready status when NOT running will not result in a failed logical status.

SCADA: Display the status of all discrete and logical discrete status points.

CS10 – ANALOG POINT STATUS

Analog input points will be checked by the PLC for the following status conditions:

Failed: Point value is less than or greater than the specified value range, typically less than 3.6 milliamps (mA) and greater than 21.6 mA.

SCADA: Display alarm. Display active and cleared-but-unacknowledged alarm in the alarm summary

CS11 – GENERAL READY, RUNNING AND FAILURE SYSTEM

The failure of driven equipment will be monitored by the SCADA system. Equipment will be considered failed under the following conditions:

1. The equipment is in AUTO and the SCADA system attempts to operate the equipment and it does not respond within a defined time period.
2. The equipment is in AUTO and running and for whatever reason, other than the SCADA system requesting the equipment to “STOP,” the equipment stops.

CS12 – SCADA INPUTS AND OUTPUTS STATUS

The PLC will monitor status of each individual input, output, communication module, and all processor statuses available.

SCADA: Display racks with status for each module using descriptive terms for alarms. Display processor battery status. Display alarms. Display active and cleared but unacknowledged alarm in the alarm summary

CS13 – GENERAL RECORDING SYSTEM

The SCADA system will store historical input point data and generate reports based upon process variables (pressure, flow, temperature, level and analytical) and equipment status (speed, and motor current or run/off status) in real time and from recent historical data. The exact report requirements will be determined by the OWNER and will be configured by others during the Project construction period.

CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM

All analog control functions will be provided as required and will include, but not be limited to, the following:

1. Proportional Integral Derivative (PID) Control – Standard controller functions with balanceless, bumpless transfer from manual to automatic, manual overrides, external reset and output summing capabilities. Provision for cascade, rationing gain, bias, lead-lag, dead-time, feed forward and feedback control will be available.
2. Human Machine Interface (HMI) display system will have a common PID controller operator interface for all equipment utilizing PID control. Controller operator interface will include alphanumeric and graphic indication of the following features as a minimum:
    a. ID of controlled equipment.
    b. ID of process variable input.
    c. Controller setpoint value.
    d. Process variable value.
    e. Controller output value.
    f. Setpoint adjustment interface.
    g. Indication if setpoint is under HAND or AUTO control.
    h. Local/Manual control output adjustment interface.
    i. Indication if control output is under local/manual control or under control of process controller.
3. Computational Functions: On-line mathematical functions will be available to provide real-time computational capability of control variables for use in feed-forward and other advanced control functions.

Appropriate control action(s) will be provided as needed.

CS16 – TREND PLOTS

SCADA workstations will graphically plot trends of process variables (pressure, flow, temperature, level and analytical), controller setpoints, and equipment status (motor current) in real time and from historical data. The plant operator will be able to select the plotting interval, within the limits of the actual data collection. Four trends per display view will be possible.

In addition to the plotted data, a trend will include:

1. Time.
2. Date.
3. Tag number.
4. Plotting interval.
5. Time at start.
6. Time at latest value.

CS17 – COLOR NOTATION FOR DYNAMIC OBJECTS ON CONTROL GRAPHIC DISPLAY SCREENS

All dynamic objects on control graphic display screens will be provided with multiple-color display to identify status as tabulated below:

Equipment	Status	Required Color
Motor	Running	Green
Motor	Ready or Off	Gray
Valve	Opened Position	Green
Valve	Closed Position	Red
All	Power On	White
All	Abnormal Condition	Red
All	Advisory, Control Mode	Blue

CS18 – DIGITAL ALARM SYSTEM

Alarms as shown on the P&ID will be determined and maintained by the PLC, whether or not specific control strategies are provided. Digital inputs can be from field instruments (level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

SCADA: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS19 – DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS

All CS16 trend plots shall be logged for historical play-back.

All CS2 previous-day flow totals will be logged for later access.

CS20 – DIGITAL STATUS SYSTEM

Digital input status will be displayed on SCADA screens as required by the reference Drawings and Specifications regardless whether or not specific control strategies are provided. Each digital input will be shown in its appropriate process screen and/or equipment status screen.

Digital inputs can be originated from field instruments (motorized actuators, heating, ventilation and air conditioning (HVAC) related air handling units, power-management related contact inputs, level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

CS24 – DATA TRANSFER REQUIREMENTS BETWEEN THE PLCS AND THE SCADA SYSTEM

Digital inputs and analog inputs to the SCADA system and the software logic-generated alarms will be displayed or annunciated at SCADA as shown on P&IDs, the Instrument Index Section 40 06 70-3.03, and this Section. The LOCAL SCADA touchscreen to PLC communications will be via Ethernet.

REMOTE SCADA system will generate separate alarms if communication is lost with any PLC.

CS51 – ALTERNATION – SOFTWARE

This provides equipment run-time equalization by alternating the lead/lag/2nd lag assignment of two or more pumps by the PLC. Alternation occurs when all of the pumps in that group stop. Similarly, alternation occurs for the last group of pumps occurs when all of the pumps in that group stop. Upon failure of a pump, the standby pump is assigned in place of the failed pump. A typical PLC determined fail alarm for each pump includes:

1. Hardwired pump-equipment related shutdowns (determined by the Process/Mechanical Engineer) including, but not limited to: high motor temperature, VFD fault, and submersible pump moisture detected if applicable. Normally reset at the VFD.
2. VFD selector switch removal from the AUTO/REMOTE position. Reset at the selector switch.
3. Status discrepancy in CS start command vs. VFD run status, typically for 30 seconds. Requires reset from the SCADA system.
4. Speed discrepancy in CS speed signal vs. VFD feedback speed, refer to CS61 – Variable Frequency Drive Speed below.

CS61 – VARIABLE FREQUENCY DRIVE SPEED

The minimum pumping speed shall be configured into the VFD for both LOCAL and REMOTE modes, preventing unintentional under-speed and motor-overheating in either mode. The PLC shall not be configured to provide an artificial zero of the 4-20 mA control signal, such as 12-20 mA to prevent under-speed in VFD REMOTE mode. The requirement to configure the VFD minimum speed setting is included in Part 3 of Section 26 29 23.

Although the minimum pumping speed must be configured into the VFD for following the CS speed signal, the feedback speed configuration is a separate VFD setting. This setting shall be left at default, with 4 mA for 0% speed and 20 mA for 100% speed. Display of speed on the SCADA system should reflect 0% when the pump is stopped and 100% when the pump is running at full speed.

One component of PLC determined pump failure is speed discrepancy as mentioned in CS51 above. The CS speed signal range is instead 0% for minimum pumping speed rather than 0% speed. For comparison with the CS speed signal, the feedback speed range must then be extrapolated from minimum pumping speed to maximum pumping speed for 0 to 100% and clamped to prevent a negative speed value by the PLC. Speed discrepancy in control system speed signal vs. VFD feedback speed is determined by the PLC when they deviate from each other by 10% or more for 20 seconds. The alarm is monitored by and requires reset from the SCADA system.

The PLC minimum feedback pumping speed for the calculation shall match the VFD configured setting for the control signal. Verification of the calculation is performed by

comparing PLC calculated speed feedback with PLC CS speed signal at various steady VFD speeds.

3.03 CONTROL STRATEGY – MINGUS TANK

A. P&ID: I-611.

B. General Description:

1. The Mingus Tank is being replaced and serves Zone 41. Zone 41 is sourced from the following:
   a. Mingus PS from Zone 0 and the North Reservoir East Tank (refer to paragraph 3.04).
2. Zone 41 can source the following:
   a. Zone 41.
   b. Zone 40 via Cedarwood Tank.
3. The Mingus Tank level controls the Mingus PS.
4. A separate SCADA installation and integration project (SCADA project) by others is replacing SCADA radio telemetry equipment, and the Mingus Tank and Mingus PS existing remote terminal units (RTUs) before the work of this Project. The Mingus Tank RTU will be reused for control of the Mingus PS after Tank replacement.
5. Intrusion switches are monitored by SCADA. A keypad is provided on the outside of the Tank RTU to disarm the intrusion timer.

C. Control Strategy Overview:
1. Refer to Mingus pumps below.
2. Refer to separate SCADA project.

D. Local Control:
1. Field:
   a. Level Gauge.
2. VFD/MCC (motor control center): None.
3. Interlocks per paragraph 3.01: None.

E. Remote or Automatic Control:
1. Control Strategy: None.
2. Software Interlocks per paragraph 3.01: None.

3.04 CONTROL STRATEGY – MINGUS BOOSTER PUMPS

A. P&ID: I-602.

B. General Description:
1. The Mingus PS, physically located in Zone 0, is being replaced and serves Zone 41.
2. The Mingus PS has three duty and one standby pump, with variable-speed drives. The pumps operate in a lead, lag 1, and lag 2 sequencing. An additional jockey pump with a variable-speed drive will be utilized for low flow conditions.

3. The Mingus Tank level normally controls the pumps via dedicated radio telemetry.
4. When the Mingus Tank is out of service or level signal is unavailable, the pumps operate based on discharge pressure.

C. Control Strategy Overview:
1. The pumps are normally operated in AUTO mode, with the VFDs set to AUTO. In this mode, the pump start/stop and speed is controlled by the PLC.
2. A SCADA operator selection of Tank Level/Discharge Pressure determines control mode. In Tank Level mode, discharge pressure control will prevail during telemetry communications failure (refer to paragraph below).
3. Switchover to Discharge Pressure control or back to Tank Level control can also be made at SCADA. Count-down timers at SCADA will indicate time remaining in each control mode until transfer.
4. In the event of utility power failure, pumps will stop due to loss of power. In the event that pumps are operating on standby power and utility power is restored, the pumps will be called to stop when the automatic transfer switch returns to the utility power position. This is required as the transfer switch does not provide for bumpless transfer from standby to utility power.
5. Pumps will restart on standby or return to utility power in the same mode, number of pumps, and speeds as they were running before. Pumps will be delay-started by the PLC, however, the Lead Pump will be restarted 5 seconds after power availability, the Lag 1 Pump 15 seconds after (if called previously), and the Lag 2 pump 25 seconds after power availability (if called previously).
6. The standby generator is sized to operate three duty pumps, with one as standby. The control system shall not attempt automatic start, or permit SCADA manual start of all four pumps when on standby power.

D. Control Strategy – Tank Level Control:
1. The Mingus Tank level is forwarded by radio telemetry to the Mingus PS.
2. SCADA adjustable tank level setpoints at the PS PLC determine pump START, pump speed control ranges, and pump STOP. The pumps should START and STOP over a range of operating level to provide tank turnover and prevent excessive water aging, as opposed to trying to hold a strict tank level at all times. Preliminary elevations and setpoints are as follows. Setpoints are operator-adjustable within a limiting range where noted:

Overflow	31 feet, elevation 5,685 feet (fixed)
High-High Level Alarm	30.5 feet, elevation 5,684.5 feet (fixed)
High Level Alarm	29.5 feet, elevation 5,683.5 feet (adjustable)
Lead Pump Level Off Setpoint	28 feet default, elevation 5682 feet, range 11.5 feet to 30.5 feet (adjustable)
Lead Pump Level On Setpoint	24.75 feet default, elevation 5678.75 feet, range 11.5 to 30.5 feet (adjustable)
Lag 1 Pump Level Off Setpoint	21.5 feet default, elevation 5675.5 feet, range 11.5 to 30.5 feet (adjustable)
Lag 1 Pump Level On Setpoint	18.25 feet default, elevation 5672.25 feet, range 11.5 to 30.5 feet (adjustable)
Lag 2 Pump Level Off Setpoint	15 feet default, elevation 5669 feet, range 11.5 to 30.5 feet (adjustable)

Lag 2 Pump Level On Setpoint	11.75 feet default, elevation 5665.75 feet, range 11.5 to 30.5 feet (adjustable)
Low Level Alarm	10.5 feet, elevation 5,664.5 feet (operations adjustable)
Low-Low Level Alarm	10 feet, elevation 5,664 feet (fixed)
Base of Tank	Elevation 5,654 feet (fixed)

3. The default setpoints can be overwritten/saved at SCADA. Setpoints can then be adjusted by the SCADA Operator. Default values saved previously can be restored at SCADA by a screen selection.
4. Setpoint Operation:
    a. When the Tank level falls below the Lead Pump Level On setpoint for 10 seconds (initial setting), the Lead Pump is started. The timer is SCADA adjustable from 5 to 20 seconds. The Lead Pump speed will range from 100% speed at or below the Lead Pump Level On setpoint level to minimum speed at the Lead Pump Level Off setpoint level.
    b. If the Tank level falls below the Lag 1 Pump Level On setpoint, and after a delay of 60 seconds (initial setting), the Lag 1 Pump is started. The timer is SCADA-adjustable from 30 to 120 seconds. The Lead and Lag Pump speeds will range from 100% speed at or below the Lag 1 Pump Level On setpoint level to minimum speed at the Lag Pump Level Off setpoint level.
    c. If the Tank level falls below the Lag 2 Pump Level On setpoint, and after a delay of 120 seconds (initial setting), the Lag 2 Pump is started. The timer is SCADA-adjustable from 120 to 240 seconds. The Lead, Lag, and Lag 2 Pump speeds will range from 100% speed at or below the Lag 2 Pump Level On setpoint level to minimum speed at the Lag 2 Pump Level Off setpoint level.
    d. When two or more pumps are called for, they will be controlled at the same speed.
    e. When Tank level rises above the Lag 2 Pump Level Off setpoint, the Lag 2 Pump is stopped. The Lead and Lag pump speeds will now range from 100% speed at or below the Lag 1 Pump Level On setpoint level to minimum speed at the Lag 1 Pump Level Off setpoint level.
    f. If the Tank level rises above the Lag 1 Pump Level Off setpoint, and after a delay of 60 seconds (initial setting), the Lag Pump is stopped. The timer is SCADA-adjustable from 30 to 120 seconds. The Lead pump speed will range from 100% speed at or below the Lead Pump Level On setpoint level to minimum speed at the Lead Pump Level Off setpoint level.
    g. If the Tank level rises above the Lead Pump Level Off setpoint, and after a delay of 120 seconds (initial setting), the Lead Pump is stopped. The timer is SCADA-adjustable from 120 to 240 seconds.
5. All pumps are called to stop upon high level alarm.
6. In the event of Tank radio telemetry signal failure, level signal changes will not be available to the PS PLC. The pumps will continue to run for 20 minutes as last commanded and at the same speed as before the failure. The pump station will then alarm and shut down.

E. Control Strategy – Discharge Pressure Control:

1. Pump discharge pressure control is used for conditions when the Tank is out of service or in the event of extended Tank to PS telemetry communications failure. Note that any existing Zone 41 pressure relief valve settings must be coordinated with the below setpoints. No high-pressure relief valve will be provided on the pump discharge. Pump shutoff head and the pump's highest pressure operational point will differ by less than 10 psi.
2. Pump operation will be set to maintain a control pressure setpoint. Pumps will start on pressure and will turn off on flow. Pumps will not exceed a maximum flow setpoint when all three Mingus pumps are in service to avoid operating beyond the maximum allowable flow stated by the manufacturer.
3. Discharge pressure and flow setpoints at the PS PLC determine pump START, Discharge Pressure setpoints for pump speed control, and pump STOP. Preliminary setpoints are as follows. Setpoints are operator-adjustable within a limiting range where noted:

High-Pressure Alarm	49 psig (set pressure switch for each pump for shutdown)
Jockey Pump Pressure On Setpoint	46 psig, default
Jockey Pump Flow Off Setpoint	180 gpm
Lead Pump Pressure On Setpoint	45 psig, default
Lead Pump Flow Off Setpoint	360 gpm
Lag 1 Pump Pressure On Setpoint	45 psig, default
Lag 1 Pump Flow Off Setpoint	750 gpm
Lag 2 Pump Pressure On Setpoint	45 psig, default
Lag 2 Pump Flow Off Setpoint	1,200 gpm

4. The default setpoints can be overwritten/saved at SCADA. Setpoints can then be adjusted by the SCADA Operator. Default values saved previously can be restored at SCADA by a screen selection.
5. Setpoint Operation:
    a. When discharge pressure falls below the Jockey Pump Pressure On setpoint, the Jockey pump is started. No delay is provided as the system may be operating with the Mingus Tank not in service, and pressure could then vary rapidly.
    b. When flow falls below the Jockey Pump Flow Off Setpoint, and after a delay of 30 seconds (initial setting),the Jockey 1 Pump is stopped if flow remains below the Jockey Pump Flow Off Setpoint. The timer is SCADA-adjustable from 15 to 60 seconds. All pumps will then be stopped.
    c. The Lead Pump will start if either of the following two conditions is met:
        1) When Jockey Pump is at maximum speed: If the pressure falls below the Lead Pump Pressure On setpoint, and after a delay of 60 seconds (initial setting), the Lead pump is started. The timer is SCADA-adjustable from 30 to 120 seconds.
        2) If the pressure falls below the Lead Pump Pressure On Setpoint and the flow increases by 50 gpm within any 10 second interval, the Lead Pump will be immediately started.
    d. If the Lead Pump is Started, the Jockey Pump will be stopped immediately. The Lead Pump will never operate in parallel with the Jockey Pump.
    e. The Lead Pump will stop when total PS flow falls below the Lead Pump Flow Off Setpoint, and after a delay of 30 seconds (initial setting), total PS flow remains

below the Lead Pump Flow Off Setpoint. The timer is SCADA-adjustable from 15 to 60 seconds. The Jockey Pump will then be started immediately.

f. When Lead Pump is at maximum speed: The Lag 1 Pump will start if the pressure falls below the Lag 1 Pump Pressure On Setpoint, and after a delay of 30 seconds (initial setting), pressure remains below the Lag 1 Pressure On Setpoint. The timer is SCADA-adjustable from 15 to 60 seconds. Lead and Lag 1 Pump will operate in parallel at the same speed to maintain the Lag 1 Pressure Setpoint. The Lead and Lag pump speeds will now range from 100% speed at or below the Lag 1 Pump Pressure On Setpoint level to minimum speed at the Lag 1 Pump Flow Off Setpoint level.

g. The Lag 1 Pump will stop when total PS flow falls below the Lag 1 Pump Flow Off Setpoint, and after a delay of 30 seconds (initial setting), total PS flow remains below the Lag 1 Pump Flow Off Setpoint. The timer is SCADA-adjustable from 15 to 60 seconds. The Lead Pump will continue to operate.

h. When Lag 1 Pump is at maximum speed: The Lag 2 Pump will start if the pressure falls below the Lag 2 Pump Pressure On Setpoint, and after a delay of 30 seconds (initial setting), pressure remains below the Lag 2 Pressure On Setpoint. The timer is SCADA-adjustable from 15 to 60 seconds. Lead, Lag 1 Pump and Lag 2 Pump will operate in parallel at the same speed to maintain the Lag 2 Pressure Setpoint. The Lead and Lag pump speeds will now range from 100% speed at or below the Lag 2 Pump Pressure On Setpoint level to minimum speed at the Lag 2 Pump Flow Off Setpoint level

i. The Lag 2 Pump will stop when total PS flow falls below the Lag 2 Pump Flow Off Setpoint, and after a delay of 30 seconds (initial setting), total PS flow remains below the Lag 2 Pump Flow Off Setpoint. The timer is SCADA-adjustable from 15 to 60 seconds. The Lead Pump and Lag 1 Pump will continue to operate in parallel.

j. When total PS flow falls below the Lag 2 Pump Flow Off setpoint, and after a delay of 30 seconds (initial setting), the Lag 2 Pump is stopped if flow remains below the Lag 2 Pump Flow Off Setpoint. The Lead Pump and Lag 1 Pump will continue to operate in parallel.

k. The combined flow of Lead Pump, Lag 1 Pump and Lag 2 Pump will not exceed a three times multiple of Condition A flow (full speed operation) by more than 30% as specified in Section 43 23 13.21. This will be the maximum allowed flow for the PS during Discharge Pressure Control.

l. Pump speed will vary between maximum and minimum based on a PID loop in the PLC to maintain the discharge pressure setpoints. When two or more pumps are called for, they will be controlled at the same speed.

6. In the event of discharge pressure or flow signal failure, the pumps will continue to run as last commanded and at the same speed as before the failure. Either signal alarm shall be indicated at SCADA.

F. Local Control:

1. Field: None
   a. Suction Pressure.
   b. Discharge Pressure.
   c. Discharge Flow.
2. VFD/MCC:

a. VFD Keypad.
b. HAND-OFF-AUTO selector.
c. START and STOP pushbuttons.
d. VFD SPEED potentiometer.
e. RUN pilot.
f. VFD FAULT pilot.
g. HIGH MOTOR TEMPERATURE pilot.
h. HIGH DISCHARGE PRESSURE pilot.
i. LOW SUCTION PRESSURE pilot.
j. ELAPSED TIME HOURS indicator.
k. RESET pushbutton.

3. Interlocks per paragraph 3.01:
   a. I1 – MOTOR PROTECTION.
   b. I2 – HIGH DISCHARGE PRESSURE.
   c. I3 – HIGH MOTOR TEMPERATURE.
   d. I18 – LOW SUCTION TANK LEVEL (PRESSURE).

G. Remote or Automatic Control:
1. Control Strategy:
   a. CS2 – FLOW TOTALIZATION.
   b. CS11 – GENERAL READY, RUNNING AND FAILURE SYSTEM.
   c. CS15 – GENERAL PROCESS CONTROL FUNCTION (ANALOG) SYSTEM.
   d. CS19 – DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS.
   e. CS51 – ALTERNATION – SOFTWARE.
   f. CS61 – VARIABLE FREQUENCY DRIVE SPEED.
2. Software Interlocks per paragraph 3.01:
   None.

3.05 CONTROL STRATEGY – POWER MONITORING

A. P&ID: I-605.

B. General Description:
1. Power monitor in the 480-volt Switchboard is monitored by SCADA.
2. Electrical enclosure temperature is also monitored.

C. Control Strategy Overview:
1. When electrical enclosure temperatures exceed 90°F, an alarm is indicated on SCADA.
2. Transfer switch positions are monitored.
3. Power in kilowatts is calculated by multiplying phase-to-phase voltage by the current and by the power factor.

D. Local Control:
1. Field:
   a. Power monitor readout and keypad.

b. Temperature indication.

2. VFD/MCC: None.
3. Interlocks per paragraph 3.01: None.

E. Remote or Automatic Control:
1. Control Strategy:
a. CS3 – PROCESS ALARM(S), SELF-RESETTING
b. CS16 – TREND PLOTS
2. Software Interlocks per paragraph 3.01: None.

3.06 CONTROL STRATEGY – SECURITY

A. P&ID: I-605.

B. General Description:
1. Intrusion switches are monitored by SCADA. A keypad is provided on the outside of the PS to disarm the intrusion timer, refer to Interlock I40.

C. Control Strategy Overview:
2. See below.

D. Local Control:
1. Field: None.
2. VFD/MCC: None.
3. Interlocks per paragraph 3.01: None.

E. Remote or Automatic Control:
1. Control Strategy:
a. CS7 – PROCESS ALARM(S), MANUAL RESET FROM SCADA REQUIRED
2. Software Interlocks per 40 61 96-3.01:
a. I40 – INTRUSION ARM/DISARM

END OF SECTION

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SECTION 40 63 43

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope

1. This Section specifies requirements for small programmable logic controllers (PLC) designed to execute discrete and continuous control logic with high reliability in industrial applications. Enclosures and components are specified in Section 40 67 00.
2. Not used.
3. Programming: Refer to Section 40 61 13.

B. General Requirements

1. General requirements shall be as specified in Sections 40 61 13 and 40 67 00.

1.02 QUALITY ASSURANCE

A. References

1. This Section contains references to the following documents or documents listed in Sections 26 05 00, 40 61 13, and 40 67 00. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
3. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEC 61131-3	Programmable Controllers – Part 3: Programming Languages
NEMA IA 2.2	Programmable Controllers – Equipment Requirements and Tests
NEMA IA 2.3	Programmable Controllers – Programming Languages

B. Systems Integrator

1. Responsibilities and qualifications shall be as specified in Section 40 61 13.

C. Factory Acceptance Tests:

1. Factory Acceptance Tests are specified in Section 40 61 21 and scheduled in paragraph 1.01 PLC Schedule.
    a. Submit factory test forms for approval prior to tests.
    b. Provide all expenses for one Owner staff member and one Engineer staff member to witness factory testing. Travel shall be during business hours on weekdays.
    c. After Factory Acceptance Testing, complete programmable logic controllers including chassis, I/O modules, associated cabling, and miscellaneous hardware shall be turned over to the Owner during construction to facilitate [Owner][Engineer] furnished programming and configuration.]

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 61 13.

B. Action Submittals -- Shop Drawings:
    1. Submit under Section 40 67 00, including:
    2. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
    3. Submittal requirements per Section 40 67 00 for the equipment specified herein.
    4. PLC Input/Output (I/O) loop diagram drawings.
    5. Internal power distribution schematic diagram drawings.
    6. PLC power supply loading calculations.
    7. List of spare parts to be provided.

C. Factory Acceptance Test Schedule And Forms
    1. Submit under Section 40 61 21 and per the requirements of this Section.

D. Closeout Submitttals - Operating and Maintenance:
    1. Submit under Section 40 67 00.
    2. Operating and maintenance information shall be provided in accordance with Section 01 78 23, including the following for the PLC system:
        a. Manufacturer, Representative, and Supplier contact information.
        b. Manufacturer instruction manuals shall include only the following as applicable to the PLC system:
            1) Safety Precautions.

2) Environmental Conditions.
3) Troubleshooting guides and diagnostic techniques.
4) Component connection diagrams.
5) Removal and replacement instructions.

c. Warranty information.
d. Final reviewed submittal.
e. As-built drawings with record of switch and jumper settings for all PLC module and rack components.
f. List of spare parts provided.

3. Annotated copies of complete PLC Software programs.
   a. Provide one PDF-format file with fully annotated PLC code that can be read without the native configuration and programming environment on electronic media (USB drive).
   b. Provide one native-format file including all supporting files so that the complete project can be opened in the native configuration and programming envirioment on electronic media (USB drive).
   c. Provide written descriptions completely defining all ladder logic used in the program.
   d. Provide list of all addresses referenced in the logic diagram with descriptions of data associated with each address (Tag database).
4. Annotated copies of the Operator Interface Terminal (OIT) Software programs
   a. Provide one PDF-format file with fully annotated OIT code that can be read without the native configuration and programming environment on electronic media (USB drive).
   b. Provide one native-format file including all supporting files so that the complete project can be opened in the native configuration and programming envirioment on electronic media (USB drive).
   c. Provide screenshots in PDF file format of the graphics screens for the OIT for the complete project at all locations.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer
   1. The Owner and Construction Manager require the specified Manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner and Construction Manager believe the Manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
   2. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.

B. Materials

1. Equipment and/or products shall be new and unused at the time of system assembly.

C. Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points.
   1. RFI/EMI Susceptibility: MIL STD 461B CS02.
   2. Showering Arc Test: NEMA Pub No ICS2-230.42.
   3. Surge Withstand: ANSI C37.90a.
   4. RFI Immunity: IEC 801-3.
   5. Ground Continuity: IEC 801-5.
   6. Electrostatic Discharge: IEC 801-2.
   7. Electromagnetic Field: IEC 61000-4-3.
   8. Fast transients: IEC 61000-4-4.

2.02 PROGRAMMABLE LOGIC CONTROLLER - SMALL

A. Manufacturer:
   1. Allen-Bradley 5069-L320ER CompactLogix 5380 controller with 5069-SERIAL.

B. NEMA IA 2.3 and IEC 61131-3 compliant program editor with program written in Sequential Function Language. Program to be written using the same type of software as is specified below.

C. Networking Connections: Provide all communication interfaces, network cables, taps, terminators, power supplies, and accessories for a complete operating network.
   1. Ethernet/IP.

D. Processor:
   1. With Ethernet port dedicated solely for programming use, and battery-backed RAM memory.

E. Input and Output Modules:
   1. Discrete Inputs: 24 Vdc.
   2. Discrete Outputs: Relay output.
   3. Analog Inputs: 4-20 mAdc/1-5 Vdc.
   4. Analog Outputs: 4-20 mAdc.
   5. I/O module terminations: By Manufacturer to match module.
   6. I/O module interface modules: Provide as necessary including cabling to interface all I/O to processor.
   7. Spare Input/Outputs: The greater of a minimum one channel or 15 percent of each type provided per control panel.

F. Power Supplies:
   1. Single, 120 Vac.

G. Miscellaneous:
   1. Provide all cables, taps, terminators, power supplies, and accessories for a complete operating PLC system.

2.03 OPERATOR INTERFACE TERMINAL

A. TFT color touchscreen, 12". Ethernet and USB ports, 24 Vdc power.
   1. Manufacturer:
      a. Allen-Bradley 2711P-T12W21D85.

B. Provide OIT for the Pump Station RTU, and for the Tank RTU.

2.04 PROGRAMMING SOFTWARE

A. The following software shall be provided by the Systems Integrator for this project.

B. Programmable Logic Controller - Small
   1. Manufacturer:
      a. Allen-Bradley RSLogix 500, RSLinx, and network module software.
   2. Licenses: Not required.

2.05 SPARE PARTS

A. The following spare parts shall be provided.

B. PLC - Small
   1. Separate 1784-SD2 (2GB) non-volatile memory with latest PLC program. Provide in container labeled with project name, date, and SI contact information.

2.06 CONTROL PANEL FABRICATION

A. Refer to Section 40 67 00. Requirements from the SCADA project prevail in the event of conflicts, except that the quantity of I/O provided shall be as required per the Drawings and as specified above for spares.

B. Detail shop drawings showing field connections and any terminal block jumpering required.

C. Terminate all used and spare I/O wiring to terminal blocks.

D. Create wire markers with "to-from" component name, PLC slot/base, or terminal column number and terminal number information identical at each end.

E. Provide terminal Blocks for field connections to PLC Discrete Inputs:
   1. One fused terminal with LED for each group of 8 inputs, connected to control power.
   2. Fused terminal connected to eight terminal blocks to provide power to each field input circuit.
   3. One terminal per PLC input.

4. One common terminal for each group of 8 inputs, connected to control power common.

F. Provide terminal Blocks for field connections to PLC Discrete Outputs:
   1. Two terminals per PLC relay output.

G. Provide terminal Blocks for field connections to PLC Analog Inputs:
   1. One fused terminal with LED for each input, connected to +24 Vdc.
   2. Two terminals per PLC input.
   3. One common terminal for each input, connected to 24 Vdc common.
   4. One ground terminal for each input shield, connected to signal ground bus.
   5. Two surge protecting terminals for each field mounted instrument or equipment, grounded to the frame ground bus.

H. Provide terminal Blocks for field connections to PLC Analog Outputs:
   1. One fused terminal with LED for each output, connected to +24 Vdc.
   2. Two terminals per PLC output.
   3. One common terminal for each output, connected to 24 Vdc common.
   4. One ground terminal for each output shield, connected to signal ground bus.
   5. Two surge protecting terminals for field mounted equipment, grounded to the frame ground bus.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 40 67 00.

B. Connect input and output devices to the PLC via control panel terminal blocks, not directly to the PLC.

3.02 FIELD INSPECTION AND TESTING

A. Refer to Section 40 67 00.

B. Equipment Manufacturer and Systems Integrator: The supplier of each PLC system shall provide a qualified service representative to perform the following:
   1. Inspect the PLC installation including I/O and network systems, hardware configuration switch and jumper settings.
   2. Monitor all PLC system diagnostic indicators, both hardware and software, and certify that the PLC system performance meets or exceeds the Manufacturer's published specifications.
   3. Assist in all testing. The Systems Integrator will provide a minimum of 4 man-weeks on-site for each PLC I/O rack.
   4. Modify PLC programs as required.
   5. Certify in writing to the Construction Manager that the PLC system has been installed and configured in accordance with the Manufacturer's published guidelines.

C. Contractor

1. Fault or trouble conditions shall be investigated and resolved by the Contractor to the satisfaction of the PLC supplier.

3.03 TRAINING

A. Operations and Troubleshooting

1. The Systems Integrator shall conduct application program maintenance, modification, and re-loading training conforming to the requirements of Section 01 79 00. A minimum of 4 man-hours on-site, including training materials and expenses, shall be provided for 3 maintenance personnel.

B. PLC Programming

1. Not required.

END OF SECTION

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SECTION 40 66 56

POINT-TO-MULTIPOINT RADIO EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies requirements for Supervisory Control and Data Acquisition (SCADA) radio communications equipment, modifications, programming, installation supervision, and on-site testing.

B. General Requirements:
   1. General requirements shall be as specified in Sections 26 05 00 and 40 61 13.

C. Radio Path Survey:
   1. A radio path survey shall be provided by an experienced, qualified firm. The survey shall include:
      a. Software terrain analysis.
      b. Field survey using portable radio equipment and telescoping poles.
      c. Antenna locations, heights, and directions.
      d. Conflicts and proposed solutions.
   2. Paths:
      a. Mingus Pump Station (PS) to Master site.
      b. Mingus PS to Mingus Tank site.

D. Frequency Licensing:
   1. Radio frequency licensing exists. Request City to add the Mingus PS site to existing licenses upon Notice to Proceed:
      a. Mingus PS to Master radio license.
      b. Mingus PS to Mingus Tank radio license.

E. Master Site:
   1. The City has the following master sites. Request City assignment of site and site address prior to Radio Path Survey and Frequency Licensing requests:
      a. PRCC.
      b. Indian Hill.
      c. Mingus Tanks.
      d. Yavapai Hills.
      e. Peavine.
      f. Northwest Tank.
      g. Airport WWTP.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents or documents listed in Sections 26 05 00 and 40 61 13. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
Motorola R56	Standards and Guidelines for Communication Sites

B. Systems Integrator (SI):

1. Responsibilities and qualifications shall be as specified in Section 40 61 13.

1.03 SUBMITTALS

A. The following information shall be provided separately in accordance with Section 01 33 00.

B. Action Submittals –Radio Path Survey:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specification are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Qualifications, including years of experience performing surveys, for both the survey firm and the person performing the survey, and survey software used.
3. Radio path survey for Mingus PS to Master site.

4. Radio path survey for Minugs PS to Mingus Tank site.

C. Action Submittals –Product and Shop Drawings:
   1. Submit under Section 40 67 00, including:
   2. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. A copy of the Contract Document's Electrical Drawings E-401, E-411, and E-506, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   4. Detailed product literature, showing product specifications and model number breakdown. Mark to denote features and options included. Include only the applicable pages.
   5. Manufacturer's installation manual excerpts, as to be used for this project:
      a. Installation details/drawings.
      b. Electrical connection diagrams
   6. List of spare parts to be provided.

D. Operating and Maintenance Information:
   1. Submit under Section 40 67 00.
   2. Operating and maintenance information shall be provided in accordance with Section 01 78 23, including the following for the communication system:
      a. Manufacturer, representative, and supplier contact information.
      b. Manufacturer instruction manuals shall include only the following as applicable to the communication system:
         1) Safety precautions.
         2) Environmental conditions.
         3) Troubleshooting guides and diagnostic techniques.
         4) Component connection diagrams.
         5) Removal and replacement instructions.
      c. Warranty information.
      d. Final reviewed submittal.

e. Record of radio configuration, switch, and jumper settings for all components.
f. Station radio transmission system voltage standing wave ratio (VSWR) readings, received signal strength readings, and antenna compass bearings per Part 3.

E. Informational Submittals:
1. Acceptance Test Results: Submit per the requirements of this section.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer:
1. The Owner and Engineer require the specified manufacturer to provide the equipment and/or products to be furnished under this section. The Owner and Engineer believe the manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this section.
2. Manufacturers and models of SCADA remote telemetry units (RTUs) shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience; no substitutions are permitted.

B. Materials:
1. Equipment and/or components shall be new and unused.

2.02 LICENSED 136-174 MHZ

A. Point-to-Multipoint Remote Radio/Modem:
1. Radio: 1-10 watt transmit power, TNC female connector. Modem: RS-232, 10 Base-T. Power: 10-30 Vdc. VLAN, AES-128 security.
2. Manufacturer: CalAmp Corp. Viper SC+.

2.03 RADIO TRANSMISSION SYSTEM

A. Radio Transmission Line – Coax and Appurtenances:
1. Coaxial Cable:
a. Polyethylene foam-dielectric, 50-ohm, tinned copper braid and aluminum outer conductor.
b. RG-8U or similar alternative types are not acceptable.
c. Manufacturer: Times Microwave Systems LMR-400, alternative manufacturers not acceptable.
2. Jumper with Radio Enclosure or Building:
a. Coaxial cable specified above. Smaller size or type not permitted.
3. Coax Grounding Kit:
a. Tinned copper, #6 cable.
b. Manufacturer: Times Microwave Systems GK-S400TT, or equal.

B. Radio Transmission Line – Connectors:
   1. Transmission Line:
      a. Type N Male connectors only.
      b. Anodized.
      c. UHF or PL-259 connectors are not permitted.
      d. Manufacturer: Andrew, or equal.
   2. Type N Converters for Connections to Equipment:
      a. Provide type as required.
      b. Silver-plated.

C. Surge Protector:
   1. Type N female connectors, surface mount, 125- to 1,000-MHz range, <=220uJ throughput energy, DC block, UL497B gas discharge tube.
   2. Manufacturer: Polyphaser IS-50NX-C2-MA, male surge side, to female protected side.
   3. Manufacturer: Polyphaser IS-50NX-C2, female to female.

D. External Ground Bus Bar (EGB):
   1. Tinned copper ground buss bar, approximately 1/4-inch x 2-inch x 12-inch, standoffs, ground cable clamp.
   2. Manufacturer: Commscope UGBKIT-0212-T, or equal.

E. Directional Antenna:
   1. VHF:
      a. Yagi type. 9.2 dBd Gain, five elements, gold anodized finish, 150-174 MHz tunable. 150-mph wind rated. Vertical polarization. Type N female connector. Clamp for up to 2-inch pipe mounting.
      b. Laird Y1505.

F. Transmission Line Cable Hangers:
   1. Stainless steel hangers to attach heliax, coax, and/or ground cable to tower legs or antenna masts. Andrew, Commscope, or equal.
   2. “Ty-wrap” or similar cable ties are not acceptable, will compress cables and attenuate signals.

G. Outdoor Transmission Line Connector Weatherproofing:
   1. Cold-shrink connector weatherproof kit.
   2. Sized for minimum diameter.
   3. Manufacturer: Andrew, or equal.

2.04 SOFTWARE

A. The following software shall be provided for each type of radio/modem provided.
   1. Configuration Software:
      a. Manufacturer: CalAmp Corp. Device Management module.
      b. Licenses: Provide 1 License. Request City licensee information prior to ordering for registration.

2. Diagnostic Software:
    a. Manufacturer: CalAmp Corp. Dashboard module.
    b. Licenses Provide 1 License. Request City licensee information prior to ordering for registration.

2.05 SPARE PARTS

A. The following spare parts shall be provided for the Master RTUs.
    1. One licensed point-to-multipoint remote radio/modem.

PART 3 EXECUTION

3.01 INSTALLATION

A. Contractor to install the equipment and components specified per manufacturer instructions.

B. SI shall provide installation supervision for the duration of the equipment and component installations, a minimum of 4 man-days on site. Witness all antenna installations, radio transmission line connector installations, pulling of lines, and installation of line ground kits.

C. Radio Transmission Line:
    1. Route transmission line in conduit to protect from damage. Conduit sweeps shall be long-radius bends and fittings shall not cause manufacturer bend-radius limits to be exceeded. Kinked line shall be replaced or a manufacturer-approved splice unit provided to remove the damaged section. Transition from outdoor conduit or pole to antenna shall be provided with a “CGB” weatherproof cord grip; weather-heads are not permitted due to possible exceeding of bend radius, causing cable damage and signal attenuation.
        a. Coax routed in minimum 2-inch conduit.
    2. SI shall install connectors per manufacturer instructions. Connection installation shall be witnessed by the Construction Manager.
    3. Surge Protectors:
        a. Provide male-female surge protector at antenna for standalone antenna mast installations with transmission line routed inside of mast. Connect to ground as shown.
        b. Provide female-female protector near ground level for installations where transmission line runs exterior to antenna tower or existing structure. Provide transmission line grounding kit near antenna.
        c. Connect to ground as shown.
    4. Transmission Line Grounding Kits:
        a. Coaxial cable installation tool: Times Microwave Systems GST-400.
        b. Provide transmission line grounding kit near antenna.
        c. Connect to ground as shown.
    5. Install weatherproof cold-shrink after connection to antenna, where transmission line grounding kits are installed, and any other outdoor connection.

D. Antenna:
   1. Install directional antennas for vertical polarization (antenna elements extend up and down), unless otherwise specified for horizontal.
   2. Align directional antennas.
   3. Field-tune directional antennas after installation for minimum VSWR. Use radio utility feature or provide a meter for the purpose. Provide means to access the antenna for tuning in-place. Tuning shall be witnessed by the Construction Manager.
   4. Record and submit VSWR reading, received signal strength reading, and antenna compass bearing as installed for each station.

3.02 FIELD INSPECTION AND TESTING

A. Refer to Section 40 61 13.

B. SI:
   1. Inspect the installation including radio transmission line and antenna installation, and radio/modem configuration, switch, and jumper settings.
   2. Use diagnostic software specified above to verify performance, and certify that the communication system performance meets or exceeds the manufacturer's published specifications. Provide software for your configuration and diagnostics use if the Owner has their own copy. Perform VSWR tests, and troubleshoot readings of 2:1 ratio or higher and resolve.
   3. Assist in all radio system testing. The SI will provide a minimum of 8 hours on site for PS site and 8 hours on site for Tank site.
   4. Certify in writing to the Construction Manager that the communication system has been installed and configured in accordance with the component manufacturer's published guidelines.

C. Contractor:
   1. Radio transmission line or antenna related fault or trouble conditions shall be investigated and resolved by the Contractor and SI to the satisfaction of the Construction Manager.
   2. The Contractor shall replace damaged antennas, radio transmission line or related components, lightning protectors, or connectors that were installed improperly. Re-align antennas as required for maximum received signal strength.

3.03 TRAINING

A. Operations and Troubleshooting – Radios:
   1. The SI shall conduct configuration and diagnostic program maintenance training conforming to the requirements of Section 01 79 00. A minimum of two separate sessions each of 4 man-hours on site, including training materials and expenses, shall be provided for groups of three maintenance personnel.

B. Installation – Radio Transmission Line Grounding Kits and Cable Connectors:
   1. The SI shall conduct installation/maintenance training conforming to the requirements of Section 01 79 00. A minimum of two separate sessions, each of 1/2 man-hour on site, including training materials and expenses, shall be provided for groups of three maintenance personnel. Training may be performed concurrent

with installation of kits at remote stations. Provide 1 day advance notice for each session.

END OF SECTION

SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies requirements for control panels.
   2. This section specifies requirements for power supply and conditioning equipment required to support the instrumentation and communication systems specified.
   3. Provide remote telemetry units (RTUs) per City requirements based on the separate Supervisory Control and Data Acquisition (SCADA) Installation and Integration Project (SCADA Project). In case of conflicts with requirements of Specifications for this project, those standards shall prevail. However, provide any additional input/output (I/O) signals specified that may exceed signals provided for in those requirements, including spares.
   4. Provide the instrument, control, and monitoring features indicated on the process and instrumentation diagrams (P&IDs) and electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600-Vac or less for power, control, and instrument signal wiring.
   5. The RTU is a programmable logic controller (PLC) based per Section 40 63 43.

B. Panel Design:
   1. General:
      a. Panel hardware and software is specified in other sections within Division 40.
   2. Control Power Distribution:
      a. Panel containing 120-volt powered equipment shall use the din-rail power distribution method with fuses and blown-fuse indication. Power is restricted to 120-Vac and 24-Vdc.
   3. Power Supplies:
      a. Panel containing direct-current powered instruments or serving as the termination point for transmission-loop powered field instruments shall contain direct-current power supply system as specified herein.

C. Control Panel Schedule:

Panel No.	Specification/P&ID	Features*	Enclosure Type	Short-Circuit Current Rating	Panel Title	E-Drawing/Notes
RTU31	40 61 13 / I-602 through I-611	V, 1, 2	NEMA 12	14,000	Mingus PS RTU	Electrical Room
RTU24	40 61 13 / I-611	1, 7, 2	NEMA 4	14,000	Mingus Tank RTU	Mingus Tank

***Features Notes:**

V = Vendor/manufacturer panel per equipment Specification requirements

1. PLC or Remote I/O Devices.
2. Panel-mounted operator interface station (OIS).
3. Hardwired control logic required.
4. Windowed outer door and inner door for displays or devices.
5. Uninterruptible power supply (UPS).
6. Fans.
7. Heating.
8. Air conditioning.
9. Sun/rain hood.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
3. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations
NFPA 79	Electrical Standard for Industrial Machinery
NFPA 70	National Electrical Code (NEC)
NEMA ICS 6	Industrial Control and Systems: Enclosures
ANSI/UL 497-1995	Standard for Protectors for Paired Conductor Communications Circuits
UL 1012	Power Supplies
EIA RS-310C	Racks, Panels, and Associated Equipment
UL 1449	UL Standard for Safety for Surge Protective Devices

B. Listed Products:
   1. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose or UL recognized.
   2. The control panels shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL-508A Industrial Control Panel label.

C. Factory Testing:
   1. Prior to shipment, the manufacturer shall test the functional operation of the control panel as described in Section 40 61 96.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Section 40 61 13.

B. Action Submittals –RTU Shop Drawings:
   1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner's Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A marked copy of Section 40 61 21.
   3. A marked copy of Section 40 61 96.
   4. A marked copy of Section 01 45 20.
   5. A copy of the Contract Document P&IDs I-602 through I-611, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   6. Marked Contract Document control single-line diagrams E-603 and E-611 related to the submitted equipment.
   7. Marked product literature of all the enclosure electrical devices and components mounted on or within the control panel.
   8. List of miscellaneous items, cables, and spare parts to be provided.
   9. Dimensioned drawings:
      a. Exterior panel and layout.
      b. Interior devices and layout.
      c. Door-in-door construction devices, where required.

10. Panel assembly drawings, including sections showing clearances between face and rear-mounted equipment.
    a. Nameplate engraving schedule:
        1) Indicate engraving by line.
        2) Character size.
        3) Nameplate size.
        4) Panel and equipment tag number and description.
    b. Wiring drawings:
        1) Schematic diagrams for power.
        2) Loop diagrams for field signal connections to RTU PLC.
11. Submittal requirements of Section 40 63 43.
12. Submittal requirements of Section 40 66 56.

C. Closeout Submittals - Operating and Maintenance (O&M):
    1. Include the following in each O&M manual:
        a. Final reviewed submittals, including revised As-Built Record Drawings.
        b. Manufacturer's O&M instructions, edited for this project.
        c. Written record of PLC configuration, jumpers, and switch settings for each module.
        d. Include list of spare parts provided.
        e. O&M submittal requirements of Section 40 63 43.
        f. O&M submittal requirements of Section 40 66 56.

1.04 ENVIRONMENTAL CONDITIONS

A. Refer to Section 40 61 13.

PART 2 PRODUCTS

2.01 FABRICATION

A. General:
    1. Panels shall be designed for the seismic requirements of Section 40 61 13. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.
    2. Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.
    3. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 foot-per-pound (ft-lb) moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.

4. Panels less than 60-inches high shall be provided with floor stands to raise the top of the panel to 60-inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall-mounted.
5. Panels with specified requirements, including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details, take precedence over the panel types or panel features indicated herein.

B. RTU Panel Layout:
1. Provide 20% spare contiguous sub-panel area for future expansion.
2. Provide minimum of 20% spare terminal blocks, with a minimum of 10 analog, discrete, power.
3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.
4. Separation between the power components (over 120-Vac) and the control/ instrument components (120-Vac and less) by locating the power components and the control/instrument components in separate sections of the cabinet enclosure.
5. Individual power and control components with internal circuit breakers, as required.
6. Panel inner door contains a copy of the As-Built Drawings in a drawing holder.
7. Panel functions as specified.

C. RTU Panel Layout:
1. Separation between the power components (over 120-Vac) and the control/ instrument components (120-Vac and less) by locating the power components and the control/instrument components in separate sections of the cabinet enclosure.
2. Individual power and control components with internal circuit breakers, as required.
3. Panel inner door contains a copy of the As-Built Drawings in a drawing holder.
4. Panel functions as specified.

D. Enclosures:
1. Panel enclosures shall comply with the requirements of National Electrical Code (NEC) Article 409 and National Electrical Manufacturers Association (NEMA) 250.
2. Pump Station: Two-door with floor stands, NEMA 12, Hoffman A604812LP or size as required.
3. Tank: NEMA 4, Hoffman CSD303012 or size as required.
4. Manufacturer:
   a. Hoffmann Enclosures, Inc.

2.02 HEATING, VENTILATING AND COOLING

A. Provide as required by City SCADA Installation and Integration Project requirements.

2.03 NAMEPLATES

A. External door-mounted components and the panel description shall be identified with plastic nameplates. Refer to Section 40 61 13.

B. Machine-embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

C. The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide Room-Temperature Volcanizing (RTV) sealant for nameplates for NEMA-4X stainless steel panels.

D. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.04 PANEL FEATURES

A. Panel Interconnecting Wiring:
   1. Panel control wiring: Single-conductor stranded copper NEC-rated Type MTW No. 16 American Wire Gage (AWG) minimum (rated 10-A per National Fire Prevention Association (NFPA) 79, Table 12.5.1), with an exception for factory-supplied PLC wiring harnesses that are UL-approved.
   2. Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.
   3. Panel power wiring: Conductors specified in Division 26 and meet the NEC requirements for power, including phase, grounded, and grounding conductors.
   4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels.
   5. Wiring channels shall comply with UL-94, Type V.
   6. Plastic wireway with covers shall be used to route groups of wires. Wireway fill shall be sized to provide 50% maximum fill.
   7. Plastic spiral wrap shall be used for exposed wires. Wires that cross door hinges shall be enclosed in plastic spiral wrap.

B. Wire Markers:
   1. Wire marker shall comply with the requirements specified in Division 26.

C. Conductor Identification:
   1. Wiring shall be tagged at terminations with machine-printed plastic sleeves with three-part wire numbers for instrument and control panel internal conductors:
      a. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
      b. Part-2: Code letter and wire colors per the following tables.
      c. Part-3: Number that identifies individual circuit conductor.

Code	120-Vac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24-Vdc Power	Blue
PS	12-Vdc Power	Violet
S+	Signal (+)	Black
SG	Signal Ground	White
EG	Equipment Ground	Green
FV	Panel Foreign Voltage	Yellow

D. Conductor Installation and Protection:
   1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.
   2. Terminal blocks shall be strap-screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8-inch high.
   3. No more than two connections shall be made to one terminal.
   4. Wire connectors shall be locking fork tongue or ring tongue insulated crimp-type terminals.
   5. Terminal blocks shall be:
      a. 600-volt 20-amperes, finger-safe terminal block.
      b. Phoenix Contact or Weidmuller, or equal products.

E. Field Wiring:
   1. Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel. Provide a dedicated raceway on the field side of the terminal block for field wiring use only.

F. Fuse and Fuse Holders:
   1. Fuses for 120-Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown-fuse indicators.
   2. Fuses for 24-Vdc circuits shall be fast-acting glass-tube type rated 1/8- or 1/10-amp for 4-20 mA loops.
   3. Fuses for 24-Vdc circuits shall be 1/2-amp for the power supply to individual instruments.
   4. Fuse holders shall be tip-out or draw-out type.
   5. Provide Phoenix Contact or equal products.

G. Control Power:
   1. 120-Vac control power source: Single-power source for all control and DC power.
      a. Provide direct-current power supplies, as required for the load.
      b. Provide uninterruptible power supply (UPS) for PLC and derived loop power as defined above, as required for the load.

H. Panel Power: Panel Power Source:
   1. Provide a 120-Vac circuit for the panel light, receptacle, heating, and any fan as required.

I. RTU Accessories:
   1. Pump Station RTU panels shall include ground fault circuit interrupter (GFCI) convenience receptacles and fluorescent utility lights.
      a. Receptacles and utility lights shall not be powered by the UPS, where included.
   2. Print pocket.
   3. Fold-up shelf for PLC programming of sufficient size, sufficient weight capacity, and the proper angle for supporting a laptop computer.

J. Failsafe Wiring:
   1. Failsafe wiring of control relay or other on/off device or instrument provides the condition that will occur upon loss-of-power or internal failure in the device such that the relay is de-energized in the failure or loss-of-power condition such that the control relay contact operation provides for equipment failing in a safe mode.

2.05 ALARM AND TROUBLE DETECTION

A. The equipment control system shall incorporate a non-energized, open-state, output contact to activate on an alarm or trouble condition or on loss-of-power. Detection of a critical alarm or trouble condition shall cause the control system to initiate the shutdown or the operation of the equipment's controlled components to achieve a "Failsafe" condition.

B. Devices that signal an alarm or a trouble conditions shall latch in the alarm position and require a manual reset at the equipment control panel.

C. Alarm and Trouble Output Shall:
   1. Open an output dry contact.
   2. Remain open until manually reset.
   3. Not indicate abnormal condition when the equipment shutdown manually or automatically.
   4. Indicate the alarm at the equipment control panel.

D. Failsafe Design and Operation:
   1. Failure of part of a system shall not result in the failure of the rest of the system.
   2. Failure of equipment or process shall not propagate beyond the failing device or equipment component.
   3. Control design and operation shall prevent improper system functioning due to a circuit malfunction or operator error.
   4. Control-system design shall cause the controlled equipment to operate in a safe mode in the event of loss-of-power or the failure of a control system component.

2.06 POWER SUPPLY AND CONDITIONING EQUIPMENT

A. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL-1012 and shall be approved by UL, Canadian Standards Association (CSA), or Factory Mutual (FM) for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the

instrumentation and communication systems. Diode isolation shall be provided for redundant direct-current supply units, and the power supply negative-output terminal shall be grounded.

B. Direct-Current Power Supplies:
   1. Nominal 24-volt direct-current instrumentation and control power supply:
      a. Convection-cooled linear type or switching type.
      b. Line regulation: 0.4% for line variations from 105 to 132 volts.
      c. Load regulation: 0.4% for load variations from 0 to full load.
      d. Ripple and noise: Not exceed 100-mV peak-to-peak.
      e. Hold-up time at maximum load: Not less than 16 milliseconds.
      f. Continuous duty from 0 to 50°C at rated load.
      g. Output electronically current limited.
      h. Over-voltage crowbar shutdown.
      i. Output voltage:
         1) Rated 28-Vdc.
         2) Adjustable plus or minus 5%.
         3) Set to provide 26.4 volts to the panel direct current bus.
      j. Power Supply: TDK-Lambda LZSA series, or equal.

C. Uninterruptible Power Supply:
   1. Provide as required by City SCADA Installation and Integration Project requirements.

2.07 SURGE PROTECTION

A. Provide primary surge protectors, per NEC Article 800.90 on all signal conductors entering the panel. Surge protectors shall be multi-stage, plug-in type selected to protect the equipment, and listed per American National Standards Institution (ANSI)/UL497. Surge protectors shall be removable without changing the impedance of the circuit. Surge protector's product manufactures shall be:
   1. Weidmuller.
   2. Or equal.

2.08 PANEL GROUNDING

A. Each RTU panel shall be provided with two copper ground bars.
   1. One bar (NEC required) shall be bonded to the panel or panel frame or back-plate and to the facility grounding system.
   2. Second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the panel ground bar only at one point.

B. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.

C. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

D. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

E. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.

2.09 PANEL DRAWING PROTECTION

A. Provide complete drawings for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.10 SECURITY KEYPAD

A. Manufacturer/Model: Storm/Keymat Technology Ltd., AXS Strike Master DE1KT10, KEY-119.

2.11 SPARE PARTS

A. The following spare parts shall be provided:
   1. Five each of each type and rating of fuse used in the panels.
   2. Two each of each type of surge protective device used in the specified panels.

PART 3 EXECUTION

3.01 GENERAL

A. Floor-mounted cabinets shall be mounted and shimmed to precise alignment so doors operate without binding. Sealant shall be provided for conduit entering the panels.

B. Floor-mounted panels, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete.

C. Provide panels with the as-built schematic, connection, and interconnection diagrams mounted behind plexiglass holder on the inside of the door. Place documentation in a waterproof clear bag in the panel document holder.

3.02 MOUNTING

A. Control panels supported directly by concrete or concrete block walls shall be spaced out not less than 5/8-inch by framing channel between instrument and wall. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding and mounted where shock or vibration will impair their operation.

B. Support systems shall not be attached to handrails, process piping or mechanical equipment. Control panels supported directly by concrete or concrete block walls shall be spaced out from the wall to provide for air circulation around the panels.

C. Steel used for support of equipment shall be galvanized steel. Support systems, including panels, shall be designed to prevent deformation greater than 1/8-inch under the attached equipment load and an external load of 200 pounds in any direction.

D. Floor-mounted cabinets, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

E. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

F. Center-line of wall-mounted panels shall be 48 inches above the floor.

G. Panel tops of wall-mounted panels shall be mounted at the same elevation.

3.03 PANEL POWER SUPPLY

A. Final raceway connections shall be a rigid or flexible conduit in compliance with Division 26.

3.04 FACTORY TESTING

A. The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment. The Owner/Engineer shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner/Engineer at least 2 weeks in advance prior of the scheduled functional shop test.

3.05 FIELD TESTING

A. Field-verify the following for instrument and control panels:
   1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.
   2. Control contacts installed in the ungrounded side of the circuit.
   3. Panel signal and control wiring separated and installed in separate wireways with barriers between the power wiring and the signal and control wiring.
   4. Barriers between the power wiring and the signal and control wiring.
   5. Connected to the plant grounding system, as specified.
   6. Inner door contains a copy of the As-Built Drawings, in a protected drawing holder. Drawings shall be enclosed in a transparent, protective jacket.
   7. Panel functions as specified.
   8. Tested in accordance with Section 26 08 00 and Section 40 61 21.

END OF SECTION

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SECTION 40 71 00

FLOW MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for process flow parameter transmitters, associated indication devices, and accessories.

B. Not used.

1.02 QUALITY ASSURANCE

A. References are listed in Section 40 61 13. They are a part of this section as specified and modified.

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of 5 years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Sections 40 61 13 and 01 33 00.

B. Action Submittals – Shop Drawings:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams I-602 and I-603 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Marked Contract Document Electrical Plan E-401 Drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Marked product literature of all equipment and features to be provided.
    a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
    c. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
5. Marked product literature for surge protectors.

C. Informational Submittals.
1. Test results as specified in Section 40 61 21-2.02.

D. Closeout Submittals - Operating and Maintenance (O&M):
1. Include the following in each O&M manual:
    a. Final reviewed submittals, including revised as-built record drawings.
    b. Manufacturer's O&M instructions, edited for this project.
    c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.
    d. Record of flow lab calibration for flow range specified in Section 40 06 70 instead of manufacturer standard range.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 60 70-3.03 and/or on the Drawings.

2.02 EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment,as required in Section 40 61 13 and this section, shall be provided. All required product data for this section shall be included in one complete package.

B. Not used.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.03 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. Not used.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600, with the power supply at a nominal 24-volts DC with the default range of 0 to 100%, corresponding to 4-20 mAdc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated National Electrical Manufacturers Association (NEMA) 250, Type 4, unless otherwise specified.
   8. Transmitters located outdoors shall be provided with surge protectors:
      a. Signal:
         1) Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or accepted equal.
      b. AC Power:
         1) UL 1449, LED indicator, screw terminal connections, NEMA-4X. EDCO HSP121A or accepted equal.
   9. Not used.
   10. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.05 connected in the output signal circuit.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital light-emitting diode (LED) or liquid crystal display (LCD) indicators that are integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Not used.

2.04 NOT USED

2.05 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Installation requirements are specified in paragraph 40 61 13-3.01.

B. Not used.

C. Not used.

D. Electrical Connections:
   1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.03 TRAINING

A. Training requirements are specified in Section 01 79 00. Provide two training sessions, each with 1 hour per flow transmitter

PART 4 APPENDIX – INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in Section 40 06 70-3.03 and/or on the Drawings.

Table A

INSTRUSPEC Symbol	Instrument Description	Instrument Function
FM	Magnetic Flow Transmitter	Flow Measurement

4.02 INSTRUMENT IDENTIFICATION: FM

A. Instrument Function: Flow Measurement.

B. Instrument Description: Magnetic Flow Metering System.

C. Signal Input: Process.

D. Signal Output: Analog signal as specified in paragraph 2.02, scaled-pulse frequency, and HART Protocol.

E. Process Connection: Flange, ANSI B16.5, Class 150, raised-face.

F. Product Requirements: Magnetic flow meter provided as a system consisting of a flow tube with converter/indicating transmitter, as scheduled in the Section 40 06 70 Instrument Index.
   1. Flow tubes shall be rated NEMA 6P/IP68 for submergence.
      a. Manufacturer shall provide grounding rings fabricated from the same metal as for the electrodes below. Integral grounding electrodes are not acceptable.
      b. Electrodes: 316L stainless steel.
      c. Liner: Polyurethane or hard rubber.
      d. National Sanitation Foundation (NSF) certified.
   2. Remote-mounted indicating transmitter for full-scale flow rates from 1.5 to 30 feet per second. System error shall not exceed the greater of 0.5% of flow rate or 0.1 foot per second from 1.5 to 30 feet per second.
      a. Transmitter: Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry.
      b. Means to calibrate the metering system without use of external calibration units.
      c. Transmitter self-diagnostics.
      d. Integral 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.
      e. Pulse frequency shall stop at flows below 2% of maximum range, where the pulse frequency feature is specified.
   3. Traceability certificate of actual flow lab certification provided with each flow tube. Calibration for flow range specified in Section 40 06 70 instead of manufacturer standard range.
   4. Manufacturers:
      a. Endress + Hauser L400.
      b. Krohne IFC.
      c. Siemens Sitrans F.

G. Execution:
   1. Install in accordance with manufacturer's instructions and the specified functional requirements.
   2. Signal cable between the flow tube and transmitter provided by the system manufacturer with sufficient length of cable for continuous installation between the flow tube and the transmitter, no splices.

END OF SECTION

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SECTION 40 72 00

LEVEL MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for process level parameter transmitters, associated indication devices, and accessories.

B. This section specifies requirements for process-level activated switches, devices, and accessories.

1.02 QUALITY ASSURANCE

A. References: References are listed in Section 40 61 13 and are a part of this section as specified and modified.

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of 5 years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Sections 40 61 13 and 01 33 00.

B. Action Submittals – Shop Drawings:

A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams I-602, I-604 and I-611 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
2. Marked Contract Document Mechanical Plan M-100 and M-103 and Electrical Drawings E-401 and E-411, and sections and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Marked product literature of transmitters and features to be provided.
    a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
    c. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
4. Marked product literature for surge protectors.
5. Marked product literature of switches and features to be provided.
    a. Installation details for the process switches and mounting accessories.
    b. Electrical and signal connection drawings for process switches and devices.

C. Informational Submittals.
    1. Test results as specified in Section 40 61 21-2.02.

D. Closeout Submittals - Operating and Maintenance (O&M):
    1. Include the following in each O&M manual:
        a. Final reviewed submittals, including revised as-built record drawings.
        b. Manufacturer’s O&M instructions, edited for this project.
        c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 06 70-3.03 and/or on the Drawings.

2.02 EQUIPMENT

A. General:

1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, Drawings, information, and technical data for all equipment, as required in Section 40 61 13 and this section, shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:

1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid-state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100-mA at 24 volts DC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as National Electrical Manufacturers Association (NEMA) ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA-250, Type 4 minimum.
7. Not used.
8. Switch range shall be selected so that the specified setpoint is at least 30% but not more than 70% of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:

1. Measured parameter output indicators complying with paragraph 2.03 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 with the power supply at a nominal 24-volts DC with the default range of 0 to 100%, corresponding to 4 to 20-madc.
4. Transmitter output shall increase with increasing measurement.
5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters.

6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
7. Transmitter enclosures shall be rated NEMA-250, Type 4, unless otherwise specified.
8. Transmitters located outdoors shall be provided with surge protectors:
   a. Signal: Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or accepted equal.
   b. AC Power: Underwriters Laboratories (UL)-1449, light-emitting diode (LED) indicator, screw terminal connections, NEMA-4X. EDCO HSP121A or accepted equal.
9. Not used.
10. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.05 connected in the output signal circuit.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital LED or liquid crystal display (LCD) indicators that are integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Not Used.

2.04 NOT USED

2.05 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Installation requirements are specified in paragraph 40 61 13-3.01.

B. Not Used.

C. Not Used.

D. Electrical Connections:
   1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.03 TRAINING

A. Training requirements are specified in Section 01 79 00. Provide two training sessions, each with 1/2-hour per level transmitter.

PART 4 APPENDIX – INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in Section 40 06 70-3.03 and/or on the Drawings.

Table A

INSTRUSPEC Symbol	Instrument Description	Instrument Function
LFS2	Flood Level Switch	Level Measurement
LFS	Float Switch, Weighted	Level Measurement
LST	Submerged Diaphragm Level Transmitter	Level Measurement

4.02 INSTRUMENT IDENTIFICATION: LFS2

A. Instrument Function: Level Measurement.

B. Instrument Description: Flood Level Switch.

C. Power Supply: 120 volts AC, 60-Hertz nominal.

D. Signal Input: N/A.

E. Signal Output: Contacts as specified in paragraph 2.02

F. Process Connection: N/A.

G. Product Requirements:
   1. Neoprene float switch with slosh shield and 6 foot cable.
   2. Normally closed, contacts open upon high level.

H. Manufacturers: Gems Sensors LS-270 43982, or equal.

I. Execution:
   1. Install in accordance with manufacturer's instructions and the specified functional requirements.
   2. Calibration in accordance with Section 40 06 70-3.03. Switch setpoint as specified.

4.03 INSTRUMENT IDENTIFICATION: LFS

A. Instrument Function: Level Measurement.

B. Instrument Description: Float Switch, Weighted.

C. Power Supply: N/A.

D. Signal Input: Process.

E. Signal Output: Contacts, in accordance with paragraph 2.02 of this section.

F. Process Connection: N/A.

G. Product Data:
   1. Switch shall be weighted-type, suspended from an oil-resistant, waterproof cable. The cable shall be designed to support the weight of the float without additional strain relief and permanently sealed where it enters the float body.
   2. The conductors shall be a minimum size of 18 AWG (American Wire Gage). The switch shall be a single-pole, double-throw, dry-contact type and rated at not less than 10 amperes at 120-Vac. Mercury switches are not acceptable. The float shall have a PVC or ABS corrosion and impact-resistant shell.
   3. Manufacturers: Anchor Scientific Roto-Float S, Warrick series M, or equal

H. Execution:
   1. Install in accordance with manufacturer's instructions and the specified functional requirements.
   2. Calibration in accordance with Section 40 06 70-3.03. Switch setpoint as specified.

4.04 INSTRUMENT IDENTIFICATION: LST

A. Instrument Function: Level Measurement.

B. Instrument Description: Submerged Level Transmitter and Meter.

C. Power Supply: 120-Vac, 60-Hertz nominal or:
   1. 24-Vdc loop-powered.
   2. As specified in Section 40 06 70-3.03.

D. Signal Input: Process.

E. Signal Output: 4-20 mA into 0 to 600-ohms.

F. Process Connection: N/A.

G. Product Requirements:
   1. Sensor/Transmitter: Diaphragm: 316 SS
   2. Housing: 316 SS
   3. Wetted Seals: Viton or equal.
   4. Cable Jacket: Polyethylene, FEP, Polyurethane, Tefzel, or equal.
   5. Output: One 4-20 mA, 2-wire.
   6. HART standard communication data protocol.
   7. Accuracy: 0.25% full scale.
   8. Operating Temperature: -25°F to 180°F.

9. Cable Length: As required.
10. Accessories: Cable suspension hardware.
11. Manufacturers:
    a. Endress+Hauswer Waterpilot FMX167.
12. Meter: Enclosure: NEMA-4X
    a. Mounting: Surface.
    b. Power Supply: 12-Vac, 5W maximum.
    c. Analog Input: 4-20 mA DC (from transmitter).
    d. Analog Output: One 4-20 mA DC isolated into a minimum of 500.
    e. Display: Graphic LCD with digital scalable process level and level display graph.
13. Accessories: Mounting hardware.
14. Manufacturers:
    a. Endress+Hauser.

H. Execution:
1. Install in accordance with manufacturer's instructions and the specified functional requirements.
2. Signal cable between the transmitter and receiving instrument or telemetry provided by the system manufacturer, with sufficient length of cable for continuous installation, no splices.
3. Calibration in accordance with Section 40 06 70-3.03.

END OF SECTION

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SECTION 40 73 00

PRESSURE, STRAIN AND FORCE MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for process pressure parameter transmitters, associated indication devices, and accessories.

B. This section specifies requirements for process pressure activated switches, devices, and accessories.

1.02 QUALITY ASSURANCE

A. References: References are listed in Section 40 61 13 and are a part of this section as specified and modified.

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of 5 years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Sections 40 61 13 and .

B. Action Submittals – Shop Drawings:

A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams I-602, I-603 and I-604 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
2. Marked Contract Document Mechanical Plan M-100 and Electrical Plan E-401 Drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Marked product literature of transmitters and features to be provided.
    a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
    c. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
4. Marked product literature of switches and features to be provided.
    a. Installation details for the process switches and mounting accessories.
    b. Electrical and signal connection drawings for process switches and devices.

C. Informational Submittals.
1. Test results as specified in Section 40 61 21-2.02.

D. Closeout Submittals - Operating and Maintenance (O&M):
1. Include the following in each O&M manual:
    a. Final reviewed submittals, including revised as-built record drawings.
    b. Manufacturer's O&M instructions, edited for this project.
    c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in Attachment A at the end of this section.

B. Application requirements are specified in the Section 40 06 70 and/or on the Drawings.

2.02 EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, Drawings, information, and technical data for all equipment, as required in Section 40 61 13 and this section, shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
   1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
   2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
   3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100-mA at 24-volts DC.
   4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as National Electrical Manufacturers Association (NEMA) ICS 2, designation B300.
   5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
   6. Switch electrical enclosures rated as NEMA-250, Type 4 minimum.
   7. Not used.
   8. Switch range shall be selected so that the specified setpoint is at least 30% but not more than 70% of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.03 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 with the power supply at a nominal 24-volts DC with the default range of 0 to 100%, corresponding to 4-20 mAdc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated NEMA-250, Type 4, unless otherwise specified.
   8. Not used.
   9. Not used.
   10. Not used.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital light-emitting diode (LED) or liquid crystal display (LCD) indicators that are integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Not used.

2.04 NOT USED

2.05 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Installation requirements are specified in paragraph 40 61 13-3.01.

B. Process Connections:
   1. General: Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
      a. Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
      b. Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.
      c. Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.
   2. Not used.
   3. Not used.
   4. Gauge Valves: Gauge valves shall be provided for each pressure gauge tap.

C. Tubing:
   1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
   2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8-inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
   3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:

1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.03 PROCESS CONNECTIONS:

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

3.04 TRAINING

A. Training requirements are specified in Section 01 79 00. Provide two training sessions, each with 1/2-hour per pressure transmitter

PART 4 APPENDIX – INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in Section 40 06 70-3.30 and/or on the Drawings.

Table A

INSTRUSPEC Symbol	Instrument Description	Instrument Function
PG	Pressure Gage	Pressure Measurement
PGT	Gage Pressure Transmitter	Pressure Measurement
PS	Pressure Switch	Pressure Measurement

4.02 INSTRUMENT IDENTIFICATION: PG

A. Instrument Function: Pressure Measurement.

B. Instrument Description: Pressure Gauge.

C. Power Supply: N/A.

D. Signal Input: N/A.

E. Signal Output: N/A.

F. Process Connection: 1/2-inch male national pipe thread (NPT).

G. Product Requirements:

1. Pressure gages shall be 4-1/2-inch premium grade. 270-degree milled stainless steel movement, phenolic case. Accuracy shall be 1% of span or better.
2. Shatterproof glass window option.
3. All exposed metal parts shall be stainless steel.
4. Glycerin-filled units with bourdon-tube element.
5. Overload stop to protect against over-pressure.
6. Underload stop to protect against under-pressure.

H. Pressure Gauge Manufacturers:
1. Ashcroft Duragage 1279.
2. Ametek 1981L.
3. Or accepted equal.

I. Execution:
1. Install in accordance with manufacturer's instructions and the specified functional requirements.
2. Gauge valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
3. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance.
4. Pressure gauges may be supported from the process tap if this location permits observation from the floor or a permanent work platform.
5. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.
6. Calibration in accordance with Section 40 06 70-3.03.

4.03 INSTRUMENT IDENTIFICATION: PGT

A. Instrument Function: Pressure Measurement.

B. Instrument Description: Gauge Pressure Transmitter.

C. Power Supply: As specified in paragraph 2.02.

D. Signal Input: Process.

E. Signal Output: Analog transmission signal as specified in paragraph 2.02.

F. Process Connection: 1/2-inch female NPT flange adapter.

G. Product Requirements:
1. Pressure Transmitter: Capacitance or piezoresistive type.
2. Wetted Parts: Type-316 stainless steel.
3. Range: 100:1.
4. Accuracy: 0.075% of calibrated span.

5. Static Pressure Rating: 2,000-psi.
6. Indicator: LCD display.
7. HART standard data communication protocol.
8. Acceptable Manufacturer:
    a. Endress + Hauser Cerabar.
    b. Rosemount 3051C (2051C not acceptable).
    c. Foxboro IGP.

H. Execution:
1. Install in accordance with manufacturer's instructions and the specified functional requirements.
2. Gauge valves provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
3. Pressure instruments located as close as practical to the process tap and be positioned to permit observation and maintenance.

4.04 INSTRUMENT IDENTIFICATION: PS

A. Instrument Function: Pressure Measurement.

B. Instrument Description: Pressure Switch.

C. Signal Input: Process.

D. Signal Output: As specified in paragraph 2.02.

E. Process Connection: 1/2-inch female NPT.

F. Product Requirements:
1. Pressure switch shall consist of a pressure transducer and a precision switch. Pressure transducer shall be the diaphragm piston type with wetted materials as recommended by the switch manufacturer. Piston backed by a cylinder disc to permit 10 times over-range pressure without affecting calibration.
2. Range spring and piston shall be isolated from process fluids by the diaphragm. Switch provided with two 3/4-inch conduit connections. Switch assembly housing shall be cast aluminum rated type 4 per NEMA ICS6. Contractor shall select pressure transducer so that setpoint falls between 30 and 70% of maximum range.
3. Approximate setpoint and, if applicable, reset point indicated on calibrated scales. Repeatability and sensitivity shall be 1% of operating range. Unless otherwise specified, switches shall be nonadjustable deadband type.

G. Approved Manufacturers:
1. Ashcroft.
2. Or accepted equal.

H. Execution:
1. Installation: Install in accordance with manufacturer's instructions and to the specified requirements.

2. Application/Calibration: Application, and setpoints as specified in Section 40 06 70-3.03.

END OF SECTION

SECTION 40 74 00

TEMPERATURE MEASUREMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for process temperature parameter transmitters, associated indication devices, and accessories.

1.02 QUALITY ASSURANCE

A. References: References are listed in Section 40 61 13 and are a part of this section as specified and modified.

B. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of 5 years.

C. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

1.03 SUBMITTALS

A. Submittals shall be provided as specified in Sections 40 06 70 and 01 33 00.

B. Action Submittals – Shop Drawings:

1. A copy of this Specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Referenced and applicable sections to be marked up and submitted include:
   a. Section 40 61 13 – Process Control System General Provision
   b. Section 40 06 70 – Schedules for Instrumentation of Process Systems

   A check-mark shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagrams I-103 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
3. Marked Contract Document Electrical Plan E-401 Drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
4. Marked product literature of transmitters and features to be provided.
    a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
    b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
    c. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.

C. Informational Submittals.
1. Test results as specified in Section 40 61 21-2.02.

D. Closeout Submittals - Operating and Maintenance (O&M):
1. Include the following in each O&M manual:
    a. Final reviewed submittals, including revised as-built record drawings.
    b. Manufacturer's O&M instructions, edited for this project.
    c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.

1.04 ENVIRONMENTAL CONDITIONS

A. Equipment provided under this section shall be suitable for operation under ambient conditions described in Section 40 61 13-1.03.

PART 2 PRODUCTS

2.01 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. General requirements for instruments specified in this section are specified on the INSTRUSPEC sheets in the Appendix at the end of this section.

B. Application requirements are specified in Section 40 06 70-3.03 and/or on the Drawings.

2.02 EQUIPMENT

A. General:
1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, Drawings, information, and technical data for all equipment, as required

in Section 40 61 13 and this section, shall be provided. All required product data for this section shall be included in one complete package.

B. Not used.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.03 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 with the power supply at a nominal 24-volts DC with the default range of 0 to 100%, corresponding to 4-20 mAdc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated National Electrical Manufacturers Association (NEMA)-250, Type 4, unless otherwise specified.
   8. Not used.
   9. Not used.
   10. Not used.

2.03 PROCESS PARAMETER OUTPUT INDICATOR

A. Provide digital light-emitting diode (LED) or liquid crystal display (LCD) indicators that are integral to the instrument housing where available from the manufacturer. Displays shall be scaled in engineering units, over the calibrated range of the instrument. Calibrate the indicator scale in process units.

B. Not Used.

2.04 NOT USED

2.05 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. Not Used.

B. Electrical Connections: Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

3.02 TESTING

A. Applicable testing requirements are specified in Section 40 06 70-3.02.

B. Testing requirements are specified in Section 40 61 21.

3.03 TRAINING

A. Training requirements are specified in Section 01 79 00. Provide two training sessions, each with 1/2-hour per temperature transmitter

PART 4 APPENDIX – INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in Section 40 06 70-3.02 and/or on the Drawings.

Table A

INSTRUSPEC Symbol	Instrument Description	Instrument Function
TMP	Temperature Transmitter	Temperature Measurement
TRE	Resistance Temperature Insertion-Type RTD (resistance temperature detection)	Temperature Measurement

4.02 INSTRUMENT IDENTIFICATION: TMP

A. Instrument Function: Temperature Measurement.

B. Instrument Description: Temperature Transmitter.

C. Power Supply: As specified in paragraph 2.02.

D. Signal Input: Process temperature monitored by RTD.

E. Signal Output: Analog transmission signal as specified in paragraph 2.02.

F. Process Connection: None.

G. Product Requirements:
   1. Temperature Transmitter: 2-wire device, powered from the programmable logic controller (PLC) analog input power supply.
   2. Temperature Limits: 0-160°F.
   3. Humidity Limits: 0-100% relative humidity.
   4. Accuracy: 0.25°F + 0.02% span, using 100-ohm platinum RTD.
   5. Output: One isolated 4-20 mA into a maximum of 600 ohms.
   6. Sensor update time: 0.5 seconds.
   7. Failure mode: Transmitter shall have a configurable failure mode to drive the analog signal either (>21 mA) in the event of microprocessor failure.
   8. Rating: NEMA-4 or as specified in Section 40 06 70.

9. Indicator: LCD display.
10. Acceptable Manufacturer:
    a. Endress+Hauswer TMT-142.

H. Calibration:
1. Factory-certified calibration report for the range specified in Section 40 06 70, not for manufacturer's standard range.

I. Execution:
1. Install in accordance with manufacturer's instructions.

4.03 INSTRUMENT IDENTIFICATION: TRE

A. Instrument Function: Temperature Measurement.

B. Instrument Description: RTD element.

C. Power Supply: N/A.

D. Signal Input: Process

E. Signal Output: 100-ohms nominal at 0°C, resistance temperature coefficient of 0.385%/°C.

F. Process Connection: Integral mount to transmitter, shortest length sensor available.

G. Product Requirements:
1. Temperature element shall be tip-sensitive, three-wire, platinum RTD in 1/4-inch American Society of Testing and Materials (ASTM) A269, Type-316 stainless steel sheath with watertight connection head.
2. Time constant in agitated water shall not exceed 8 seconds. RTD shall comply with ASTM E1137, tolerance Grade A.
3. Three-wire lead configuration for ambient temperature compensation shall be provided.

H. Execution:
1. Installation: Temperature elements shall be installed in accordance with the manufacturer's instructions.

END OF SECTION

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SECTION 41 22 00

HOISTS AND CRANES

PART 1 GENERAL

1.01 SUMMARY

A. Scope:

1. This section specifies a hoist, trolley, and festooning system for equipment removal. This system will be used to lift and maintain pump equipment and related components for occasional maintenance. The trolley will be attached to structural steel beam provided in the pump room building as indicated on the Contract Drawings.
2. The equipment supplier shall review the mechanical layout and instrumentation drawings within the Contract Documents which relate to the equipment specified in this section to familiarize themselves with the location and the setup of the equipment specified and shall assure themselves that the equipment specified is appropriate for and coordinated with that which is shown on the Drawings.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.
2. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI B30.11	Monorails and Underhung Cranes
OSHA	Specification 1910.179 - Overhead and Gantry Cranes

B. Warranty;

1. The supplier shall provide a warranty for the equipment specified under this section. The warranty shall be in accordance with the General Conditions and shall cover the materials and labor for the equipment specified in this section. The warranty shall be for 1 year from Substantial Completion. Partial Substantial Completions may be awarded based on the schedule of the work; however, these shall be specifically

requested by the Contractor and approved by the Engineer. If extended warranties are required, a special paragraph calling for an extended warranty will be included in this section.

2. In addition to the guarantee provided under the General Conditions, provide two 2-year duration, full coverage against manufacturer's defects and include parts and labor. This warranty shall commence at the beginning of the commissioning period.

1.03 ENVIRONMENTAL CONDITIONS

A. Refer to Section 01 11 80 – Environmental Conditions for site-wide environmental conditions.

1.04 SUBMITTALS

A. Submittals shall be submitted in accordance with Section 01 33 00 - Submittal Procedures and shall include at a minimum the following:

1. A copy of this section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check-marks shall denote full compliance with a paragraph as a whole.

   If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations.

   The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up Specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
2. Equipment literature, cut sheets and data sheets for all equipment supplied under this section.
3. Performance calculations.
4. Dimensional drawings for the equipment supplied under this section. In addition to dimensional information for the equipment specified, these drawings shall dimensionally show the connection points to the structural steel beam. Contractor or equipment supplier shall confirm adequacy of equipment connection to structural steel.
5. Weights for the provided equipment and major components.
6. Information regarding the materials of construction for all equipment supplied under this section.
7. Spare parts list.
8. Warranty information.
9. Special shipping, storage and protection, and handling instructions.
10. Installation instructions.

11. Manufacturer's catalog data, including weights, rated capacity, equipment speeds, electrical requirements (if any), and materials of construction.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Suppliers:
   1. The Engineer and the Owner believe that the following suppliers are capable of producing equipment and products which will satisfy the requirements of this section. This statement, however, shall not be construed as an endorsement of a particular supplier or product, nor shall it be construed that a named supplier's standard product will comply with the requirements of this section.
   2. Candidate suppliers include Gorbel Inc, Hoist Systems, Inc., Washington Crane, or equal.

      Supplier Qualifications: The supplier shall have 10 years of experience manufacturing and installing hoists and trolleys in similar sized projects.

B. The hoist and trolley system shall be designed, fabricated, and installed in accordance with American National Standards Institution (ANSI) B30.11, and Occupational and Health Administration (OSHA) 1910.179.

C. Clearly label hoist with rated load capacity. Place label at height and location easily read from floor level and loading position.

2.02 HOIST

A. Productivity ratio: Hoist shall be designed to manually move load with maximum force of 1/100 load weight.

B. Operating temperature: 5 to 200 degrees F (-15 to 93 C).

C. Hoist shall be designed to withstand:
   1. Hoist dead load.
   2. Live load capacity equal to net-rated hook load: 2,000 pounds (907 kg).
   3. Inertia forces from hoist, trolley and load movement.

2.03 TROLLEY

A. Type: Rigid-body trolley designed to ride on steel beam (as shown in Contract Drawings) and carry hoist and load. Articulating trolleys are not acceptable.

B. Construction: Two-piece stamped steel body with two wheels each side and tapered clevis positioning hoist hook at center of trolley so load weight is evenly distributed to all four trolley wheels. Provide removable clevis pin of type and size determined by manufacturer for specified capacity. Trolleys with non-removable clevis pins are not acceptable.

C. Drop lugs: Provide on both sides of trolley to limit trolley drop to 1-inch (25-mm) maximum in event of wheel, axle, or load bar failure.

D. End stops: Provide resilient bumper installed on steel beam to prevent hoist trolley from coming in contact with building wall or steel beam connections to wall. Bolt stops without energy-absorbing bumper are not acceptable

2.04 FESTOON ASSEMBLIES:

A. Provide length of electrical cable and/or air hose to supply lifting device and festoon along monorail.

B. Festoon trolleys: Four-wheeled trolleys with pivoting saddle and applicable attachment to support service run on steel beam and allowing festooning as hoist trolley travels.

C. Festoon clamp: Steel clamp assembly attached to track to prevent festoon trolleys from exiting track.

D. Festoon assembly shall connect to structural steel beam as required.

2.05 SAFETY ENCLOSURES AND MEASURES

A. Equipment shall have adequate removable enclosures to protect personnel against accidental contact with moving parts and prevent dripping.

2.06 PRODUCT DATA

A. The following product data shall be provided in accordance with Section 01 33 00 – Submittal Procedure.
   1. Operations and Maintenance Manuals.
   2. Factory Test Report.
   3. Certificate of Proper Installation.
   4. Field Test Reports.
   5. Certificate of Field Testing and Commissioning.
   6. Certificate of Training Completion.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install units and accessories in accordance with manufacturer's instructions and approved shop drawings.

B. Do not modify hoist or trolley components in any manner without advance written approval by hoist manufacturer.

3.02 FIELD QUALITY CONTROL

A. Perform field quality-control testing as recommended by manufacturer.

B. Move hoist trolley through entire travel to ensure hoist and trolley are clear of obstructions and moves freely and smoothly.

C. Field-test hoist, trolley and accessories for operating functions. Ensure movement is smooth and proper. Adjust as required and correct deficiencies.

D. Protect hoist and trolley from other construction operations.

3.03 PROTECTION

A. Protect installed products until completion of project.

B. Touch up, repair or replace damaged products before Substantial Completion.

3.04 TRAINING

A. Training shall be provided per Section 01 79 00 – Demonstration and Training.

B. A minimum of 2 hours of total training shall be provided on hoist and trolley installations:
   1. The 2 hours of training shall be comprised of 1 hour of Operations Training and 1 hour of Maintenance Training.
   2. Conduct one training session per week on consecutive weeks to accommodate the shift schedules of operation and maintenance staff.

C. Upon completion of the training activities, the supplier shall provide a Certification of Training Completion.
   1. Commissioning: Provide minimum 1-hour dedicated commissioning session in conjunction with each training session as specified in this section. During each commissioning session, Owner staff will operate hoist and trolley system.

END OF SECTION

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SECTION 43 05 11

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This Section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this Section in addition to the specific requirements of each individual equipment Specification Section.

B. Equipment Lists:

1. Equipment lists, presented in these Specifications and as specified on the Drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this Contract. The Contractor shall prepare its own material and equipment takeoff lists as necessary to meet the requirements of this Project Manual.

1.02 QUALITY ASSURANCE

A. Arrangement:

1. The arrangement of equipment shown on the Drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The Contractor shall, in determining the cost of installation, include these differences as part of its Bid Proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. References:

1. This Section contains references to the documents listed below. They are a part of this Section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that

date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI S2.19	Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

C. Unit Responsibility:

1. The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit-responsibility manufacturer, where specified. The unit-responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the Specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly Specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit-responsibility manufacturer shall be the manufacturer of the driven-component equipment in the equipment assembly. The unit-responsibility manufacturer is designated in the individual equipment Specifications found elsewhere in this Project Manual. Agents, representatives or other entities that are not a direct division of the driven-equipment manufacturing corporation shall not be accepted as a substitute for the driven-equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of its responsibility to the Owner for performance of all systems as provided in the General Conditions of the Contract Documents.

D. The Contractor shall ensure that all equipment assemblies provided for the Project are products for which unit responsibility has been accepted by the unit-responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical-equipment assembly does not require or obligate the unit-responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual Specification requires the Contractor to furnish a certificate from a unit-responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit-responsibility manufacturer's corporation, and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit-responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.

E. Balance:

1. Unless specified otherwise, for all machines 10-horsepower (HP) and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

   a. $U_{per} = 6.015 \frac{GW}{N}$

   b. Where:

      1) U_{per} = permissible imbalance, ounce-inches, maximum
      2) G = Balance quality grade, millimeters per second
      3) W = Weight of the balanced assembly, pounds mass
      4) N = Maximum operational speed, rpm

2. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as Product Data. Equipment balance quality grade shall be *G* 2.5 (*G* = 2.5 mm/sec) or better in accordance with American National Standards Institution (ANSI) S2.19.

PART 2 PRODUCTS

2.01 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this Section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse-thread series, Class 2 fit.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat-faced.

C. Flange assembly bolts shall be heavy-pattern, hexagonal-head, carbon-steel machine bolts with heavy-pattern, hot-pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS

A. Unless otherwise specified, equipment bearings shall be oil- or grease-lubricated, ball- or-roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of American Bearing Manufacturers Association (ABMA) Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

B. Grease-lubricated bearings, except those specified to be factory-sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

C. Oil-lubricated bearings shall be equipped with either a pressure-lubricating system or a separate oil-reservoir type system. Each oil-lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60°C and shall be equipped with a filler pipe and an external level-indicator gage.

D. All bearings accessible to touch, and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65°C or less for continuous operation at bearing-rated load and a 50°C ambient temperature or shall be provided with appropriate shielding that will prevent inadvertent human contact.

2.03 V-BELT ASSEMBLIES

A. Unless otherwise specified, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.

B. Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5,500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap-tightening screws. Bushings shall be key seated to the drive shaft.

C. Belts shall be selected for not less than 150% of rated-driver HP and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion-proof equipment is specified.

2.04 PUMP SHAFT SEALS

A. General:
   1. Seals for water pump shafts shall be mechanical seals. Unless specified otherwise, mechanical seals shall conform to the requirements set forth in this paragraph.

B. Mechanical Seals:
   1. Unless otherwise specified in the detailed pump Specifications, mechanical seals shall be split-mechanical seals requiring no field assembly, other than assembly around the shaft and insertion into the pump. They shall be self-aligning, and self-centering, single seals. They shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area (no shaft sleeve). Where the detailed Specifications call for cartridge instead of split seals, all other requirements of this paragraph apply.
   2. Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C, Elgiloy, or other Duplex SS selected for resistance to chloride attack. Rotary faces shall be silicon carbide or chrome oxide. Stationary faces shall be silicon carbide for solids-bearing fluid service and carbon for clean-water service. Elastomers shall be ethylene propylene or fluorocarbon. Mechanical seals shall be suitable for operation between full vacuum (0 pounds per square inch absolute [psia]) up to 200% of the

maximum specified operating pressure, but in any event not less than 200 pounds per square inch gauge [psig]).

3. Seal chambers shall be provided with vented solids-removal restriction bushings, except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. The bushing shall both control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.
4. Candidate seals include:
   a. Chesterton 442 seals provided with Chesterton/SpiralTrac solids-removal restriction bushings Version N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.
   b. AESSEAL RDS seals with Cyclops bushing.
   c. John Crane 3710 seals with Type 24SL bushing.
5. Seals for all vertical pumps (whether column- or volute-type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start-up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed Specifications, permissive confirmation automatic vent systems shall be provided.

2.05 COUPLINGS

A. Unless otherwise specified in the particular equipment Sections, equipment with a driver greater than 1/2-HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper-lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering HP, speed of rotation, and type of service.

B. Where torque or HP capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.06 GUARDS

A. Exposed moving parts shall be provided with guards which meet all applicable Occupational Safety and Health Administration (OSHA) requirements. Guards shall be fabricated of 14-gauge steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.07 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "Caution – Automatic Equipment May Start At Any Time." Signs shall be constructed of fiberglass material minimum 1/8-inch thick or vinyl-clad aluminum minimum 40-mil, rigid, suitable for post-mounting. Letters shall be white on a red background. The sign size shall be per Section 10 14 00. Signs shall be installed near guarded moving parts.

2.08 GAUGE TAPS, TEST PLUGS AND GAUGES

A. Gauge taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gauges shall be provided where specified. Gauge taps, test plugs, and gauges shall be as specified in Division 40.

2.09 NAMEPLATES

A. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.10 LUBRICANTS

A. The Contractor shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period.

B. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in its construction schedule for starting, testing and adjusting equipment (Section 01 45 20), the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 20. Unless otherwise stated in the individual equipment Specifications, anchor bolt materials shall conform to the provisions of Section 05 05 20.

2.12 SPARE PARTS

A. Spare parts, wherever required by detailed Specification Sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by part name and Project equipment number and identified by part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly

protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 3 EXECUTION

3.01 GENERAL

A. Installation of equipment accessories included in this Section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment Specification Section.

END OF SECTION

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SECTION 43 05 13

RIGID EQUIPMENT MOUNTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This Section specifies minimum requirements for rigid equipment mounts. Completed equipment mounts shall consist of equipment pads, equipment anchors, and mounting plates (baseplates, soleplates, or fabricated steel frames) set in grout.
2. Equipment mounts shall conform to the requirements specified in the Equipment Mounting Schedule included in this Specification. Where equipment-mounting requirements are not specifically identified in the Equipment Mounting Schedule, the default mounting configuration for equipment shall consist of pad-anchored equipment pads per Standard Detail M7007, mounting plates leveled within 0.005 inch/foot, anchored to the equipment pad with cast-in-place equipment anchors per Standard Detail M7002, equipment anchor sleeve length is ten times the bolt diameter, and the mounting plate is grouted in position using non-shrink grout.
3. If a conflict exists between this Section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.
4. Requirements for non-rigid equipment mounts (vibration-isolation systems) are specified in individual equipment specifications. Rigid equipment mounts conforming to the requirements of this section shall be furnished for the equipment pad and other equipment-mounting components supporting the vibration-isolation system.

B. Definitions:

1. Specific equipment-mounting terminology used in this Section conforms to the following definitions:
    a. Baseplate: A mounting plate configured with a top plate and a perimeter edge of the mounting plate that is below the top plate. Baseplates have a cavity between the top plate and a horizontal plane at the bottom edge of the perimeter of the mounting plate.
    b. Soleplate: A machined or pre-formed mounting plate with a uniform horizontal surface across the entire underside of the mounting plate, excepting shear lugs/keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.). Soleplates have a top plate but lack the perimeter bottom edge that extends below the underside of the top plate that is a defining feature of baseplates.
    c. Fabricated Steel Frame: An equipment-mounting plate constructed of rolled-steel shapes and plates welded into a frame. Fabricated steel frames do not have top plates.
    d. Equipment Pad: Concrete foundation (block or slab) supporting and elevating mounting plates above the supporting structural floor slab or local grade.
    e. Mounting Pads: Milled/machined areas of baseplates, soleplates, and fabricated steel frames where the feet or mounting surfaces of mounted equipment and drivers are bolted to the baseplate, soleplate, or fabricated steel frame.

f. Leveling Blocks: Steel blocks temporarily placed under baseplates, soleplates, or fabricated steel frames at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or fabricated steel frames prior to grouting.

g. Shims: Thin stainless steel plates of uniform thickness used for fine adjustment of level. Shims are used on top of leveling blocks for mounting-plate leveling or used between equipment drivers and baseplates, soleplates, or fabricated steel frames for equipment alignment.

h. Wedges: Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges are used between equipment pads and baseplates, soleplates, or fabricated steel frames for the purpose of leveling mounting plates.

i. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or fabricated steel frames for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or fabricated steel frames.

j. Reinforcement Dowels or Reinforcement Hooks: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.

k. Leveling Position: A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and fabricated steel frames prior to grouting.

l. Grout Manufacturer: Refers to the manufacturer of the grout product used for installation of rigid equipment mounts.

m. Grout Manufacturer's Technical Representative(s): Refers to the technical representative(s) of the grout manufacturer. The grout manufacturer's technical representative shall not be an employee of the Contractor.

1.02 QUALITY ASSURANCE

A. References:

1. This Section contains references to the following documents. Referenced documents are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. References to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ACI 318, Appendix D	Building Code and Commentary, Anchorage to Concrete
ANSI/HI 1.4	Centrifugal Pumps – Installation, Operation and Maintenance
ANSI/HI 2.4	Vertical Pumps – Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F1554	Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2
IBC	International Building Code (including local amendments)

B. Quality Control by Contractor:
   1. To demonstrate conformance with the specified requirements for rigid equipment mounts, the Contractor shall provide the services of an independent testing laboratory that complies with the requirements of the American Society for Testing and Materials (ASTM) E329. The testing laboratory shall sample and test materials installed as part of rigid equipment mounts as specified in this section. Costs of testing laboratory services shall be borne by the Contractor.
   2. Where epoxy grout is specified in individual equipment Specifications, the Contractor shall furnish the services of a grout manufacturer's technical representative who has been factory-trained by the grout manufacturer. The grout manufacturer's technical representative shall perform training and quality control of epoxy grout installation for rigid equipment mounts as specified in this section.

C. Special Inspection for Equipment Anchors:
   1. Equipment anchors shall comply with special inspection requirements specified in Section 05 05 20.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with the submittal requirements specified in Section 01 33 00.
   1. A copy of this Specification Section, including addendum updates, (referenced Sections need not be included for this Section) with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations shall be sufficient cause for

rejection of the entire submittal with no further consideration. Copies of this Specification Section shall be numbered and marked (Specification number and equipment number) for inclusion (filing) with submittal materials furnished for individual equipment Specifications.

2. Name, employer, a copy of the employee's Qualified Millwright card or other equivalent certificate of journeyman qualifications for millwrights who will install rigid equipment mounts, as specified in paragraph 3.03.
3. Certificates or other documentation issued by the epoxy grout manufacturer that demonstrates that the grout manufacturer's technical representative has been factory trained on installation of epoxy grout for equipment mounts, as specified in paragraph 1.02.
4. Shop Drawings for equipment pads, equipment anchors, and baseplate, soleplate or fabricated steel frame details. Shop Drawings shall depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment-mounting features embedded in equipment pads. Shop Drawings for equipment pads, equipment anchors, and baseplate, soleplate, or fabricated steel frames shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Equipment mounts shall conform to the requirements specified in the Equipment Mounting Schedule.

B. Equipment and drivers shall be rigidly mounted on a common mounting plate and grouted into place on a concrete equipment pad unless alternate requirements are specified in the Contract Drawings or the Equipment Mounting Schedule in this Section. Unless otherwise specified in the individual equipment Specification, mounting plates shall be anchored to equipment pads with a layer of grout between the equipment pad and the mounting plate.

2.02 EQUIPMENT PADS

A. Materials:
   1. Equipment pads shall be reinforced concrete as shown in Contract Drawings.
   2. Minimum dimensions for equipment pads are shown on Mechanical Drawings where the equipment pad is required to provide a minimum mass for vibration dampening.

B. Equipment Pad Drainage:
   1. Equipment pads shall be furnished with 2-inch drains.
   2. Locate equipment pad drains at drainage outlets from equipment or mounting plates
   3. Route equipment drainage outlets or mounting plate drainage outlets to equipment pad drains
   4. Route equipment pad drains to the floor drainage collection system.

5. Drainage piping for equipment pads shall be routed below the finished floor elevation.
6. Exposed drain lines mounted on the floor are not acceptable.

Equipment Mounting Schedule

Equipment Number	Specification Section	Specification Title	Equipment Pad Detail	Mounting Plate Leveling Tolerance (inch/foot)	Equipment Anchor Type	Equipment Anchor Sleeve Length	Grout Type	Application Notes
Default Config.	Various	Various	M7007	0.005	M7002	See Detail	Non-shrink	Default equipment-mounting configuration for all equipment not otherwise specified in this schedule.
Freestanding Floor-Mounted Electrical Panels and Equipment	Various	Various	M7006	Not applicable	M7004	Not required	Not required	
P3110 P3120 P3130 P3140 P3150	43 23 13.21	Close-Coupled Vertical In-Line, Single Stage Centrifugal Pumps	M7007	0.0005	M7002	See Detail	Epoxy	
Bladder-Type, Hydropneumatic, Surge Tank	43 42 21	Bladder-Type, Hydropneumatic Tanks	M7008	0.002	M7002	See Detail	Non-shrink	

2.03 EQUIPMENT ANCHORS

A. Equipment Anchor Materials:
   1. Equipment anchors shall be all-thread rod with heavy hex-welded nuts, heavy hex bolts, post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors), or adjustable canister anchors as specified in the Equipment Mounting Schedule.
   2. Post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors) shall conform to the requirements of Section 05 05 20.
   3. Adjustable canister anchors shall be cast-in-place pre-manufactured adjustable anchor inserts. Adjustable canister anchors shall provide a minimum of 6 inches of vertical bolt height adjustment and lateral adjustment of the anchor bolt, while maintaining the anchor bolt in a true vertical orientation. Adjustable canister anchors shall be Jakebolts as manufactured by Unisorb, Heavy Duty Adjustable Anchors as manufactured by Deco, Rowan Adjustable Canister Anchor Bolt, or approved equal.
   4. Equipment anchor materials shall conform to the following table for the area exposure condition where the equipment is installed.

Area Exposure	Equipment Anchor Materials
Indoor, Dry	Carbon Steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod
Indoor, Wet	Galvanized Carbon Steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod
Outdoor	304 Stainless, ASTM F593, Cond. CW
Submerged, Immersed	316 Stainless, ASTM F593, Cond. CW
Process Corrosive	316 Stainless, ASTM F593, Cond. CW

B. Equipment Anchor Design:
   1. The size (diameter) of anchors for clamping/fastening mounting plates to equipment pads shall be as specified by the equipment manufacturer.
   2. Equipment anchor size, embedment, and edge distance shall comply with the International Building Code (IBC), 2018 Edition, and the "2015 Changes to the City of Prescott 2012 International Building Code," and shall be sufficient to resist the maximum lateral and vertical forces.
   3. The Contractor shall furnish equipment anchor calculation submittals for the Close-Coupled, Vertical, In-Line, Single-Stage Centrifugal Pumps. Equipment anchor calculations shall be furnished as product data and submitted with equipment submittals. Equipment anchor calculations shall be sealed by a registered structural or civil engineer licensed in the State of Arizona.

C. Equipment Anchor Tension:
   1. Unless alternate bolt torque/tension requirements are specified by the equipment manufacturer, equipment anchors shall be tightened to provide a final clamping force that produces a tensile stress of 15,000 psi in each equipment anchor. Adjustable canister anchors shall be tightened to the manufacturer's maximum safe working load. Equipment anchors consisting of post-installed anchors shall be tightened to manufacturer's recommendations.
   2. Bolt torque values required to produce the specified bolt tension based on well-lubricated, plain-finish, national coarse-thread bolts are presented in the following

table. Revise bolt torque values per equipment manufacturer's recommendations for alternate thread patterns, thread lubrication, bolt material, or bolt finish.

Bolt Diameter (inches)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Final Bolt Torque for 15,000-psi Bolt Stress (ft*lbs)	8	15	30	50	80	125	180	250	400

Note: ft*lbs = foot*pounds

3. Prior to leveling and grouting mounting plates, grouted equipment anchors shall be pull-tested to the values specified in the following table.

Anchor Diameter (inches)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Pull-Test Load (kips)	2.1	3.8	6.1	9.1	13	17	22	28	43

Note: kips = 1,000 pounds-force

D. Anchor Sleeves:

1. Equipment anchors shall be fitted with sleeves as specified in the Equipment Mounting Schedule. Sleeve length for equipment anchors shall be 15 times the bolt diameter, unless otherwise specified in the Equipment Mounting Schedule. Sleeves may be installed at the Contractor's option if not specified in the Equipment Mounting Schedule.
2. Adjust equipment anchor length/embedment depth shown in Standard Detail M7002.
3. Anchor sleeves shall be flexible polyurethane foam, steel cylinder/tubes, or ribbed plastic sleeves.
4. Fill steel cylinders/tubes and ribbed plastic sleeves with a flexible room-temperature vulcanizing (RTV) sealant prior to embedment/installation.

2.04 MOUNTING PLATES

A. General:

1. All baseplates, soleplates, and fabricated steel frames shall have edges of surfaces bearing on grout rounded to a radius of not less than 0.25-inch.
2. Perimeter corners of baseplates, soleplates, or fabricated steel frames shall be rounded to a radius of not less than 2.0 inches to avoid producing stress risers on the grouted foundation.
3. Grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2.5 inches in diameter for cementitious non-shrink grout) shall be provided in all baseplates and soleplates and all baseplates and soleplates shall have air-release holes.
4. Grout relief or vent holes (minimum 1 inch in diameter) shall be provided in all baseplates and soleplates.
5. Mounting holes for equipment anchors shall be drilled through baseplates, soleplates, and fabricated steel frames.
6. Mounting holes for equipment anchors shall be drilled. Mounting holes shall not be burned out and they shall not be open slots.

7. Terminations requiring connections to baseplates and soleplates shall be acorn nuts welded to the underside of the baseplate or soleplate or nuts welded to the underside of the baseplate or soleplate and plugged with cork, plastic plugs or grease.
8. Where fasteners terminate only into the baseplate, soleplate, or fabricated steel frame, threaded lengths (tapped or embedded in mounting plates) shall be not less than the bolt diameter.
9. Where baseplates, soleplates, or fabricated steel frames are leveled using jackscrews, jackscrew threads shall be tapped in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
10. Mounting pads and/or mounting surfaces for baseplates, soleplates, and fabricated steel frames shall be milled flat after all welding and stress relieving and shall be coplanar within 0.0005 inch per foot in all directions. Baseplates shall be pre-grouted prior to milling.
11. Baseplates, soleplates, and fabricated steel frames shall provide common support for the equipment and driver (and flywheel, if one is specified).
12. Baseplates, soleplates, and fabricated steel frames for equipment with drivers 20-horsepower and greater shall be furnished with transverse-alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates.
13. Alignment/positioning jackscrews shall be in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Additional jackscrews shall be provided for transverse alignment of the flywheel, if flywheels are specified in the equipment Specification.)
14. Where specified in individual equipment Specifications, baseplates, soleplates, and fabricated steel frames shall be fitted with RK Fixators as manufactured by Unisorb, or approved equal.
    a. Fixators shall be installed at mounting surfaces for drivers.
    b. Fixators shall be a three-piece wedge leveling-adjustment device incorporating a spherical washer assembly to provide true level height adjustment at each mounting surface for the equipment driver.

B. Fabricated Steel Frames:
1. Fabricated steel frames shall be plate or fabricated structural steel mounting plates with thickened steel mounting pads for bolting equipment to the mounting plate.
2. Fabricated steel frames shall be rectangular in shape, excepting fabricated steel frames for centrifugal refrigeration machines and pumps which may be T- or L-shaped fabricated steel frames to accommodate the equipment driver and accessories.
3. Fabricated steel frames for the pumps specified in Contract Documents shall include supports for suction and discharge elbows, if required by the specified configuration.
4. Perimeter members shall be I-beams or C-channel with a minimum depth equal to 1/10 of the longest dimension of the fabricated steel frame. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
5. Fabricated steel frames shall be furnished with mounting pads welded to the fabricated steel frame.

6. Surfaces of fabricated steel frames in contact with grout shall be sandblasted to white metal per Society for Protective Coatings (SSPC) SP-5.
7. Apply a high-strength epoxy primer as specified in paragraph 2.06 within 8 hours of sandblasting the fabricated steel frame.

C. Baseplates:
1. Baseplates shall be welded steel, cast steel, or cast iron with thickened mounting pads for bolting equipment to the baseplate.
2. Internal stiffeners shall be provided on all cast and fabricated baseplates and shall be designed to allow free flow of grout from one section of the baseplate to another.
3. The minimum acceptable opening in cross bracing and stiffeners shall be 2 inches high by 6 inches wide.
4. All welds shall be continuous and free from skips, blowholes, laps and pockets.
5. Baseplates shall be pre-grouted at the factory after all welding has been completed and prior to machining the mounting pads on the baseplate. Baseplates that have not been pre-grouted at the factory shall be pre-grouted in the field by removing the equipment from the baseplate, inverting the baseplate, and pre-grouting as specified in this section.
6. The underside of baseplates shall be sandblasted to white metal per SSPC SP-5 prior to pre-grouting.
7. Pre-grouting shall be completed within 8 hours of sandblasting.
8. Pre-grouting shall fill the underside of the baseplate to the bottom edges of the baseplate.
9. Cast iron baseplates shall be sealed to prevent surface bleeding prior to shipment to the Project site.

D. Plate Steel Soleplates:
1. Plate steel soleplates shall be not less than 1.0-inch thick for equipment with drivers greater than 30-horsepower.
2. Plate steel soleplates shall be furnished with grout keys/lugs or stiffeners on the underside of the soleplate.
3. Excepting grout keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.) the underside of plate steel soleplates shall be a flat uniform horizontal surface.
4. The underside of plate steel soleplates shall be scribed with the words “THIS SIDE DOWN” using welding rod material prior to milling the mounting pads for equipment or mounting surfaces.
5. Plate steel soleplates without grout pouring holes are acceptable provided that no dimension of the soleplate (width or length) exceeds 18 inches.
6. Surfaces of plate steel soleplates in contact with grout shall be sandblasted to white metal per SSPC-SP-5 prior to shipment to the Project site.
7. Apply a high-strength epoxy primer as specified in paragraph 2.06 within 8 hours of sandblasting the underside of plate steel soleplates.
8. Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom-suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of mounting on a common equipment pad and soleplate. In such instances, the

equipment shall be supported at the feet or mounting surfaces on individual plate steel soleplates, which shall be leveled and grouted into place on the individual piers or equipment pads as specified in this section. Where multiple soleplates are installed for an equipment installation, soleplates shall be installed coplanar within 0.002-inch/foot.

E. Polymer Concrete Soleplates:
   1. Polymer concrete soleplates shall be pre-cast soleplates consisting of polymer concrete with stainless steel inserts for equipment mounting.
   2. Mounting surfaces on polymer concrete soleplates shall be coplanar within 0.002-inch/foot. Polymer concrete soleplates shall be furnished with a uniform horizontal surface over the entire underside of the mounting plate.
   3. Excepting grout keys, grout pour holes and vent holes, the underside of soleplates shall provide a flat, uniform, horizontal surface.
   4. Polymer concrete soleplates shall be PoxyBase as manufactured by Basetek, Chembase as manufactured by Goulds, or approved equal.

F. Corrosion-Resistant Fiberglass Reinforced Plastic (FRP) Baseplates:
   1. Corrosion-resistant FRP baseplates shall be pre-formed FRP fabrications.
   2. Corrosion-resistant FRP baseplates shall be products of the manufacturer of the equipment that are mounted on the baseplate.

2.05 GROUT FOR EQUIPMENT PADS

A. Epoxy Grout for Equipment Mounting:
   1. Where epoxy grout is specified in the Equipment Mounting Schedule, grout for setting bearing surfaces of baseplates, soleplates, and fabricated steel frames on equipment pads shall be Epoxy Grout for Equipment Mounting as specified in Section 03 60 00. Where the term epoxy grout is used in the context of Details and Specifications for equipment mounting it shall mean epoxy grout for equipment mounting as specified in Section 03 60 00.

B. Cementitious Non-shrink Grout:
   1. Where non-shrink grout is specified in the Equipment Mounting Schedule, cementitious non-shrink grout, specified in Section 03 60 00, may be used for setting bearing surfaces of baseplates, soleplates, or fabricated steel frames. Where the term non-shrink grout or cementitious grout is used in the context of Details and Specifications for equipment mounting it shall mean cementitious non-shrink grout as specified in Section 03 60 00. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

2.06 EPOXY PRIMER

A. Epoxy primer shall be a high-strength, lead-free, chrome-free, and rust-inhibiting two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer's bond strength to sandblasted metal shall not be less than 1,500 psi. Epoxy primer shall be Phillybond Phillyclad 1000 Series, or approved equal.

2.07 ANTI-SEIZE/ANTI-GALLING COMPOUND

A. Anti-seize or anti-galling compound shall be a molybdenum disulfide and graphite combination in aluminum complex base grease conforming to MIL-PRF-907E. Acceptable products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or approved equal.

2.08 PRODUCT DATA

A. The following information shall be provided in accordance with the product data requirements specified in Section 01 33 00:
   1. Equipment anchor calculations demonstrating compliance with paragraph 2.03.
   2. Results of grout strength tests, as specified in paragraph 3.03.
   3. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (43 05 13-A), as specified in paragraph 3.02.
   4. List of Contractor's equipment installation staff that has completed epoxy grout manufacturer's grout installation training specified in paragraph 3.02.

PART 3 EXECUTION

3.01 GENERAL

A. General Requirements:
   1. Roughen the underside of soleplates and fabricated steel frames and wipe with a residue-free solvent as recommended by the epoxy primer manufacturer before placement of the baseplate, soleplate, and fabricated steel frames on the equipment pad for leveling. Roughen surfaces of mounting plates that will be in contact with grout by power-tool cleaning. Cleaning shall be performed by power-wire brushing, power sanding, power grinding, power-tool chipping or power-tool descaling. Cleaning shall impart a minimum profile of 1.0 mil.
   2. Prior to placement on the equipment pad for leveling, exposed grout surfaces of pre-grouted baseplates shall be roughened and wiped with a residue-free solvent as recommended by the manufacturer of the epoxy grout used for pre-grouting.
   3. Prepare the underside of corrosion-resistant FRP baseplates and polymer concrete baseplates per the baseplate manufacturer's recommendations prior to placement of the baseplate on the equipment pad for leveling.
   4. Grout for equipment mounting shall be as specified in the Equipment Mounting Schedule.
   5. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems.
   6. Unless the Construction Manager accepts an alternate installation procedure in writing, baseplates, soleplates, and fabricated steel frames shall be leveled and grouted with the equipment removed.
   7. Pumps shall be installed in accordance with this section and American National Standards Institution/Hydraulics Institute (ANSI/HI) 1.4 or ANSI/HI 2.4, as appropriate for the type of pumping equipment installed.
   8. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended function of these joints is maintained in the piping system without imposing strain on the equipment connections.

B. Alternate Piping Connections:

1. Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, the Contractor shall delete any flexible coupling (including equipment-connection fittings) shown on the Drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:
    a. The equipment pad shall be installed as shown on the detail specified in the Equipment Mounting Schedule.
    b. The baseplate, soleplate, or fabricated steel frames supporting the equipment shall be installed, leveled, and grouted in place as specified in this Section.
    c. The piping shall be installed and aligned to the equipment connections and the field-piping connections without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints shall be bolted-up and pressure-tested.
    d. All piping shall be fully supported by supports designed to accept their full weight and thrust forces.
    e. The final sections of piping shall be aligned with the equipment and field connections without the use of jacks, chain falls, or other devices to force it into alignment.
    f. The final piping joints shall be welded only after the previous steps have been completed and accepted by the Construction Manager.

3.02 EPOXY GROUT TRAINING AND QUALITY CONTROL

A. Epoxy Grout Training:

1. Prior to commencing rigid equipment mount installation work on equipment pads, the Contractor shall furnish the services of a grout manufacturer's technical representative to conduct a training school for the workers who will be using epoxy grout for rigid equipment mount installations. The school shall be not less than 4 hours in length and shall cover all aspects of using the products, including form construction for each equipment installation, surface preparation, mixing, application, void prevention/elimination, and cleanup. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. The epoxy grout manufacturer shall furnish a list of school attendees who have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

B. Epoxy Grout Quality Control:

1. For equipment mounted with epoxy grout, the epoxy grout manufacturer's technical representative shall provide quality-control services for epoxy grout installation in rigid equipment mounts. The epoxy grout manufacturer's technical representative shall be on site to inspect and verify that the installation personnel have successfully performed surface preparation, epoxy grout application, and quality control inspection in accordance with these Specifications for a representative portion of the epoxy grout installation work.
2. Specifically, the epoxy grout manufacturer's technical representative shall perform the following services for at least one rigid equipment mount installation for each equipment type and size installed with epoxy grout:

a. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
b. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
c. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
d. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
e. Inspect preparation and application of epoxy grout form work for conformance to the Specifications.
f. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
g. Inspect epoxy grout for cure.
h. Inspect and record that localized repairs made to grout voids conform to the Specification requirements.
i. Conduct a final review of completed epoxy grout installation for conformance to these Specifications.
j. Attest to conformance of the Contractor's work by signing appropriate entries in the "Rigid Equipment Mount Inspection Checklist," Form 43 05 13-A in Section 01 99 90.

3.03 INSTALLATION

A. Concrete Equipment Pad Preparation:
1. Roughen the top of the equipment pad after the concrete has reached its 28-day compressive strength.
2. Remove all laitance and defective or weak concrete.
3. Roughened surface profile shall be 0.25-inch amplitude, minimum.
4. Expose broken aggregate without dislodging unbroken aggregate from the cement matrix and without fracturing concrete and aggregate below the concrete surface.
5. Roughen using a light-duty (15 pounds or less), hand-held chipper with a chisel-type tool.
6. Abrasive-blast, bush-hammer, jack-hammers with sharp chisels, heavy chipping tools, or needle-gun preparation of concrete surfaces to be grouted are not acceptable.
7. Demonstrate removal of defective or weak concrete to the Construction Manager prior to leveling.
8. The chipped surface of the concrete shall be such that the final elevation of the equipment pad provides the grout manufacturer's recommended thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate, or underside of the fabricated steel frame.
9. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the surface protected with plastic sheeting until grout is installed.
10. Concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions shall be protected from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Leveling positions shall be restored by installing leveling blocks or leveling plates for

jackscrews on a high compressive-strength epoxy putty (Philadelphia Resins, Phillybond Blue 6A, or equal). Leveling blocks and leveling plates shall be installed level on the epoxy putty.

B. Leveling:
   1. Except where union rules require installation by another trade, all equipment and machinery shall be mounted and leveled by a Qualified Millwright.
   2. Use precision surveying equipment for leveling.
   3. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or fabricated steel frame with a plan dimension greater than 4 feet.
   4. Baseplates, soleplates, and fabricated steel frames shall be leveled to the tolerance specified in the Equipment Mounting Schedule or as otherwise required by the equipment manufacturer, if more stringent.
   5. An anti-seize or anti-galling compound specified in paragraph 2.07 shall be applied to all equipment anchor threads prior to beginning baseplate, soleplate, or fabricated steel frame leveling.
   6. All baseplates, soleplates, and fabricated steel frames shall be leveled against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited.
   7. Leveling equipment and tools shall be stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates.
   8. Leveling nuts may be used for leveling baseplates, soleplates, and fabricated steel frames weighing less than 200 pounds (including the weight of the equipment if leveled with the equipment on the mounting plate).
   9. Leveling blocks shall be stainless steel, 4 inches square and 1.5 inches thick with an open-ended slot terminating in the center for the equipment anchor.
   10. Leveling blocks shall be machined flat on all horizontal surfaces and placed under the baseplate or soleplate at each equipment anchor.
   11. Shims shall be pre-cut stainless steel, slotted for removal after grouting. Leveling blocks and shims shall be coated with a light oil just prior to beginning the leveling and grouting work. Shims shall be placed so the tabs on the shims are easily accessible.
   12. Clamp baseplates, soleplates, or fabricated steel frames in position (after leveling) by installing the equipment anchor nuts and washers.
   13. Bolt tension to fix the position of mounting plates during grouting shall be 30 to 60% of the final clamping force applied to clamp the mounting plate to the equipment pad.
   14. Prior to grouting, verify that the correct level and position of the baseplate, soleplate, or fabricated steel frame has been maintained after clamping it to the equipment pad.

C. Grouting:
   1. Design forms for a minimum of 6 inches hydrostatic head above the final elevation of the grout.
   2. Install grout expansion joints at 4- to 6-foot intervals, perpendicular to the centerline of baseplates. Design expansion joints in accordance with the grout manufacturer's written instructions.

3. Coat forms with three coats of paste wax on all areas of the forms that will be in contact with the grout.
4. Wax forms before assembly.
5. Prevent accidental application of wax to surfaces where the grout is to bond.
6. Remove any foreign material, such as oil, sand, water, wax, grease, etc. from concrete surfaces that will contact grout before forms are installed.
7. Forms shall be liquid-tight. Seal any open spaces or cracks in forms, or at the joint between forms and the foundation using sealant, putty, or caulking compound.
8. Vertical and horizontal edges of the grout shall have 45-degree chamfers as specified in equipment pad details. The 45-degree perimeter chamfer strip shall be located at the final elevation of the grout.
9. Match chamfers in concrete portions of the equipment pad.
10. Install block-outs at all leveling positions to allow removal of leveling equipment and leveling nuts to be backed off after the grout has cured.
11. Coat jackscrews with a light oil or other acceptable bond-breaking compound prior to grouting.
12. Final elevation of grout on fabricated steel frames shall be at the top of the lower flange of the perimeter I-beams or C-channel.
13. Top of grout elevation for baseplates and soleplates shall be at least 0.125-inch but not more than 0.5-inch above the bottom or underside of the perimeter edge of the baseplate or soleplate.
14. Seal equipment anchor sleeves to protect the sleeved length of the anchor from contact with grout.
15. Wrap exposed portions of equipment anchors with duct tape to protect them from grout splatter and to prevent bonding to grout.
16. Adjust ambient temperature to maintain mounting plate, foundation, and grout temperatures to grout manufacturer's recommended temperature.
17. Mix grout for equipment mounting in accordance with the grout manufacturer's written recommendations.
18. Epoxy grout shall be placed in a manner that avoids air entrapment, using a head box to pour grout into the grout holes.
19. Place grout at one end of the baseplate or soleplate and work grout toward the opposite end to force the air out from beneath the baseplate or soleplate.
20. Pour grout through a head box into grout pouring holes.
21. When the head box is moved to the next grout hole, a 6-inch standpipe shall be placed over the grout hole and filled with grout.
22. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.
23. Never allow the grout in the head box to fall below the top of the baseplate or soleplate once the grout has made contact with the baseplate or soleplate.
24. Grout placement shall be continuous until all portions of the space beneath the baseplate, soleplate, or fabricated steel frame have been filled.
25. Prepare subsequent batches of grout prior to depleting the preceding batch.
26. Maintain grout height in standpipes after the space under the baseplate, soleplate, or fabricated steel frame has been filled.

27. When the grout has started to take an initial set (typically this is determined by a noticeable increase in temperature and no flow of grout at the vent holes) the standpipes shall be removed and excess grout cleaned from all surfaces.
28. Check for leaks throughout grout pours. Leaks shall be repaired immediately to prevent formation of voids.
29. Check baseplate, soleplate, or fabricated steel frame level and elevation before the grout sets.
30. Cure grout in accordance with the grout manufacturer's written instructions.
31. Where specified in the individual equipment specifications, a grout sample shall be taken for each equipment pad.
    a. Samples shall be placed in a cylinder of sufficient size to yield three 2-inch cubes as test samples.
    b. Samples shall be tagged with Project name, date, time, the equipment number, and ambient temperature at the time of placement.
    c. Place samples next to the foundation of the equipment being grouted and cure for 48 hours.
    d. Test grout samples in accordance with the grout manufacturer's recommendations.
    e. Grout samples shall be tested by the independent testing laboratory specified in paragraph 1.02.
    f. Test results shall be reported directly to the Construction Manager.

D. Completion:
1. Upon acceptance by the Construction Manager and the equipment manufacturer's representative and after the grout has reached sufficient strength, grout forms and block-outs at leveling positions shall be removed. Leveling blocks and shims or wedges and support plates shall be removed, and leveling nuts and jack screws shall be backed off to allow the grout to fully support the baseplate, mounting block, or soleplate. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.
2. The equipment anchor nuts shall be tightened, using calibrated indicating torque wrenches, to develop the full bolt tension specified in paragraph 2.03.
3. Equipment anchor nuts shall be tightened in increments of not more than 25% of the final torque value in an alternating pattern to avoid stress concentration on the grout surface. After tightening equipment anchor nuts to final values, apply additional wax, grease, or mastic to all exposed portions of the equipment anchor beneath the baseplate, soleplate, or mounting block.
4. After applying additional wax or mastic to exposed portions of equipment anchors, block-outs (pockets) for access to leveling nuts, leveling blocks and shims, or wedges shall be filled with the grout material installed under baseplates, soleplates, or fabricated steel frames and pointed after the equipment anchor nuts have been tightened to final values. Jackscrews shall be removed and holes in the baseplate, soleplate, or fabricated steel frames filled with a flexible sealant (silicone rubber) or a short cap screw.
5. Check for baseplate, soleplate, or fabricated steel frame movement (soft foot) by individually loosening and re-tightening each equipment anchor. Vertical movement at each equipment anchor shall be measured and recorded during loosening and retightening and shall not exceed 20 micrometers (0.001-inch). Vertical movement

shall be measured using a magnetic-based dial indicator on the baseplate, soleplate, or fabricated steel frame referenced to the epoxy grout surface of the equipment pad or other approved method. Soft foot conditions shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or fabricated steel frames.

6. Check for grout voids by tapping along the upper surfaces of the baseplate, soleplate, or mounting block. Grout voids shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or fabricated steel frames. Grout voids shall be marked. At the discretion of the Construction Manager, grout voids may be repaired as specified in Chapter 5, Section 3.16 of the American Petroleum Institute (API) RP 686.

3.04 FINAL INSPECTION

A. The Construction Manager will conduct a final inspection with the Contractor for conformance to requirements of this Section.

END OF SECTION

SECTION 43 05 21

COMMON MOTOR REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Squirrel-cage type, AC induction motors, up to 500-horsepower (HP), for 2 to 4 poles (3,600 or 1,800 revolutions per minute (rpm) nominal), or up to 250-HP for 6 poles (1,200 rpm) shall be per National Electrical Manufacturers Association (NEMA) MG1.

1.02 RELATED SECTIONS

A. This Section contains specific references to the following related Sections. Additional related Sections may apply that are not specifically listed below.

1. Section 26 29 23

1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
IEEE 112	Standard Test Procedures for Polyphase Induction Motors and Generators
IEEE 841	Standard for Petroleum and Chemical Industry- Premium-Efficiency, Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 500 HP
NEMA ICS 2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA MG 1	Motors and Generators
Department of Energy	Energy Policy and Conservation Act, Final Rules EERE-2010-BT-STD-0027-0117
UL 1004	Electric Motors

1.04 DEFINITIONS

A. Terminology used in this section conforms with NEMA MG-1. Motors covered in this specification are those defined in NEMA MG1 as small (fractional) and medium (integral) AC induction motors.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility: Where unit responsibility is specified in the driven-equipment sections of these Specifications, the motor supplier shall coordinate with the provider of

the driven equipment to verify that the motor provided under this Section is fully compatible with and meets the specified performance requirements for that equipment.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00.
   1. Action Submittals – Product Information:
      a. Copy of this Section, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks (✓) to denote full compliance with a paragraph as a whole. Underline deviations and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification Sections with justification(s) for any requested deviation will cause rejection of the entire submittal with no further consideration.
      b. Motor Data Sheets specified in this section and Division 01.
         1) Motors in conformance with Institute of Electrical and Electronics Engineers (IEEE) 841: Manufacturers to complete IEEE Standard 841 Data Sheet for AC induction motors.
         2) Motors not in conformance with IEEE 841: Motor supplier to complete Form 43 05 21-A in Section 01 99 90 with required factory data.
      c. Motor mounting, outline, dimensions, and weight.
      d. Motor-winding temperature devices, where specified.
      e. Motor-winding space heaters, where specified.
      f. Motor nameplate data.

B. Informational Submittals:
   1. Submittal requirements for operation and maintenance (O&M) manuals as per requirements of Section 01 78 23.

1.07 QUALITY ASSURANCE

A. Factory Testing:
   1. All polyphase motors shall be factory-tested in conformance with routine tests per NEMA MG1 and IEEE 112. Provide the following tests:
      a. Measurement of winding resistance.
      b. No-load readings of current and speed at normal voltage and frequency.
      c. Current input at rated frequency with rotor at standstill.
      d. High-potential test.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:

1. Baldor.
2. General Electric.
3. Siemens.
4. US Motors.
5. WEG.
6. Approved Equal.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions:
   1. Temperature: -25°C to +40°C.
   2. Altitude: 5,570 feet above sea level.
   3. Derate motors for higher ambient temperature and for higher altitude with motor size based on brake-horsepower.

B. Design Requirements:
   1. Operation: Continuous.
   2. Compliance: Energy Policy Act of 1992 (EPAct), Final Rule 2014.
   3. Tolerance: +/- 10% of rated voltage at rated frequency; +/- 5% of rated frequency at rated voltage.
   4. Standard design: NEMA Design B.

C. Service Factor (percent of additional HP):
   1. 1.15 for sine-wave motors.
   2. 1.0 for inverter-duty motors.

D. Motor Efficiency:
   1. NEMA Premium™ efficiency electric motor, single-speed, polyphase, 1 to 500 HP, 3,600 rpm, 2-pole, 1,800 rpm, 4-pole, and 1,200 rpm, 6-pole (1 to 250 HP), squirrel-cage induction motors, NEMA Design B, continuous-rated. NEMA Standards Publication MG 1 2011, in Table 12-12.

Table 12-12
Full-Load Efficiencies for 60-HZ Premium Efficiency Electric Motors
Rated 600-Volts or Less (Random Wound)

Open Motors								
HP	2-Pole		4-Pole		6-Pole		8-Pole	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.5	84	81.5	86.5	84.0	86.5	84.0	77.0	74.0
2	85.5	82.5	86.5	84.0	87.5	85.5	86.5	84.0
3	85.5	82.5	89.5	87.5	88.5	86.5	87.5	85.5
5	86.5	84.0	89.5	87.5	89.5	87.5	88.5	86.5
7.5	88.5	86.5	91.0	89.5	90.2	88.5	89.5	87.5
10	89.5	87.5	91.7	90.2	91.7	90.2	90.2	88.5

Table 12-12
Full-Load Efficiencies for 60-HZ Premium Efficiency Electric Motors
Rated 600-Volts or Less (Random Wound)

Open Motors								
HP	2-Pole		4-Pole		6-Pole		8-Pole	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
15	90.2	88.5	93.0	91.7	91.7	90.2	90.2	88.5
20	91.0	89.5	93.0	91.7	92.4	91.0	91.0	89.5
25	91.7	90.2	93.6	92.4	93.0	91.7	91.0	89.5
30	91.7	90.2	94.1	93.0	93.6	92.4	91.7	90.2
40	92.4	91.0	94.1	93.0	94.1	93.0	91.7	90.2
50	93.0	91.7	91.5	93.6	94.1	93.0	92.4	91.0
60	93.6	92.5	95.0	94.1	94.5	93.6	93.0	91.7
75	93.6	92.4	95.0	94.1	94.5	93.6	94.1	93.0
100	93.6	92.4	95.4	94.5	95.0	94.1	94.1	93.0
125	94.1	93.0	95.4	94.5	95.0	94.1	94.1	93.0
150	94.1	93.0	95.8	95.0	95.4	94.5	94.1	93.0
200	95.0	94.1	95.8	95.0	95.4	94.5	94.1	93.0
250	95.0	94.1	95.8	95.0	95.8	95.0	95.0	94.1

2.03 MATERIALS

A. Motor Frames:
   1. Totally enclosed fan-cooled (TEFC) motors shall be cast-iron.
   2. Aluminum frame motors are not permitted.

B. Stator Windings:
   1. Shall be copper with Class F minimum insulation not to exceed Class B temperature rise of 80°C at rated load and with Design B torque/current characteristics for all medium (integral) motors.
   2. Small (fractional) motors shall be supplied with Class F insulation where available.

C. Rotor material shall be aluminum or copper.

D. Fans shall be non-sparking fan blades.

E. Motor leads shall be non-hygroscopic.

2.04 MOTOR TYPES

A. General Requirements for Motors 1/2-HP through 500-HP:
   1. Three-phase, squirrel-cage, with copper windings.
   2. Rated for full-voltage starting and continuous-duty.
   3. Rating shall be:
      a. 460/230-volt, three-phase, 60-Hertz (Hz), as shown on the Contract Drawings.

4. General-purpose type motors, which may also be called Type 1 per the project equipment Specifications shall be:
    a. Open drip-proof motors shall be as defined per NEMA MG1, self-cooled by convection air.
5. Severe-duty type motors, which may also be called Type 2 per the project equipment Specifications, shall be in accordance with IEEE 841.
    a. TEFC shall be defined per NEMA MG1.
    b. Enclosure: TEFC with external fan blowing air to the motor frame cooling fins for cooling.
    c. Applications: Severe-duty and most outdoor installations.

B. Motors Less than 1/2 HP:
1. Type shall be:
    a. Squirrel-cage, capacitor-start with Class F insulation and copper windings.
    b. Fan motors rated 1/8 HP or less: split-phase or shaded-pole type.
2. Rating shall be:
    a. 115-volt, single- phase, 60-Hz.
    b. 208-volt, single-phase, 60-Hz.
    c. 230-volt, single-phase, 60-Hz.

2.05 COMPONENTS

A. Inverter-Fed Polyphase Motors per NEMA MG1 Part 31:
1. Applications: Variable-torque or constant-torque loads, for vertical or horizontal motors with variable-frequency drive (VFD) controllers.
2. Features shall include:
    a. Insulation design to meet 2000-volt peak at a minimum of 0.1 micro-second rise time;
    b. Built-in motor winding protection as specified;
    c. Electrically insulated bearings; or
    d. Provide Electro Static Technology's AEGIS Shaft Grounding Ring for Bearing Protection, or equal. The shaft-grounding ring shall be solidly bonded per manufacturer's recommendations.

B. Vertical Motors:
1. Features: Inverter duty or non-inverter duty with solid-shaft P-base and high-thrust bearing compatible with loads imposed by the driven equipment.

C. Thermal Protection:
1. Inverter duty motors:
    a. Motors larger than 50 HP up to and including 250 HP:
        1) Protection to be NEMA Type 2 bi-metallic thermal switch (Klixon) type.
        2) Motor nameplate: Marked "OVER TEMP PROT 2" in accordance with NEMA MG 1 12.43.

D. Motor Nameplates:
   1. Materials: Engraved or stamped stainless steel.
   2. Features shall be as follows:
      a. NEMA Standard MG 1 motor data.
      b. Permanently fastened to the motor frame.
      c. American Bearings Manufacturers Association (ABMA) bearing identification number for motors meeting IEEE 841.
      d. NEMA nominal efficiency for all motors.
      e. NEMA nominal and minimum efficiency for motors meeting IEEE 841.
      f. Underwriters Laboratories (UL) frame temperature limit code for explosion-proof motors.
      g. Space heater data.
      h. Over-temperature protection type number.
      i. Temperature device rating and alarm and shutdown setpoint.

E. Conduit Boxes:
   1. Provide oversized boxes, with split construction with threaded hubs and petroleum-resistant gaskets.
   2. Conduit boxes can be rotated in order to permit installation in any of four positions 90 degrees apart.
   3. Provide grounding lug located within the conduit box for ground connection.
   4. Provide separate conduit boxes for temperature devices and space heaters.
   5. Separate terminal box for any signal leads (resistant temperature detection [RTD], thermistor, vibration transmitter, etc.).

F. Bearings:
   1. Provide grease-lubricated ball bearings, angle-contact roller bearings for axial thrust loads, and cylindrical bearings for radial-only loads.
   2. Rated for a minimum L-10 life of 50,000 hours for direct-connected loads.
   3. Cartridge-type bearings will not be accepted.
   4. Fitted with lubricant fill and drain or relief fittings.
   5. Belt loads not to exceed forces calculated from NEMA MG 1 Tables 14-1 and 14-1A.

G. Bearing lubrication shall be either grease or oil as per the requirements in either 1 or 2:
   1. Grease-lubricated bearings:
      a. Shall be for electric motor use only.
      b. Grease shall be capable of higher temperatures associated with electric motors and shall be compatible with polyurea-based greases.
      c. Provide grease fittings, similar to Alemite™ type (or equivalent).
      d. Shielded bearings with regreasable provisions are permissible.
   2. Provide oil-lubricated bearings with externally visible sight glass to view oil level.

H. Lifting Eyes:
   1. Provide lifting eyes with a safety factor of 5.
   2. Provide one lifting eye for motors more than 50 pounds.

3. Provide two lifting eyes for motors over 150 pounds.

I. Winding space heaters when specified or shown:
   1. Provide winding space heaters to prevent condensation.
   2. Rating: 120-volt, single-phase, 60-Hz.
   3. Motor nameplate to show space heater rating in watts and volts.
   4. Provide terminal block in motor conduit box for heater leads termination.

2.06 FINISHES

A. Paint Finish:
   1. Provide standard manufacturer paint finish.
   2. Provide motors with semi-gloss finish, scratch- and heat-resistant electric motor paint.

PART 3 EXECUTION

3.01 EXAMINATION

A. Delivery Inspection:
   1. Inspect driven equipment motor assembly and components immediately upon delivery and unloading at the jobsite for damages.
   2. Take photos of damage(s), if any, to substantiate the Delivery Inspection Report.

3.02 INSTALLATION

A. Grounding of Motors:
   1. Connect the motor feeder ground cable (green) to the grounding lug terminal in the conduit terminal box.

B. Supplemental Grounding of Motors: Provide for motors fed from VFDs and all motors above 10 HP.
   1. Bond the motor frame to the grounding grid/electrode system to provide supplemental grounding.

C. Field-Coating of Motors:
   1. Refer to the Section 09 90 00 for coating requirements.

3.03 FIELD QUALITY CONTROL

A. Field Testing:
   1. Measure winding-insulation resistance of motors to no less than 10-megohm with a 1000-vac megohmmeter.
   2. Perform motor-phases current-imbalance testing for motors 20 HP and larger.
   3. Test motors for proper rotation prior to connection to the driven equipment.

B. Field Inspection:
   1. Compare equipment nameplate data with Drawings and Specifications.
   2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.
4. Verify the installation of breather/drain fittings as specified herein.
5. Check for proper connections of space heaters, winding and RTDs and/or thermostats.
6. Visually check for correct phase and ground connections:

C. Manufacturer Services: Provide where specified or shown on the Drawings.
1. Provide services to the driven-equipment manufacturer for the inspection and certification of the installation of the motor-driven equipment.
2. Provide assistance in the startup and operational testing of the motor-driven equipment.

3.04 SYSTEM STARTUP

A. Commissioning Test: Provide where specified or shown on the Drawings.
1. Provide assistance during the commissioning test of the motor-driven equipment.

3.05 CLOSEOUT ACTIVITIES

A. Operation and Maintenance (O&M):
1. Provide the O&M manual of the motor(s). Include testing result information in the O&M manual.

END OF SECTION

SECTION 43 23 03

GENERAL REQUIREMENTS FOR CENTRIFUGAL AND AXIAL-FLOW PUMPING EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This Section provides minimum requirements applicable to centrifugal pumping equipment furnished under this Contract. More restrictive requirements, where found in individual pump Specifications, supersede requirements of this Section.
2. "Detailed pump Specification," "detailed Specification," "individual pump Specification," "referencing section," or words of similar import in this Section, mean the Specification Section where the requirements for specific pump performance are presented. "Pumping unit," whenever and wherever used, means the complete pumping assembly, including driver (whether engine, turbine, or motor) and includes accessories such as variable-speed drives required for motor operation, gear reducers, intermediate shafting and bearings, flywheels, and supports for equipment furnished with the pump.

B. Definitions:

1. The following definitions apply for classifying pumps specified in this and referencing sections:
   a. General: Terminology and definitions in this section follow those established in American National Standards Institute/Hydraulic Institute (ANSI/HI) 9.1 through 9.5, unless otherwise noted.
   b. Clear liquids: Liquids to be pumped mostly free of deleterious solids. Potable water, heat reservoir, raw water, secondary effluent pumping, and similar services are clear liquids.
   c. Efficiency: For the purposes of this section and sections referencing this Section, efficiency, as related to pumps, is the ratio of the pump output power (water horsepower [hp]) divided by the pump input power (brake hp) required to deliver the total head, with meanings as defined in ANSI/HI 1.2.3.8 and ANSI/HI 2.2.3.8.
   d. Net positive suction head, 3% reduction (NPSH3): For the purposes of this Section and Sections referencing this Section, NPSH3 means the value of NPSH resulting in a reduction of 3% in the developed pump discharge head when the pump is tested in accordance with procedures established by ANSI/HI. NPSH3 is the successor designation to net positive suction head required (NPSHR). Where NPSHR is used in the Contract Documents it means NPSH3.
   e. NPSH margin: For the purposes of this Section and Sections referencing this Section, "NPSH margin," wherever used, means net positive suction head available (NPSHA) divided by the candidate pump's NPSH3 for the specific operating condition in question.
   f. POR: Preferred operating region as defined in ANSI/HI 9.6.3.
   g. AOR: Allowable operating region as defined in ANSI/HI 9.6.3.

1.02 NOT USED

1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section and any referencing Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. The following order of precedence prevails in the event of conflict between the requirements of this Section or any referencing Section and those of the listed documents (in the order of primacy):
   1. The referencing Section.
   2. This Section.
   3. The referenced document.

B. Unless otherwise specified, references to documents mean the documents in effect at the time of advertisement for bids or invitation to bid (or on the effective date of the agreement if there were no bids). References to documents mean the replacement documents issued or otherwise identified by the organization if referenced documents have been discontinued, or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
AISC	American Institute of Steel Construction – Manual of Practice
ANSI/API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries (also referenced as ISO 13709-2009)
ANSI/ASME B46.1	Surface Texture, Surface Roughness, Waviness and Lay
ANSI/HI 1.1–1.6	Rotodynamic (Centrifugal) Pumps
ANSI/HI 2.1–2.4	Rotodynamic (Vertical) Pumps
ANSI/HI 9.1–9.5	Pumps – General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation
ANSI/HI 9.6.1	Rotodynamic Pumps – Guideline for NPSH Margin
ANSI/HI 9.6.2	Centrifugal and Vertical Pumps for Allowable Nozzle Loads
ANSI/HI 9.6.3	Rotodynamic Pumps (Centrifugal and Vertical) Guideline for Allowable Operating Region
ANSI/HI 9.6.4	Rotodynamic Pumps – Vibration Measurements and Allowable Values
ANSI/HI 9.6.6	Rotodynamic Pumps for Pump Piping
ANSI/HI 9.6.8	Rotodynamic Pumps – Guideline for Dynamics of Pumping Machinery
ANSI/HI 9.8	Pump Intake Design
ANSI/HI 11.6	Submersible Pump Tests
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
API 686/PIP REIE 686	Recommended Practices for Machinery Installation and Installation Design
ASME B18.8.2	Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series)
ASME Code	ASME Boiler and Pressure Vessel Code
ASTM A27	Steel Castings, Carbon, for General Application
ASTM A36	Carbon Structural Steel

Reference	Title
ASTM A148	Steel Castings, High Strength, for Structural Purposes
ASTM A322	Steel Bars, Alloy, Standard Grades
ASTM A564	Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A571	Austenitic Ductile Iron Castings for Pressure-Containing Parts Suitable for Low-Temperature Service
ASTM A744	Quality Standards for Steel Castings
ASTM A995	Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts, Grades 2A, 3A, or 6A
ASTM B148	Aluminum-Bronze Sand Castings
ASTM B505	Copper Alloy Continuous Castings
ASTM B584	Copper Alloy Sand Castings for General Applications
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
NSF/ANSI 61	Drinking Water System Components – Health Effects
IEC 61298-2	Process Measurement and Control Devices. General Methods and Procedures for Evaluating Performance Tests Under Reference Conditions
ISO 1940-1:2003	Mechanical Vibration – Balance Quality Requirements for Rotors in a Constant (Rigid) State—Part 1: Specification and Verification of Balance Tolerances
ISO 9001	Quality Management Systems – Requirements, 3rd Edition (2000)
ISO 10816-1	Mechanical Vibration – Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 1: General Guidelines, Annex B, Table B.1. Class I, II or II, as applicable. For the purposes of this Specification, Annex B of ISO 10816, Part 1 forms a part of this Specification and ISO 10816, Part 1.
ISO 10816-3	Mechanical Vibration – Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 3: Industrial Machines with Nominal Power above 15 kW and Nominal Speeds between 120 r/min and 15000 r/min when Measured In situ, Annex A, Table A.1 and A.2. For the purposes of this Specification, Annex A of ISO 10816, Part 3 forms a part of this Specification and ISO 10816, Part 3.
ISO 10816-6	Mechanical Vibration – Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 6: Reciprocating Machines with Power Ratings above 100 kW, Annex A, Table A.1, Machine Vibration Classification Number 3. For the purposes of this Specification, Annex A of ISO 10816, Part 6 forms a part of this Specification and ISO 10816, Part 6.
ISO 10816-7	Mechanical Vibration – Evaluation Machine Vibration by Measurement on Non-rotating Parts—Part 7: Rotordynamic Pumps for Industrial Applications, Including Measurements on Rotating Shafts, Annex A, Tables A-1 and A-2 Category II as applicable. For the purposes of this Specification, Annex A of ISO 10816, Part 7 forms a part of this Specification and ISO 10816, Part 7.
MIL STD 167-2	Mechanical Vibrations of Shipboard Equipment (Reciprocating Machinery and Propulsion System and Shafting)

1.04 DESIGN REQUIREMENTS, ALL PUMPS

A. General:

1. Conform equipment furnished under Sections referencing this Section to the objective of paragraph 6.1.1, ANSI/API 610, and ensure that the equipment and “auxiliaries” are designed for at least a 20-year service life and 3 years of “uninterrupted operation.” Select all components associated with the rotating elements in the drive train, including equipment supports and supports for rotating elements, that are designed to function without damage or disassembly at reverse rotational speeds up to 130% of maximum operational speed during flow reversals through the pump. Ensure that the complete pumping unit operates without overload

on any component at any point along the pump's entire full-speed operating curve. Furnish pumps required by virtue of the specified operating conditions to operate against a closed valve or throttled for any period of time exceeding 5 seconds with drivers sized to operate continuously at the power requirement for that condition, even though the power requirements at the rated condition may be less.

2. Ensure that pump connection nozzles are designed for the loads and moments stipulated in ANSI/HI 9.6.2. Where ANSI/HI 9.6.2 does not cover a specific pump type or category, or where that document is silent on allowable nozzle loads or a particular type of nozzle load (e.g., thermal pipe strain), the Contractor shall furnish documentation from the manufacturer attesting to the limitations on loads and moment forces that can be tolerated on each connection and recommended connection details to be used.

B. Pump Selection:

1. Proven designs:
   a. Ensure that pumps furnished under Sections referencing this Section are proven designs that have been in similar conditions of service with no objectionable performance characteristics for a period of not less than 5 years. The Contractor shall furnish a detailed list of installations with contact information supporting qualification under this requirement with the information required under paragraph 1.08. To satisfy this requirement, ensure that the listed pump is of the same size volute or bowl, discharge case and nozzle size, and impeller design (including number of vanes) and is operating under similar conditions of pumped fluid, head, capacity, speed, rotation, and NPSHA.
2. General performance criteria:
   a. Ensure that pumps furnished under this Section and any referencing Section operate without loss of head due to cavitation or vibration over the entire specified range of flow and head conditions and are specifically selected for NPSH margin requirements detailed in paragraph 1.04. Pump selections that do not provide the specified margin will be rejected.
3. General design criteria:
   a. Select pumps furnished under Sections referencing this Section that are designed in accordance with applicable portions of ANSI/HI 1.1–1.4, 2.1–2.4, 9.6.2, 9.6.3, 9.6.4, 9.6.6, and 9.6.8 and the requirements of this Section. Select pumps that are specifically designed to pump the fluid described in the detailed Specification and to operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. Clogging or fouling conditions may be of any cause, demonstrated by a 5% or greater capacity drift within 2 hours of sustained operation.
   b. Unless otherwise noted or specified, slope pump head capacity curves in one continuous curve within the specified operating conditions. Pumps with head/capacity curves with a reverse inflection are specifically prohibited if these characteristics will cause unstable operation within the specified range of operating conditions and where startup/shutdown conditions entail operation against a slow opening/closing valve.
   c. Ensure that pumps specified to operate at variable-speed function without loss of head or capacity due to cavitation or excessive vibration over the entire specified range of flow and head conditions defined by the region bounded by Condition Points A, B, and C and any other continuous-duty operating condition specified in

the detailed Specification referencing this section. Ensure that unless otherwise specified in the Section referencing this Section, acceptance criteria include the following:

1) Ensure that Operating Condition Point C and any other continuous-duty operating point specifically required in the detailed specification reside within the region defined by the POR, or in a modified POR if stipulated in the detailed pump specification.
2) Unless otherwise noted in the detailed Specification referencing this Section, Operating Condition Point A must reside within the area defined by the POR; Condition Point C will be located within the POR, or in a modified POR if stipulated in the detailed pump Specification; and Condition B will preferably be located within the POR, or within 5 BEPQ percentage points (in terms of flow) outside the POR so long as Condition Point C resides in the POR or the stipulated modified range.

4. POR:
   a. Unless otherwise specified, the POR for a given pump is as defined in ANSI/HI 9.6.3.
   b. The detailed Specifications may stipulate a narrower POR than indicated in ANSI/HI 9.6.3.
   c. The detailed Specification Sections identify the duty points that must be within a pump's POR and those that may be within the AOR and take precedence over this Section.

C. Not Used.

D. Not Used,

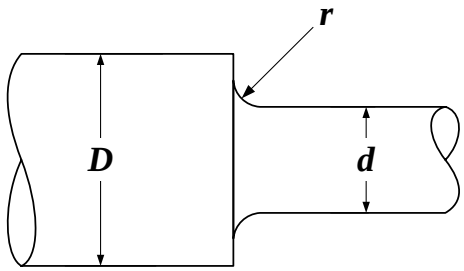
E. Component Design Criteria:
   1. Anchorage and equipment mounts:
      a. The Contractor shall hold the pump manufacturer responsible for the design of the anchor-bolting system and equipment supports for each separately mounted component furnished under the detailed Specification. Conform anchorage and equipment support requirements for pumps to the requirements of Section 43 05 13.
      b. Not used.
      c. Soleplates shall be designed to span openings for equipment connections and provide access to maintenance points. Ensure that soleplates are of sufficient section to key, not less than 1 inch, into the supporting grout provided for bonding the soleplate to the structure. Provide soleplates of sufficient size to bolt the pump base to the soleplate without encumbering the anchor bolts required for clamping the soleplate to the structure.
   2. Torsional shaft stresses:
      a. Shaft stresses shall be calculated using the following equation and the stress concentration factors in the tables below:

$$S = S_{cf} \times \frac{G \times D \times \Delta_{\Theta}}{2 \times L}$$

where:

S	=	stress, pounds per square inch (psi)
S_{cf}	=	stress concentration factor, dimensionless
D	=	minimum shaft diameter at point of concentration, inches
Δ_Θ	=	twist in shaft between adjacent masses, radians
L	=	effective length between masses, inches
G	=	shear modulus of shaft material, psi

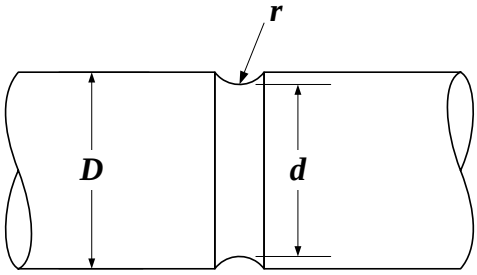
b. The S_{cf} shall be applied at changes in shaft diameter is as follows:



Shaft diameter ratio D/d = 1.05	
r/d	S_{cf} [a]
0.0025	2.67
0.0100	1.84
0.0200	1.58
0.0300	1.47
0.0400	1.39
0.0500	1.34
0.1000 and greater	1.22

Shaft diameter ratio D/d = 1.50	
r/d	S_{cf} [a]
0.0025	4.05
0.0100	2.54
0.0200	2.07
0.0300	1.85
0.0400	1.72
0.0500	1.62
0.1000 and greater	1.40

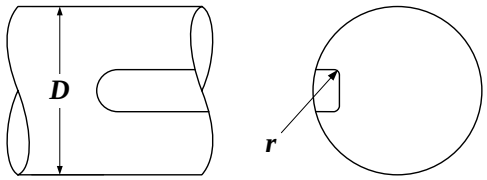
c. The S_{cf} shall be applied at circumferential shaft grooves is as follows:



Shaft diameter ratio D/d = 1.05	
r/d	S_{cf} [a]
0.0025	3.73
0.0100	2.34
0.0200	1.92
0.0300	1.74
0.0400	1.64
0.0500	1.57
0.1000 and greater	1.39

Shaft diameter ratio D/d = 1.30	
r/d	S_{cf} [a]
0.0025	5.04
0.0100	2.82
0.0200	2.24
0.0300	1.99
0.0400	1.84
0.0500	1.73
0.1000 and greater	1.49

d. The S_{cf} shall be applied at the roots of keyways is as follows:



r/D	S_{cf} [a]
0.0025	4.35
0.0100	3.20
0.0200	2.64
0.0300	2.43
0.0400	2.32
0.05 00	2.25
0.1000 and greater	2.12

a. Base values of S_{cf} between data points in the tables above upon a straight-line interpolation.

3. Shaft deflection:
   a. Pump shafts installed on volute-type pumps shall be selected to provide sufficient stiffness to operate without distortion or damaging vibration throughout the range of service specified. Shaft deflection at the face (impeller side) of the shaft seal shall be limited to no more than 2 mils at any operating condition within the zone described by the specified continuous-duty operating conditions. Deflection at the shaft seal shall be calculated as required by provisions set forth in ANSI/HI 1.3.
4. Bearings:
   a. Unless otherwise specified, anti-friction bearings for pumps shall be selected for a minimum L–10 life of 50,000 hours in accordance with American Bearing Manufacturers Association (ABMA) 9 or 11. Bearings for other elements in the rotating system such as motors, intermediate shaft bearings, and flywheel bearings shall be selected using the same criteria as specified for the pump. Bearing selection shall be based upon the worst combination of continuous-duty operating conditions specified, and include both steady-state and transient loads. Calculations supporting the selection of bearing sizes shall be provided as Product Data.
5. Bearing isolators:
   a. Unless otherwise specified, pump and motor bearings shall be fit with bearing isolators, specifically selected for the size and type of bearing. Bearing isolators shall be provided that are the labyrinth, non-fretting type designed to expel contaminants by centrifugal force and prevent the escape of lubricants. Vapor-block capability shall be provided. The bearing seals shall be Inpro/Seal, or an approved equal.
6. Pump shaft seals:
   a. Unless otherwise specified in the detailed Specification, pump shaft seals must be mechanical seals as specified in Section 43 05 11.

F. NPSH Margin Limitations:
   1. General:
      a. Pumps furnished under this Section and Sections referencing this Section shall be selected for NPSH margin limitations using the criteria set forth in this Section. NPSH3 characteristics for the candidate pump shall be based upon documented test data not more than 5 years old. Testing shall be performed on a pump not more than two nominal pump diameters larger or smaller than the proposed pump with an impeller of the same geometry as that proposed for the pump to be used for the subject application, and operating at either the same speed as the pump for the proposed application or a speed that provides ±10% of the impeller inlet velocity if reduced-speed testing is used.
      b. The detailed Specification Sections provide NPSHA information for anticipated operating conditions for each application. This information is generally referenced to a specific elevation, stated in terms of project datum. The Contractor is responsible for requiring the pump manufacturer to adjust the NPSHA information in the Specification Section to the elevation of the pump impeller eye for the specific pump model and size proposed for the application. NPSH3, as used in the following paragraphs, means the NPSH3 at the impeller eye, determined in accordance with ANSI/HI 11.6 or 14.6, as applicable for the proposed pump. The Contractor shall require the pump manufacturer to document the method used to determine NPSH3 for the proposed pump and justify compliance with the NPSH margin limitations established under this paragraph for each specified operating condition in material submitted under paragraph 1.08. Include in the documentation justification of the NPSH3 tests used to develop NPSH3 characteristics, including the following:
         1) Date, test procedure, and test logs of original NPSH3 information used to project requirements for the pump selected for the application.
         2) Test pump size, impeller diameter, impeller model, eye diameter, and speed.
         3) Calculations projecting NPSH3 test information to NPSH3 curve information for the pump proposed for the application.
         4) Calculations demonstrating compliance with the NPSH margin requirements established in this paragraph.
      c. The Contractor shall submit the manufacturer's margin calculations justifying the proposed pump selection with the material required under paragraph 1.08. The NPSH margin ratios specified in this paragraph are the minimum acceptable margin ratios. If the proposed pump requires greater margin ratios to operate within the specified operating conditions without loss of head due to cavitation, then it is the responsibility of the Contractor to bear costs associated with achieving the required margin ratio by lowering the elevation of the pump setting, lowering the elevation of the structure, or through other means. Subject any such adjustments to review and acceptance by the Construction Manager if necessary.
      d. Individual restrictions are applicable to NPSH margin depending upon the type of pumping equipment and the fluid to be pumped as set forth in ANSI/HI 9.6.1, Table 9.6.1.4.5. Under no circumstances may the absolute value of the NPSH3 margin be less than 3.5 feet.

G. Electric Motors:
   1. General:

a. Pumps must be electric-motor driven unless otherwise specified. All motors shall be selected to be non-overloading at any operating point along the pump's full-speed operating curve, including points located beyond specified operating conditions. All vertical motors shall be solid-shaft construction. Hollow-shaft motors will not be accepted. Motors furnished with pumps specified for operation at variable-speed inverter-duty types shall conform to the requirements of Section 43 05 21, and be compatible with the variable-speed equipment furnished with the pump.

b. Motor bearings with bearing isolators shall be protected as specified in this paragraph 1.04.

2. Not used

3. Balance:

a. Motors rated 50-hp or greater shall be precision-balanced, conforming to a balance grade of G2.5 per International Organization for Standardization (ISO) 1940-1.

b. The Contractor shall provide certified balance logs attesting to achieving these requirements, submitted as required by paragraph 1.08. The chief engineer or person in charge of the test facility shall sign the balance logs.

1.05 NOT USED

1.06 QUALITY ASSURANCE: ALL PUMPS

A. Quality Certification:

1. All manufacturers and manufacturing sites proposed by the Contractor for supply of equipment furnished under this Section and Sections referencing this Section shall hold current certification under ISO 9001. Application for certification under ISO 9001 is not deemed as an acceptable substitute for current certification. Provide documentation of the manufacturer's ISO 9001 certification and the manufacturer's written quality assurance/quality control (QA/QC) program.

B. Unit Responsibility:

1. The Contractor shall assign unit responsibility to the pump manufacturer in conformance with the requirements of Section 43 05 11.

C. Performance Confirmation:

1. Hydrostatic tests:

a. All pressure-sustaining parts shall be subject to factory hydrostatic tests. Unless otherwise specified, hydrostatic tests shall conform to the requirements of ANSI/HI 11.6 for submersible pumps and ANSI/HI 14.6 for dry pit pumps. Unless otherwise indicated in the detailed Specifications, castings shall be held at the test pressure for the duration indicated in ANSI/HI 11.6 and 14.6. For process pumps designed in accordance with ANSI/API 610, hydrostatic testing must comply with the requirements of paragraph 8.3.2 of ANSI/ ANSI/API 610. Test results shall be certified correct by the chief engineer or individual in responsible charge of the manufacturing facility.

2. Performance guarantee:
    a. Unless specified otherwise in the detailed Specification, pump performance (flow and head, efficiency, and NPSH3) shall be guaranteed by the pump manufacturer to the criteria specified under this paragraph.
    b. Equipment performance documentation, including test data, where tests are specified, shall include sufficient test points (not less than eight) to document hydraulic performance along the complete head/capacity curve from shutoff to maximum capacity, and covers full-speed operating points specified in the detailed specification section referencing this section. Tests conducted at specified operating conditions shall be inlet-throttled to produce the NPSHA indicated for that specific condition in the detailed Specification. NPSH3 tests shall be performed for not less than four full-speed operating conditions, but not less than specified operating conditions and at the best efficiency point (BEPQ).
    c. Test procedures shall conform to those set forth in ANSI/HI 14.6 acceptance grade 1U, and as specifically detailed in these Specifications. However, any increase in flow or head permitted under acceptance grade 1U cannot result in overload (nameplate basis, S. F. = 1.0) of the specified motor power rating at any location on the pump's head/capacity curve. Performance tests shall be conducted at the specified maximum speed. Affinity relationship-predicted test results will not be accepted. For column-type pumps, the performance documentation shall include curves showing both bowl efficiency and overall efficiency (including inlet, bowl, column, and discharge head losses) at maximum operating speed for the application.
    d. Ensure that acceptance criteria for head and capacity test results, based upon the rated condition specified in the detailed Specification, are as required in ANSI/HI 11.6 and 14.6, acceptance grade 1U, with the above-stated limitation with respect to motor power overload.
    e. Ensure that acceptance criteria for NPSH3 at any specified operating condition are the values proposed by the Contractor in the curves submitted under paragraph 1.08, and duly accepted by the Construction Manager, with a tolerance of plus 0, minus unlimited, with the exception that Nss, as calculated for the specific pump, does not exceed the limitation established under paragraph 1.04A.2. If the NPSH3 data result in an increase in Nss, the manufacturer shall confirm that the stable operating region for the pump corresponds to the POR as defined in ANSI/HI 9.6.3, and that the operating conditions specified to be within the POR are within the stable operating region for the pump. In addition, the manufacturer shall identify the onset of suction recirculation and confirm that the onset of suction recirculation is outside of the specified operating range.
    f. Include in the guarantee a statement to the effect that the pump will operate within the operating regions specified in the detailed specification. Put the guarantee in writing, and the chief engineer or individual in responsible charge of the test facility shall sign it. Under no circumstances should deviations from specified operating conditions result in overload of the driver furnished with the equipment, nor should such deviations result in power requirements greater than the driver's nameplate (1.0 service factor) rating.
3. Non-witnessed tests:
    a. Unless specified otherwise, performance-test pumps in accordance with ANSI/HI 14.6, Acceptance Grade 1U, with the above restrictions on motor power overload. Include in the factory tests test data for each full-speed performance requirement

(Condition Points A and B specified in the detailed Specification) and any other points stipulated for this test procedure in the detailed Specification. Conduct these tests with the pump inlet throttled to provide the specified NPSHA. If specified in the detailed specification, include shaft vibration and case noise in the test data at the full-speed operating conditions.

b. Duplicate the test setup in the manufacturer's test facility as closely as possible to the inlet conditions in the proposed installation, using temporary baffles and other means, within the limitations of the test facility. Where centrifugal pumps are furnished with inlet elbows, inlet adapters or inlet reducers as a part of the manufacturer's scope of supply, test the pumps with the elbow, adapter, or reducer fitted to the pump and apply specified performance criteria to the complete pump assembly, including losses through any elbow, adapter, or reducer. Where submersible pumps are to be furnished with inlet nozzles and/or discharge elbows or adapters, test the pumps with these components fitted to the pumps. Apply the specified performance requirements to the complete pumping assembly including any inlet nozzles, and discharge elbows or adapters. Include in the certified test data separate readings for inlet and discharge head for each data point.

c. Take not less than eight test points, including not less than three within ±8% (in terms of rated flow) of the rated condition (Condition Point A) and not less than two test points within ±4% of the pump's BEP at the test speed. In addition, one test point is sufficient to define head and power requirements at shutoff head.

d. Perform NPSH3 tests in accordance with ANSI/HI 14.6, paragraph 14.6.5.8.2.1, Type 1 Test except that not less than four tests should be performed at the test motor speed to completely cover the range of operating conditions specified in the detailed Specification. Ensure that one of the test points is at BEP flow to confirm the test pump's Nss. Ensure that translation of test results to specified operating conditions is in accordance with ANSI/HI 14.6, paragraph 14.6.6.1.1 so long as the exponent used can be supported by certified test data performed on a pump of the same type, size, speed, and specific speed as that of the proposed pump. Include NPSH3 tests at both the proposed and test speeds in test data justifying the exponent, test points at BEP, and at least three other points on the test pump head/capacity curve at least 15 percentage points removed from the BEP. Use the results of the NPSH3 tests to confirm the NPSH margins for each specified operating condition as specified in paragraph 1.04. Perform NPSH3 tests for column type (axial, mixed-flow, and vertical-turbine) pumps using the open sump/water level or closed tank/tank pressure methods described in ANSI/HI 14.6, Table 14.6.5.8.2.1. Perform NPSH3 tests for submersible wastewater pumps using the method described in Figure 11.6.8 in ANSI/HI 11.6. Extend all NPSH3 tests from 50% to 140% of best efficiency flow at full speed, or to not less than 10% (in terms of flow) past the flow at Operating Condition B, whichever is greater. For a given pump, if the manufacturer can provide documentation that the upper flow limit of the AOR on the right side of the pump curve is less than 140% of best efficiency flow, the AOR may be used as the limit for the NPSH3 test. Cause for rejection is failure to achieve specified performance or performance proposed in accepted submittal documents (capacity and head, efficiency, or NPSH3), whichever is more restrictive. Acceptance tolerances are as set forth in paragraph 1.06C.2.

e. Ensure that all test procedures are in strict conformance with the referenced standards. However, prediction of performance of a trimmed impeller from test

data of the larger impeller will not be permitted. If trimming is required, re-test the pump. Do not allow deviations from specified operating conditions, though allowed by the referenced standards, to result in overload of the driver furnished with the equipment, nor allow such deviations to result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

f. The Contractor shall furnish the Construction Manager with not less than 2 weeks' advance written notice of the date and place of the non-witnessed tests.

g. All test results, including test logs and generated curves, shall be certified correct by the chief engineer or individual in responsible charge of the manufacturer's test facility, and submit in accordance with paragraph 1.08.

1.07 NOT USED

1.08 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. In addition to the material listed in the detailed Specification, provide the following submittals:
   a. Documentation of successful pump designs or proposed alternatives as specified under paragraph 1.04B.1B.1. If included as part of the design, include in the documentation applications where pump cans of a similar size have been provided as part of the design.
   b. A Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
   c. A copy of this Specification Section and the specification sections listed for submittal in the detailed Specification Sections. Ensure that the Specification copies are complete with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated and, therefore, requested by the Contractor, underline each deviation and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Accompany the submittal with a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
   d. A copy of the Contract Document control diagrams and process and instrumentation diagrams (P&IDs) relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the Drawing or Drawings as "no changes required." Failure to include copies of the relevant Drawings with the submittal is cause for rejection of the entire submittal with no further review.

e. Documentation of certification in accordance with ISO 9001 as specified under paragraph 1.06.

f. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH3 on the ordinate plotted against capacity (in million gallons per day [mgd]) on the abscissa. Provide curves for variable-speed pumps to demonstrate operation at speeds required to achieve the specified reduced-speed operating conditions. Ensure that all curves clearly display the specified operating conditions and conformance with POR and AOR limits in the individual specification sections. Provide variable-speed plots showing specified operating conditions and POR limits. Plot curves at increments of not more than 5% speed or 50 rpm increments, whichever is less, from full speed to the lowest speed required to meet specified operating conditions. Ensure that curves for column-type pumps show bowl efficiency and allowances for inlet, column, and discharge head losses separately.

g. NPSH margin calculations performed for each specified operating condition in accordance with paragraph 1.04 as applicable and including the information required under paragraph 1.04.

h. Motor submittal information as specified in Section 43 05 21. In addition, include in this information certified calculations for motor rotor and frame reed frequencies, as specified under paragraph 1.04.

i. Complete description and sketch of proposed test setup for factory test if a factory test has been required under the detailed Specification Section or as required by the provisions of this Section. Include in submittal material sample calculations and proposed test log format. If the Contractor proposes a model test for a part or all of the specified performance tests, include in the submittal information the proposed model details and a complete description of the proposed method for comparing the model impeller profiles with the impeller profiles for the prototype pumps.

j. Drawings showing general dimensions and confirming the size of pumps, motors, drives, and specified appurtenances; piping connections; construction details of equipment (including bearings and bearing isolators); wiring diagrams; and weight of equipment.

k. Variable-speed drive information as required under Section 26 29 23 if the equipment specified includes variable-speed capability.

l. Detail drawings of the pump and driver unit foundation demonstrating conformance to this section and Section 43 05 13. Include in the submittal drawings depicting type, size, number, projection, and arrangement of anchor bolts; dimensional drawings of the sole and baseplates; and dimensional drawings for the concrete supports for both the pump and motor, if applicable. Ensure that drawings also depict other pertinent information, including location of equipment pads and reinforcement; equipment drains; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment-mounting features embedded in equipment pads.

m. Limiting nozzle-loading criteria, if different from that established by ANSI/HI 9.6.2.

n. The qualifications of the personnel proposed by the Contractor to perform field alignment procedures in accordance with the requirements of paragraph 3.04.

B. Information Submittals
   1. Procedures: Section 01 33 00:
      a. Performance guarantee as specified in paragraph 1.06.
      b. Equipment anchor calculations specified in paragraph 1.04.
      c. O&M information specified in Section 01 78 23.
      d. Motor product data as specified in Section 43 05 21.
      e. Bearing L-10 life calculations.
      f. Nozzle-loading information required under paragraph 3.01.
      g. Motor balance logs, certified and notarized as specified in paragraph 1.04.
      h. Certified balance logs and worksheets, as specified in paragraph 2.05.
      i. Installation certification Section 43 05 11-Form A as specified in paragraph 3.01.
      j. Training certification Section 43 05 11-Form B as specified in paragraph 3.08.
      k. If factory tests are specified in the detail Specification Section, certification of satisfactory testing of each unit as specified. Include in the certified material copies of test logs and resulting performance curves.

C. Not Used.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Where this Section and Sections referencing this Section are silent with respect to materials of construction on any component, material selection shall follow the requirements of Table H.1, ANSI/API 610, Materials Class I-1, with the exception that shafts for vertical column-type pumps be 12% chromium stainless steel. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Pumps:
   1. Finish for surfaces in contact with pumped fluid:
      a. Indicate surfaces to be machine-finished on the shop drawings by symbols that conform to ANSI B46.1.
      b. Flaws such as scratches, ridges, holes, peaks, cracks, or checks that will make the part unsuitable will be cause for rejection. Ensure that machine-finished surfaces are thoroughly cleaned and coated with a protective layer of rust preventive. Oil and wrap small pieces, unassembled pipe, or finished bolts with moisture-resistant paper.
   2. Materials:
      a. Unless otherwise specified, ensure that wetted cast-iron parts for pumps for solids-bearing liquid services have 2 to 3% nickel added to the cast iron.

C. Not Used.

2.02 GENERAL QUALITY

A. Ensure that details of manufacture and assembly of equipment furnished under this Section and referencing sections follow the requirements of ANSI/API 610 with respect to the following features (paragraph references, ANSI/API 610):
   1. Alignment aids (paragraph 6.1.24).
   2. Removal of rotating element (paragraph 6.1.25).
   3. Jackscrews for assistance in alignment on baseplates and equipment supports (paragraph 9.3.8.3.2).
   4. Castings (paragraph 6.12.2).

2.03 BASEPLATES AND SOLEPLATES

A. Unless otherwise noted in the detailed Specification, the pump manufacturer shall furnish pumps with baseplates or soleplates conforming to the requirements of Section 43 05 13. Design baseplates and soleplates to be installed in the housekeeping curb shown, and ensure that they are machined flat and co-planar to within 0.002 inch per foot in all directions on the face mating with the pump and motor or driver support. Ensure that soleplates have the words “THIS SIDE DOWN” permanently affixed to the underside using a welding rod material or stamped prior to milling. Alternative marking methods, using heavy scribing or machining, are acceptable provided that they may be observed following blasting in preparation for coating.

2.04 WEARING RINGS

A. Where specified, fit pumps with both stationary and rotating wearing rings. Except for the difference in hardness between stationary and rotating rings, ensure that wearing rings are stainless steel and conform to the requirements of American National Standards Institute/American Petroleum Institute (ANSI/API) 610, paragraph 6.7 and material class S-8 (Table H.1, Annex H). Ensure that maximum wearing-ring clearances do not exceed 150% of the values stated in Table 6, ANSI/API 610. Ensure that minimum wearing-ring hardness on the rotating ring is 350 Brinell Hardness Number (BHN), with the stationary ring not less than 100 hardness points greater.

B. Not Used.

2.05 BALANCE

A. Ensure that balancing for pumps and associated components conform to the requirements set forth in ANSI/API 610, paragraph 6.9.4.1 (equivalent to ISO 1940 or ANSI 2.19 Grade 2.5), unless other portions of this Project Manual impose more restrictive requirements. It is the intent that the components be balanced as an assembly (“rotor”) in accordance with ANSI/API 610 definitions. For extended-shaft pumps, balance impeller(s) and shaft up to the first coupling with the line-shaft.

B. For separately balanced components, perform a residual unbalance inspection after rotor assembly per ANSI/API 610 requirements, as described in Annex J of that document. Provide copies of worksheets and demonstrate that tolerances are in

compliance (i.e., rotor has passed) in addition to other reporting requirements of this paragraph.

C. Furnish all balance logs, certified correct and signed by the chief engineer or individual in responsible charge of the manufacturing facility, in accordance with paragraph 1.08.

2.06 NOT USED

2.07 NOT USED

2.08 NOT USED

2.09 NOT USED

PART 3 EXECUTION

3.01 GENERAL

A. Connect pump inlet and discharge nozzles to field piping using equipment connection fittings conforming to the requirements of Section 40 05 06.16. Select restraining rods on equipment connection fittings that is designed specifically to restrain the unbalanced hydraulic thrust developed by the pump when operating at full speed against a closed valve. Torque all restraining rod nuts to ensure that any moment or shear transmitted to the pump nozzles is within the values permitted under ANSI/HI 9.6.2, or that permitted by the equipment manufacturer, whichever is greatest. Where ANSI/HI 9.6.2 is silent with respect to any particular aspect of allowable nozzle loads, the Contractor shall follow the written requirements provided by the equipment manufacturer. Ensure that equipment installation procedures conform to the requirements of Section 43 05 13. Upon completion of installation work, the Contractor shall submit a complete, properly signed certification Form 43 05 11-A as specified in Section 01 99 90.

3.02 SOLEPLATES

A. Level soleplates, if provided pursuant to this Section or any Section referencing this Section, or where required by the equipment manufacturer's recommendation, in the presence of a factory-authorized installation specialist to a maximum tolerance of 0.002 inch per foot in all directions. Where the equipment manufacturer requires more stringent tolerances, those tolerances prevail.

3.03 NOT USED

3.04 ALIGNMENT

A. Ensure that journeymen millwrights perform alignment of equipment furnished under this section and any referencing section. Carpenters, laborers, or any other trades are specifically excluded from performing this work. In locations where such trades are not available, the Contractor shall retain the services of a firm specializing in this type of work to perform the setting and alignment work. The Contractor shall submit the qualifications of the proposed firm to the Construction Manager for acceptance prior to performing the work. Ensure that the Construction Manager personally witnesses final alignment procedures for each item of equipment as a condition precedent to beginning any work required under Section 01 45 20.

B. NOT USED

3.05 NOT USED

3.06 FIELD VIBRATION TESTS

A. Qualifications:

1. The contractor shall retain the services of an independent testing laboratory to conduct the testing work specified under this paragraph. The work shall be directed by a professional mechanical engineer, registered to practice in any one of the 50 states composing the United States. The engineer (hereinafter termed "professional vibration analysis specialist") shall be a graduate of a college holding Accreditation Board for Engineering and Technology Inc. (ABET) accreditation in mechanical engineering and has been engaged in the practice of providing the type of monitoring services required under this paragraph for rotating machinery for a period of not less than 10 years. Submit the professional vibration analyst's qualifications and references, certified and notarized, for review and acceptance by the construction manager not less than 6 weeks prior to the date scheduled for the field vibration test work specified herein. The construction manager shall review the required documentation and references and indicate acceptance or rejection of the proposed analyst's qualifications within 14 days of submission. If the analyst proposed by the contractor is rejected, the contractor shall propose an alternative choice with appropriate documentation.
2. The independent testing laboratory's testing team (comprising the professional vibration analysis specialist and any technicians required to complete the specified tasks) shall be fully equipped to provide continuous pressure, velocity, and displacement values for rotating equipment installed under the requirements of this section. Ensure that vibration testing equipment includes sufficient calibrated pressure and flow monitoring devices to determine pump operating conditions as well as vibration levels.

B. Vibration Tests:

1. The RMS vibration velocity shall not exceed the limits established in the appropriate standards indicated in the Table below. The measurement locations shall correspond to the guidelines provided in the specific standards given in the Table below.

Component	Standard
All Pumps	ANSI/HI 9.6.4 or ANSI/HI 11.6
Electric Motors of Any type	ISO 10816-3 Table A.1 or A.2, Zone Boundary A/B

2. Provide vibration test reports as an information submittal in accordance with paragraph 1.08, and provide the signature of the responsible professional vibration analysis specialist. The vibration spectra shall be of sufficient resolution for legibility of magnitude and frequency data to be properly reviewed by the construction manager. Cascade diagrams are not sufficient for variable-speed drive application unless supported by the required data in a format suitable for more detailed analyses. Provide separate spectra at the maximum and minimum operating speeds and any potential resonant frequencies.

3.07 TRAINING

A. Ensure that training conforms to the requirements of Section 01 79 00 and includes separate training sessions for each operator shift maintained by the Owner and a separate session for maintenance personnel. Ensure that the training session for maintenance personnel includes a comprehensive presentation, employing cut-away models or comparable graphics, and documentation on the step-by-step disassembly and subsequent reassembly of a pumping unit. Upon completion of training requirements, ensure that the Contractor submits certified Form 43 05 11-B as specified in Section 01 99 90.

END OF SECTION

SECTION 43 23 31.21

CLOSE-COUPLED, VERTICAL, IN-LINE, SINGLE-STAGE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This Section specifies vertical in-line, single stage centrifugal pumps for pumping potable water containing no solids. Equipment furnished under this section shall conform to the requirements of this Section and to the requirements in Section 43 23 03.

B. Type:

1. Pumps used for continuous, unattended operation, single-phase fluid as indicated hereafter. Pumps shall be vertical in-line, single-stage, close-coupled centrifugal type complete with electric motors, adjustable-speed controllers, baseplates, couplings, and all necessary appurtenances, as indicated and specified.

C. Equipment List:

Item	Equipment Number
Zone 41 Mingus Pump 1	P3110
Zone 41 Mingus Pump 2	P3120
Zone 41 Mingus Pump 3	P3130
Zone 41 Mingus Pump 4	P3140
Zone 41 Jockey Pump	P3150

D. Performance Requirements:

1. Service Conditions:
   a. Pumped Fluid — Potable
   b. pH Range — 6 to 9
   c. Specific Gravity of Process Fluid — 1
   d. Viscosity, Centipoises of Fluid — 1
   e. Maximum solids content % — Trace
2. For purposes of this Specification and Section 43 23 03, this is “Clear Liquids” service.
3. Operating Conditions: Operating Conditions are defined for both Mingus Pumps 1 through 4 and the Jockey Pump.
4. Operating Requirements:
   a. Mingus Pumps 1 through 4:

Operating Condition	
Condition A (Full Speed Operation)	
Capacity, gpm	860
Total head, feet	126
NPSHA, feet	29
Condition B (Full Speed Operation)	

Capacity, gpm	From pump H/Q curve
Total head, feet	115
NPSHA, feet	29
Condition C (Reduced Speed Operation)	
Capacity, gpm	360
Total head, feet	116
NPSHA, feet	29
Condition D (Minimum Speed Operation)	
Capacity, gpm	0
Total head, feet	112
NPSHA, feet	29

b. Jockey Pump:

Operating Condition	
Condition A (Full Speed Operation)	
Capacity, gpm	382
Total head, feet	123
NPSHA, feet	29
Condition B (Full Speed Operation)	
Capacity, gpm	From pump H/Q curve
Total head, feet	115
NPSHA, feet	29
Condition C (Reduced Speed Operation)	
Capacity, gpm	180
Total head, feet	114
NPSHA, feet	29
Condition D (Minimum Speed Operation)	
Capacity, gpm	0
Total head, feet	112
NPSHA, feet	29

c. Condition A shall be taken as the rated, continuous-duty operating condition. Performance at the rated condition shall be guaranteed in accordance with Section 43 23 03. Condition A has been selected to obtain the rated pumping capacity for the installation. Condition A shall be used for pump selection. Pumps furnished under this section shall be selected to achieve Condition A performance, and also shall operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A shall be located in the Preferred Operating Region, as established by the pump manufacturer in accordance with American National Standards Institute/Hydraulic Institute (ANSI/HI) 9.6.3 and published in the manufacturer's published application data for the specific model proposed for this application.

d. Condition B head is presented to indicate operating conditions when the pump is operating against minimum anticipated system head, assuming a hypothetical head-capacity curve. Condition B for the Mingus Pumps shall be located within the Allowable Operating Region and shall also not exceed 125 percent of the flow at the pump's best efficiency point. Condition B for the Jockey Pump shall be located in the Preferred Operating Region. The Allowable Operating Range shall be as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed

in the manufacturer's published application data for the specific model proposed for this application. Pumps with head-capacity curves steeper than that assumed will produce somewhat less flow at somewhat lower head. The reverse will occur with pumps having a shallower head-capacity curve. Net positive suction head available (NPSHA), as listed for Condition B is calculated on a pumped flow of 1,000 gpm for the Mingus Pumps and 425 gpm for the Jockey Pump.

e. Condition C is the anticipated continuous duty minimum speed condition. Provide pumps furnished under this specification capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 43 23 03. Condition C shall be located within the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3, and listed in the manufacturer's published application data for the specific model proposed for this application.

f. Condition D represents the expected momentary (startup/shutdown) condition. Pumps furnished under this specification will operate for no more than 30 seconds at this condition when initiating or terminating a service cycle. The maximum anticipated number of service cycles is 12 per day.

Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 – 1.6. NPSHA in the above tabulation is referred to the pump inlet piping centerline elevation as shown and is calculated in accordance with ANSI/HI 1.3 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump-installation details. An allowance of 2 feet has been included. Required NPSHA margin shall be as specified in Section 43 23 03.

g. Maximum expected surge pressure is 150 psig.

h. The pump, bearings, shaft and other components shall be sized for and capable of handling the maximum torque generated by motor needed for the largest impeller diameter for the pump casing.

i. Overall vibration levels (peak velocity) at the shaft bearing housings shall not exceed the requirements of Section 43 23 03-3.06.

j. Pump performance test requirements, as stated in paragraph 1.02 shall be based on Conditions A, B and C. Performance guarantee shall be for Condition A.

5. Design Requirements: Equipment provided under this Section shall conform to the following:

a. Mingus Pumps 1 through 4:

Pump	
Minimum[1] efficiency at Best Efficiency Point (BEP), percent	77
Minimum ratio of NPSHr/NPSHa within specified operating range	See 43 23 03
Piping connection size, inches, minimum	
Inlet	5
Discharge	5
Operating speed, rpm, maximum	1780
Suction Specific Speed (NSS) gpm, maximum	8,000

Motor	
Horsepower, maximum	60
Classification	Type 2; TEFC, 460-Vac 3-Phase, Inverter Duty

Note:

[1]The minimum acceptable efficiency at Best Efficiency Point (BEP) is not necessarily required to be associated with any operating condition specified in paragraph 1.01 Performance Requirements. The value indicated is the minimum acceptable efficiency at the BEP on the proposed pump's head capacity curve.

b. Jockey Pump:

Pump	
Minimum[1] efficiency at Best Efficiency Point (BEP), percent	75
Minimum ratio of NPSHr/NPSHa within specified operating range	See 43 23 03
Piping connection size, inches, minimum	
Inlet	3
Discharge	3
Operating speed, rpm, maximum	3560
Suction Specific Speed (NSS) gpm, maximum	8,000
Motor	
Horsepower, maximum	25
Classification	Type 2; TEFC, 460-Vac 3-Phase, Inverter Duty

Note:

[1]The minimum acceptable efficiency at Best Efficiency Point (BEP) is not necessarily required to be associated with any operating condition specified in paragraph 1.01 Performance Requirements. The value indicated is the minimum acceptable efficiency at the BEP on the proposed pump's head capacity curve.

6. The pumps and driver shall be capable of being started and stopped intermittently up to seven times per hour.

E. Operating and Maintenance Quality Requirements:

1. The pump system while operating shall meet the requirements listed hereafter. Pump system not meeting the requirements shall be rejected and replaced by Contractor at its own expense.
   a. If oil-lubricated bearings are used, no oil leakage shall be acceptable from tubing, fittings or along the shaft. Oil reservoir shall be properly connected and marked for optimum oil level. A drilled or machined pipe cap is not acceptable as an oil breather (air vents).
   b. All seal and cooling water piping and/or tubing shall be stainless steel or copper with unions and shutoff valves for proper disassembly.
   c. Coupling shall be sized and set such that it can handle float at motor start but prevents rotor oscillations between magnetic and gravity centers.
   d. The entire system shall operate as solid unit with no loose, shaking or vibrating objects or connections. All piping, tubing, wiring and sensors shall be rigidly and discretely fastened and supported along the structures with minimal protrusions or extensions.

1.02 QUALITY ASSURANCE

A. References shall be as listed in Section 43 23 03.

B. Unit Responsibility:
   1. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in Section 43 05 11-1.02 for both the equipment assembly specified in this Section and for compatibility of the adjustable-frequency drive specified in Section 26 29 23, motor specified in Section 43 05 21, and all other equipment assembly components specified elsewhere but referenced in this section. A completed, signed, and notarized Certificate of Unit Responsibility (Form 43 05 11-C, Section 01 99 90) shall be provided.

C. Factory Tests:
   1. Each pump shall be subjected to a factory hydrostatic test and shall be subjected to non-witnessed performance test in accordance with the requirements established in Section 43 23 03.

D. Rotor Critical Speed Analysis and System Design:
   1. The complete unit shall be subjected to the rotor critical speed analysis and system design in accordance with a Level 1 analysis per ANSI/HI 9.6.8 and meet the submittal requirements established in Section 43 23 03-1.05.

E. Shipment, Protection and Storage:
   1. The equipment shall be protected during shipment and storage as specified in Section 01 66 00. In addition, the following requirements shall apply.
      a. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
      b. Deliver spare parts at same time as equipment. Deliver to Owner after completion of work.
      c. Contractor and Construction Manager shall inspect and inventory items upon delivery to site.

1.03 SUBMITTALS

A. Submittals shall conform to the requirements of Section 43 23 03.

B. Action Submittals - Shop Drawings:
   1. Sections to be marked-up and submitted in accordance with Section 43 23 03 requirements include:
      a. This Section.
      b. Section 43 05 11.
      c. Section 43 05 13.
      d. Section 43 23 03.
      e. Section 43 05 21.
   2. A copy of the Contract Document Drawings E-601, I-602, and I-603 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. Submittal requirements of Section 43 05 21.
4. Motor assembly weight as specified in paragraph 2.07.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following manufacturers are capable of producing equipment and products, which will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's product, nor shall it be construed that a named manufacturer's standard product will comply with the requirements of this section. Candidate manufacturers include Goulds, or approved equal.

2.02 MATERIALS

A. Materials of construction shall meet the requirements specified in Section 43 23 03.

2.03 EQUIPMENT

A. Materials shall be as specified in the table below:

Component	Material
Casing	Cast iron, ASTM A48, Class B
Shaft	Carbon steel
Impeller	Stainless steel, ASTM A743 Grade CF8
Shaft sleeve	Stainless steel
Impeller wear rings	304 stainless steel

B. Casing:
1. Pump Type: Each pump shall be vertical-shaft, single-stage. Each volute casing shall be of one-piece construction and shall be designed to permit the removal of all rotating internal parts without disturbing the suction and discharge piping connections. Casing shall be provided with at least 3 lifting eyes and valved 1/2-inch vent fitted to the top of the discharge nozzle.
2. Flanges: Suction and discharge flanges for pumps shall be cast solid with casings. Drilling and dimensions of flanges conform to 125-pound ANSI Standard (rated for 175 psi working pressure). Flanges spot-faced at each bolt hole.
3. Thrust: Casings shall be designed to transmit hydraulic thrust developed by pumps under all conditions of operation, including starting and stopping, to the baseplate without any deflection that would adversely affect pump and motor alignment. Pumps shall be suitable for the allowable nozzle loads specified in ANSI/HI 9.6.2 for vertical in-line pumps.

C. Impeller:
1. The impeller shall be stainless steel per ASTM A748, Grade CF8. The impeller shall be machined outside and smoothly finished on the internal water passages; and it shall be hydraulically balanced. The impeller shall be securely mounted on the shaft with a single key that extends beyond the impeller hub locking the impeller and shaft sleeves against rotation on the shaft.
2. The impeller shall be protected from wear at the suction inlets by 304 stainless steel

wearing rings held in place by set screws. The impeller, with wearing rings and shaft attached, shall be statically and dynamically balanced to the criteria established by ANSI/HI 1.5, Figure 1.106. Impellers shall be dynamically balanced to an International Organization of Standards (ISO) 1940 G6.3 minimum for rotating speeds up to 1,800 rpm. Speeds above 1,800 rpm shall have an ISO 1940 G2.5 minimum balance quality if impeller weight exceeds 100 pounds.

D. Wearing Rings:
   1. The case shall also be fitted with matching 304 stainless steel wearing rings. The case wearing rings shall be of one-piece construction held rigidly in slots machined in the case by stainless steel pins or threaded fasteners and shall not be held by the clamping action of the casing. The diametrical clearance between casing and impeller wearing rings shall not be less than 0.022-inches. The field-replaceable wear rings shall be made of aluminum bronze, with a lower Brinell Hardness than its counterpart, to be the sacrificial ring. Impeller wearing rings shall be secured with stainless steel set screws. Replaceable impeller wearing rings shall be provided in accordance with Section 43 23 03.

E. Shaft:
   1. Shafts shall be designed for a maximum deflection of 0.0020 inches at any specified operating condition.
   2. Shafts shall be ground and polished over entire length.
   3. Shafts for pumps shall be fitted with a removable stainless steel sleeve through the seal area. An O-ring seal shall be provided to prevent leakage between the shaft and the seal.

F. Bearings:
   1. All antifriction bearings shall have a minimum L-10 life of 100,000 hours at the worst possible operating and design conditions using the largest impeller size the pump can accommodate. Internal clearances resulting from shaft and housing fits, thermal expansion, speed and other operating conditions shall be kept to a minimum.

G. Motor:
   1. The motor shall conform to the requirements of paragraph 1.01 and Sections 43 23 03 and 43 05 21.
   2. Rated for high-altitude operation per Section 43 05 21.
   3. Motor-winding high temperature protection.
   4. Motor space heater.

2.04 SPARE PARTS

A. Pump:
   1. The following spare parts shall be provided by the respective manufacturers for each different size of pump:
      a. One complete set of impeller and case wearing rings.
      b. One complete set of pump bearings.
      c. One complete set of gaskets, keys, nuts, and accessories.

d. One complete pump to motor coupling, if used.

B. Motor:
   1. The following spare parts shall be provided by the motor manufacturer for each size of motor:
      a. One set of bearings.

C. Packaging, Delivery, and Storage:
   1. Spare parts shall be provided as specified in paragraph 43 05 11-2.12.

2.05 PAINTING

A. Unless otherwise specified, all non-mounting surface steel parts shall be shop-painted with one coat of primer and shop-painted with one coat of finish paint. Also, painted equipment shall be field-painted with one coat of paint after installation. All interior and exterior surfaces of the casing shall be prepared and coated per Section 09 90 00.

B. Paint color and type for all applications shall be as specified in Section 09 90 00 and as directed by the Construction Manager. Stainless steel, aluminum, brass, bronze, galvanized or cadmium-plated steel, and plastic-covered parts shall not be painted.

C. Machined and finished surfaces shall be protected with a suitable lubricant to prevent rust.

2.06 TOOLS AND LUBRICANTS

A. The Contractor shall furnish a complete set of any special tools required for the maintenance and operation of this equipment.

2.07 MOTOR-ASSEMBLY WEIGHT LIMITATION

A. Any removable appurtenance not included in the motor-assembly weight shall be easily removable from the assembly without disturbance to the pump or nearby equipment. The manufacturer shall supply the motor-assembly weight, including all accessories attached to and supported from the motor in the submittal to be judged compliant.

B. The motor assembly shall be removable as a unit (except easily removed appurtenances), without disturbance to the pump or nearby equipment.

2.08 PRODUCT DATA

A. Product data shall conform to the requirements of Section 43 23 03.

PART 3 EXECUTION

3.01 GENERAL

A. Execution shall conform to Section 43 23 03.

END OF SECTION

SECTION 43 42 21

BLADDER-TYPE HYDROPNEUMATIC TANKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This Section specifies American Society of Mechanical Engineers (ASME) pre-pressurized bladder-type hydropneumatic tanks for use with potable water systems. This includes complete bladder-type hydropneumatic tank, air pressure recharging system piping, pressure-indicating transmitter, differential pressure transmitter, air volume monitoring system and indication panel, and necessary appurtenances to provide a complete and operable installation. The system shall include a means of automatically indicating bladder charge pressure and air leakage volume without disrupting operation.

B. Type: Hydropneumatic tank shall be of the vertical, welded-steel type, cylindrical in shape, with a replaceable internal butyl rubber diaphragm. The fluid inlet to the tank shall include a bladder retaining mechanism for retaining the bladder in the tank in the event of over-expansion. Construction shall be per ASME Code Section VIII.

C. Equipment List:

Description	Equipment No.
Potable Water Hydropneumatic Tank	T3181
Hydropneumatic Tank Level Gage	LI3181
Hydropneumatic Tank Level Transmitter	PDIT3181
Hydropneumatic Tank Pressure Gage	PI3181
Hydropneumatic Tank Control Panel	VCP3181

1.02 QUALITY ASSURANCE

A. General: Hydropneumatic tanks shall be designed for surge control service in a municipal potable water pumping system with cyclic operation. Clean, potable water will be used in the hydropneumatic tank.

1. Tanks shall be fabricated and assembled in strict compliance with the design drawings and specifications. The tanks shall not be shipped prior to approval by the Engineer.
2. The hydropneumatic tanks shall be furnished by a manufacturer who is fully experienced, reputable and qualified in the design and manufacture of the equipment and has completed a minimum of six operating surge control systems of similar size or larger within the last 5 years.
3. Submit description of the manufacturer's design and equipment fabrication ability and a list of completed installations that are similar to this project in size and service for Engineer’s review.

B. Design Requirements:

Item	Requirement
Total Tank Volume, minimum, gallons	2,000
Tank Size, approximate	
Diameter, inches	84
Height[1], inches	142
System Operating Pressure Range, psig (pounds per square inch gauge)	60 – 90
Maximum Allowable Design Pressure, psig	150
System Connection Size, minimum, inches	12

[1] *Tank height is from top of surge tank to floor; this includes surge tank supports extending below main tank vessel.*

a. The design shall satisfy all Building Code, Mechanical Code, and Seismic Requirements.
b. The design shall allow for the most severe combination of conditions, which may include any or all of the following:
c. Internal or external pressure.
d. Specifically:
    1) Shell overturning due to seismic:
        a) Critical buckling.
        b) Design factor on tension side.
    2) Anchoring, due to overturning or internal pressure:
        a) Lug design.
        b) Analysis of attachment to shell.
        c) Effect on shell knuckle.
        d) Maximum pullout forces and moments reported for the foundation design.
    3) Internal pressure or vacuum:
        a) Main shells, hoop and axial.
        b) Cutout reinforcements at nozzles.
        c) Effect on any discontinuities or special components.
    4) Thermal:
        a) Differential expansion at temperature extremes.
        b) Thermal gradient through tank wall.
e. Factory Testing:
    1) Results of all tests shall be provided as Product Data.

f. Unit Responsibility: This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified in Section 43 05 11-1.02, for the equipment assembly specified in this Section, and all other equipment assembly components specified elsewhere but referenced in this Section. A completed, signed,

and notarized Certificate of Unit Responsibility (Form 43 05 11-C, Section 01 99 90) shall be provided.

1.03 ENVIRONMENTAL CONDITIONS

The equipment to be provided under this Section shall be suitable for continuous service and installation indoors. Water will be potable. Temperatures indoors are expected to range between 45°F and 90°F. Water temperatures are expected to range between 50°F and 75°F. The pH for this water will range between 6 and 8.

1.04 SUBMITTALS

A. Submittals shall be provided as specified in Section 01 33 00.
B. Action Submittals –Shop Drawings:
    1. A copy of this Specification Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked (✓) to indicate Specification compliance or marked to indicate requested deviations from Specification requirements. Check-marks shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the Specifications. Failure to include a copy of the marked-up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
    2. A copy of the Contract Document Control Diagrams and Process and Instrumentation Diagram I-604 relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the Drawing or Drawings shall be marked "No Changes Required." Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    3. Marked applicable Contract Document Mechanical and Electrical Drawings, including sections and details showing sensor installation locations and details. Failure to include copies of the relevant Drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
    4. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
    5. Manufacturer’s data, including tank capacity, weight, materials of construction and rated design pressure to show conformance with this section.
    6. Detailed fabrication drawings, system assembly and installation drawings.

7. Complete design calculations signed by a registered mechanical or structural engineer that the tanks have been designed to meet all design criteria given in these specifications.
8. Weights of all components and anchor bolt designs.
9. Provide all submittals required by Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.
10. Marked product literature for differential pressure transmitter, level gauge, and other components.
11. Calibration range for analog signals to be provided for use by the programmable logic controller (PLC) programmer.
12. Manufacturer's warranty in accordance with paragraph 1.05.
13. Control panel drawings:
    a. Exterior and interior panel layout.
    b. Nameplate engraving schedule.
    c. Schematic diagram.
    d. Loop diagrams for signal connections to the PLC.

C. Closeout Submittals – Operating and Maintenance (O&M):
1. Provide per Section 01 78 23.
2. Include the following in each O&M manual:
    a. Final reviewed submittals, including revised As-Built Drawings.
    b. Manufacturer's O&M instructions, edited for this Project.
    c. Written record of level transmitter configuration settings.
    d. Include list of spare parts and tools provided.

1.05 WARRANTY

The surge control system shall carry a warranty of one year from completion of component test, and final acceptance by the City.

1.06 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.
1. American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels, Section VIII, Division 1, Latest Revision
2. Local Plumbing Codes
3. International Building Code (IBC)
4. National Electrical Code (NEC)

5. ASME B16.5 Pipe flanges and Flanged Fittings
6. ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers
7. ASME B31.1 Power Piping
8. ASTM A36/A36M Carbon Structural Steel
9. ASTM A53/A53M Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
10. ASTM A181/A181M Carbon Steel Forgings, for General-Purpose Piping
11. NSF/ANSI 61 Drinking Water System Components

PART 2 PRODUCTS

2.01 GENERAL

The vertical bladder-type surge tank shall be provided with the manufacturer's services at the jobsite at no additional cost to the Owner. One full 8-hour day of service from manufacturer's representative shall be provided per tank to approve the tank installation and advise the Contractor during startup, testing, and final adjustment of each tank. The manufacturer's representative shall include as part of this 8-hour day instruction to the Owner's personnel in the O&M of the tank system.

2.02 ACCEPTABLE PRODUCTS

A. Candidate equipment manufacturers include:
   1. Pulsco
   2. Young Engineering
   3. Charlatte
   4. Approved equal

2.03 MATERIALS

A. Minimum design pressure shall be as stated in this Section of the Specifications. Perform hydrostatic testing in shop. Test pressure shall be a minimum of 130% of the design pressure of the tank.

B. The bladder material and tank interior coating shall be National Sanitation Foundation (NSF-61) approved for potable water.

C. Complete anchor-bolt assembly (studs, nuts, washers, etc.) to be provided by installing contractor.

D. Provide a 1/2-inch threaded connection at the top of the tank to contain a gas-charging valve and 0 to 150 psig pressure gauge.

E. Tank shell will be constructed of deep-drawn, carbon steel, double-welded domes and side shells with double-welded seams.

F. Tank shall be equipped with a food-grade, heavy-duty, butyl rubber bladder. Bladders made of polyvinyl chloride (PVC) or polyester will not be allowed. The bladder shall have dimensions equal to and conforming to the inner shape of the surge vessel. The pre-charge pressure will be located inside the bladder.

G. The manway shall be removable with permanently mounted davit to allow inspection and maintenance of the bladder. Manway size shall be 24-inch diameter.

H. National Board-approved ASME Liquid Relief Valve set at 10% above the operating pressure shall be supplied.

2.04 EQUIPMENT

A. Design and Fabrication Requirements:

1. Equipment delivered under this section shall meet the requirements of Section VIII of the ASME Boiler Code. Minimum ASME pressure rating shall be 150 psig.

2. Each ASME constructed tank shall bear an ASME inspector's stamp, complete with design pressure, date and place of manufacture.

B. Hydropneumatic Tank:

1. All painting and coating shall be completed at the factory. Field-painting and coating will not be accepted. The tank interior shall be painted with two coats of an NSF-61 epoxy coating each with a uniform layer thickness of 5 to 6 mils, for a total of 10 to 12 mils dry film thickness. The tank exterior shall be painted with an anti-corrosion polyurethane and shall have a uniform layer with a minimum thickness of 10 mils.

2. The hydropneumatic tank shall be provided with integral factory-welded ASME fabricated steel pedestal supports for vertical mounting on the concrete equipment pads. The tank shall be fitted with the following accessories:
   a. Top- and side-mounted lifting rings.
   b. Air-charging valve.

2.05 VESSEL MONITORING

A. Flag-style magnetic level gauge (Jorgeson Magecator with 4-20 mA option) for visual monitoring of tank level. Level gauge shall be furnished with manual isolation valves at the top, at the bottom, and for draining the gauge.

B. A 2-inch, side-mounted, flanged connection shall be provided on the vessel outlet for tank drain with a 2-inch flanged stainless steel ball valve for isolation of the tank drain, Apollo standard port or equal. Ball valve provided with bolt kits and blind flange.

C. Provide tank pressure gage and isolation valve, in compliance with Section 40 73 00-4.02.

D. Spare Parts:

1. One spare bladder.
2. One manway gasket.

PART 3 EXECUTION

3.01 INSTALLATION

The hydropneumatic tank and accessories shall be installed, filled and pressurized in strict accordance with the tank manufacturer's written instructions. Initial tank pressurization shall be completed by the Contractor with a Contractor-supplied air compressor.

3.02 TESTING

A. The hydropneumatic tanks shall be completely tested to ensure compliance with operating requirements described in paragraph 1.02-B. Field-testing shall be in accordance with the testing procedures specified in Section 01 45 20. The tank and potable water pump control system, including pressure-relief and pressure-regulating valves and switches, shall be tested as a unit by the Contractor. The Contractor shall make all necessary adjustments to system setpoints to achieve the specified operating requirements.

B. The manufacturer's representative, Construction Manager, Owner, and the Contractor shall all be present during the on-site tests.

C. During testing, manufacturer’s representative shall take field measurements using a properly selected data-acquisition system capable of measurements at least ten (10) times per second. Measurements shall include pressure magnitude prior to, during, and after each shutdown with locations of testing at the pump station as a minimum, with optional locations at the two major pipeline high points.

END OF SECTION

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APPENDIX A
GEOTECHNICAL REPORTS

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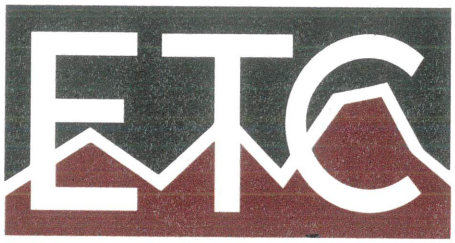


ENGINEERING & TESTING CONSULTANTS INC.

July 18, 2019

Ms. Tracy Moraca, PE, PMP
Brown and Caldwell
2 North Central Avenue
Suite 1600
Phoenix, AZ 85004

SUBJECT: SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT - ZONE 41 PUMP STATION AND WATERLINE

Dear Ms. Moraca:

Engineering & Testing Consultants, Inc., (ETC) has completed the geotechnical soil exploration for the above referenced project.

We understand that this phase of the project will include a new pump station and upsized pipeline installation.

The purpose of the geotechnical exploration is to evaluate the general subsurface soil and rock conditions at the locations provided to us. Representative samples were collected for laboratory testing and analysis in order to provide geotechnical recommendations for site grading, slabs-on-grade, foundation support, lateral design parameters, and slope stability for the proposed site improvements.

SITE & PROJECT INFORMATION

The Zone 41 site is generally located on the northeast corner of Willow Creek Road and Douglas Avenue.

We understand that the project will include a new pump station in the southwest corner of the facility. A smaller, existing structure is currently present near the west side of the proposed new building. The eastern portion of the proposed building area appears to be in an area that was somewhat low, and previously filled.

Boring B-1 - Area of proposed new Pump Station (Looking West)

In construction of the new pump station, any abandoned at-grade and underground site features associated with current and prior development shall be located and removed during the initial grading operation. As discussed herein, existing fills were also encountered, that will require removal and replacement, as needed, in controlled, compacted lifts.

Areas explored for the proposed new pipeline include Douglas Avenue, just west of Northside Drive, and the tank/towers access road along the east portion of the site. The access road north of Douglas Avenue slopes downward to the south at a relatively steep grade, with more moderate

to mild topography in the uphill portion of the site. Rock outcrops, and several trees and bushes were observed along the area of the existing access road.

Boring B-6 – Looking Northwest

Boring B-2 was performed on the eastern access road off Douglas Avenue in the southeast corner of the facility. An existing fill slope was observed just south of the boring and access road. The boring, B-2, encountered existing gravel fill.

Boring B-2 – Looking West (Fill slope west of fence)

SUBSURFACE CONDITIONS

ETC performed a total of six (6) exploratory test borings at locations provided to us. The exploratory borings were performed to determine general subsurface soil and rock conditions, and to collect representative subsurface soil samples for laboratory analysis. If soil conditions and/or project information differs from those described herein, ETC shall be contacted for review.

A more detailed description of the subsurface conditions encountered by each of the test borings is shown on the boring logs included in Appendix A. A Boring Location Map is attached as Figure 1.

Pump Station

Boring B-1 was performed in the area of the proposed pump station building. The eastern portion of the building site, where the boring was performed, appeared to a low area that was

previously filled to create a more level site. The upper 3 feet is likely fill, comprised of firm, low plasticity, Clayey Sand with Gravel (SC).

At a depth of 3 feet, boring B-1 encountered a medium dense, "decomposed granite" material, comprised of Clayey Silty Sand (SC-SM). An odor resembling decomposing organics was noted, confirming the observation that this area was likely a previous low area that was filled. Weathered Granite was encountered a depth of approximately 7¾ feet, to depths explored, 10 feet.

ETC is recommending that the existing fill in the area of the new building be removed to a minimum depth of 3 feet below existing grade, or finished pad grade, whichever depth is greater. Removal shall extend at least 5 feet outside of the building footprint. Any loose or otherwise unstable soils, if exposed at the bottom of the excavation, shall also be removed. The exposed ground surface shall be scarified, moisture conditioned, and compacted, except on rock. The removed soils may then be replaced in controlled, compacted lift, in accordance with the compaction criteria herein.

The soils encountered by boring B-1 are suitable for support of the proposed new building. However, high plasticity, expansive clay soils are present on the property. If encountered in the area of the building site, these clay soils will also require removal, as determined by the engineer.

Pipeline

The depth of dense and hard rock at different stages of weathering varied throughout the project site. Weathered rock was encountered below a depth of 7¼ feet in boring B-3. Borings B-4, B-5, and B-6 encountered rock at depths of 2 to 8.5 feet, with auger refusal on rock at depths as shallow as 5 to 8.5 feet.

Rock outcroppings are exposed on site, especially on the northern hillside. The Contractor should be prepared to encounter shallow, hard rock conditions at several locations.

Boring B-2 was performed near the southeast corner of the facility. Fill has previously been placed in this area of the site. This boring encountered approximately 1.5 feet of gravel road fill, underlain by firm, low to medium plasticity, Clayey Sand (SC). Medium dense, low plasticity, Sand with Clayey Silt and Gravel with occasional cobble was encountered below 4 feet, to depths explored, 10 feet.

The southeast boring, B-3, near Northside Drive, encountered 3 inches asphaltic concrete on 6 inches base course material. Subgrade soils consist of high plasticity Clayey Sand (SC) and Sandy Clay (CH). Medium dense to dense, Clayey Sand with Gravel (SC) was encountered below a depth of approximately 4.5 feet. Dense, decomposed/weathered rock material was encountered below 7¼ feet, to depths explored, 10 feet.

Borings B-4, B-5, and B-6 were drilled along the access road, north of Douglas Avenue. The overlying soils encountered by these borings typically consist of medium and high plasticity, Clayey Sand (SC) and Clayey Gravel (GC).

Weathered rock was encountered by boring B-4 at a depth of 3 feet, becoming more intact at 5.5 feet, to depths explored, 10 feet.

Lightly weathered rock was encountered by boring B-5 at a depth of 2 feet, with auger refusal on rock at 5 feet.

Boring B-6 encountered auger refusal on rock at 8.5 feet. However, basalt rock outcroppings were noted near to the boring location.

LABORATORY

Selected soil samples were collected for laboratory analysis to determine classification and general engineering properties of the soils encountered. Atterberg limits, gradation, and expansion index laboratory tests were performed for representative soil samples collected during the subsurface exploration.

Laboratory testing was performed in accordance with applicable ASTM standards. A summary of the laboratory test results is presented below in Table 1.

As shown in Table 1, low to high plasticity clayey soils were encountered at the site. The soils tested are typically granular, consisting of a majority sand and gravel. However, some soil with predominate clay was also encountered.

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

Boring	Depth (feet)	Liquid Limit (%)	Plasticity Index	Fines Content (%)	Gravel Content (%)	Moisture Content (%)	USCS
B-1	0 – 3	27	9	13	28	3.1	SC
B-1	3 – 7.5	22	6	19	10	4.2	SC-SM
B-2	1.5 – 4	31	12	19	12	4.7	SC
B-2	4 – 9	26	7	12	32	3.6	SP-SC-SM
B-3	1¾ – 3	60	37	53	1	24.1	CH
B-3	3 – 5	42	21	34	3	15.5	SC
B-4	1 – 2.5	53	27	36	5	16.8	SC
B-5	1 – 4	25	4	14	12	4.5	SC-SM
B-6	0 – 5	59	29	36	38	17.6	GC
B-6	5 – 8.5	39	11	19	35	12.8	SC

A summary of the in-place density testing is presented below in Table 2.

TABLE 2
IN-PLACE DENSITY TEST RESULTS

Boring	Depth (feet)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)
B-1	2.5 – 3	5.2	132.2	125.7
B-4	2 – 3	22.3	122.6	100.2

An expansion index test (ASTM D4829) was performed for a sample of the upper 3 feet of soil obtained from boring B-1, performed in the area of the pump station. The soil sample was compacted to approximately 48% saturation and inundated. Under a surcharge load of 144psf, the sample exhibited negligible swell, with a low expansion index of ***0***. The sample was tested at a remolded dry density of 120.3pcf, and compaction moisture content of 7.0%.

It is noted that expansive clay soils are present in the area. If encountered, ETC is recommending removal of any clay soil from the proposed building area.

Corrosivity

Selected samples of the on-site soils were collected for corrosion potential testing of the soils to buried pipeline.

Resistivity and pH testing were performed to evaluate the soil corrosivity. A summary of the test results is presented below in Table 3.

We are utilizing the 10-point scale developed by the American Water Works Association, Standard C105-05, and ASTM A888, Appendix X.

Resistivity values less than 1,500 ohm-cm add 10 points to the ten-point scale, indicating that the soil is corrosive to ductile iron pipe, and protection is recommended. As shown in Table 3, two of the samples tested meet this criterion. Values over 3,000 add 0 points.

The same specifications also state that pH values between 4 and 8.5 do not contribute to the corrosion potential of the soil.

TABLE 3
PH & RESISTIVITY TEST RESULTS

Boring	Depth (feet)	pH	Resistivity[1] (Ohm-cm)
B – 1	3 – 7¾	7.89	5,106
B – 3	3 – 5	7.52	973
B – 6	0 – 5	7.76	1,342

[1]Note: saturated (ASTM G57).

Using the above referenced standards, two of the three soil samples tested meet the 10 point criteria, *indicating that that the soil is corrosive to ductile-iron pipe, and protection is recommended.* Other

higher plasticity clayey soils were also encountered in other areas explored, which tend to be more corrosive.

Lead and Hexavalent Chromium

Selected samples of the on-site soils were also tested for Lead and Hexavalent Chromium levels. A summary of the test results is presented below in Table 4. More detailed test results are included in Appendix B.

TABLE 4
LEAD & HEXAVALENT CHROMIUM

Boring	Depth (feet)	Lead (mg/kg)	Hexavalent Chromium (mg/kg)
B – 1	3 – 7¾	5.24	<0.403
B – 3	3 – 5	7.67	<0.397
B – 6	0 – 5	10.8	<0.398

PUMP STATION

As discussed herein, the boring performed in the area of the pump station encountered some fill, approximately 3 feet. ETC is recommending existing fill, where encountered, be removed to a minimum depth of 3 feet below existing grade, or finished pad grade, whichever depth is greater.

Removal shall extend at least 5 feet outside of the building footprint. Any over-excavation may be terminated at a shallower depth where firm, granular, native soil is encountered.

High plasticity, expansive clay soils exist in the area. If encountered in the building site, clay shall also be removed, as determined by the engineer.

The exposed ground surface shall be scarified, moisture conditioned and compacted. The removed soils may be replaced in controlled, compacted lifts, per the compaction criteria herein.

Foundations

ETC recommends that all foundations be seated in firm, native, granular soils and/or compacted and tested fill.

All foundations shall be seated in the recommended bearing stratum at a minimum embedment depth of **1.5 feet**.

In determining foundation embedment depth, lowest, adjacent finished grade should be measured from within 5 feet of the foundations for exterior footings, and may be measured from finish floor for interior footings. Uncompacted fill and/or landscaping shall not be considered as finished grade.

Due to the anticipated varying foundation support conditions, ETC recommends a maximum allowable foundation pressure of **2,000 psf** be used for design.

Bottom of footing excavations shall be relatively level, and benched as needed. Footing excavations shall be free of loose, saturated, or otherwise unsuitable material.

The cavity between the footings/stem walls and trench sidewalls shall be adequately backfilled and compacted, to prevent the creation of a loose soil zone directly above or adjacent to foundations, which can allow moisture infiltration into foundation soils.

Continuous footings and stem walls should be reinforced to distribute stresses arising from small differential movements, and long exposed walls should be provided with control joints to accommodate these movements. Reinforcement and control joints are suggested to allow slight movement and minimize cracking.

Providing that site preparation is carried out as set forth herein, ETC has estimated differential movements to be less than ¾ inches. Increased movements may occur if adequate drainage is not maintained around the perimeter of the building, or foundation soils experience a significant increase in moisture content.

Special attention shall be given to design, final grading, and landscaping improvements to ensure efficient drainage away from foundations and slabs.

ETC shall be contacted to review the bottom of over-excavated areas prior to fill placement, to confirm adequate depth and extent of removal. ETC shall also be contacted to observe

foundation excavations to verify foundation-bearing soils and footing dimensions are in conformance with the construction documents and our recommendations presented herein.

Slabs-on-Grade

ETC recommends a minimum thickness of **6 inches** of processed aggregate base course in accordance with MAG Specifications, Section 702, be placed between the prepared subgrade and concrete slabs on grade.

A turndown edge is also recommended for exterior slabs, to help mitigate moisture infiltration into the underlying soils.

ETC recommends the American Concrete Institute (ACI) be used as a reference for placement, curing, and finishing of Portland cement concrete. Concrete should be placed at the appropriate slump determined by mix design, required strength, and application. After placement, concrete should be cured properly, and special attention shall be given to ensure adequate moisture is present during the initial curing process to prevent/reduce shrinkage and stress cracks.

Concrete slabs should be properly jointed, with maximum joint spacing of 24 to 36 times the slab thickness, unless noted otherwise. Any required saw cutting should be performed to an appropriate depth and in a timely manner, typically within 12 hours of concrete finishing.

It should be noted that for any exterior concrete, that the use of deicing salt within the first year of concrete placement can cause damage to the concrete surface. This can be avoided by using 4,500psi concrete with a water/cement ratio of 0.45 and a recommended fly ash content of 18%.

DRAINAGE

Positive drainage is critical to the successful performance of any foundation or slab system. Excess moisture infiltration into foundation soils is often the primary cause of soil-related problems below structures. Efficient surface and subsurface drainage should be established prior to and maintained during and after construction to prevent water from ponding and/or saturating the soils within or adjacent to building, pavements, concrete slabs, or other structural areas.

Due to the relatively shallow dense soil and/or rock conditions in areas of the site, storm water and heavy irrigation water may tend to flow at relatively shallow depths. Water may surface at the face of excavations, especially during times of inclement weather.

The design should intercept water seepage from cut slopes, and include drains that will intercept and adequately drain excessive water from any below grade levels, and behind retaining walls.

The design should divert water away from where it could penetrate the ground, particularly if granular fills are used. Care should be taken in design and construction to assure that water is contained to prevent seepage into the underlying soils. Roof water down pipes shall not discharge water adjacent to building foundations.

Special attention shall be given to providing for efficient surface drainage around the perimeter of the building, especially on the uphill side, and between the building and any adjacent cut slope.

ETC recommends that vegetation not be planted within 5 feet of buildings. Backfill against footings, exterior walls, and in utility trenches shall be adequately compacted to reduce the possibility of moisture infiltration through loose soil.

Special attention should be given to exterior grading to ensure efficient drainage away from the structures. Minimizing irrigation water near foundations and slabs, positive drainage of surface water away from the structures, and adequate compaction of soils around the structures and in utility trenches is very important for the long-term stability of foundation soils.

EARTHWORK

In construction of the new pump station, any abandoned at-grade and underground site features associated with current and prior development shall be located and removed during the initial grading operation. Any excavations made for removal shall be properly backfilled in controlled, compacted lifts.

As discussed herein, ETC is recommending existing fill, where encountered within the area of the proposed pump station building, be removed to a minimum depth of 3 feet below existing grade, or finished pad grade, whichever depth is greater.

Removal shall extend at least 5 feet outside of the building footprint. Over-excavation may be terminated at shallower depths wherever firm, granular, native soil is encountered, which is anticipated at least in the southwest portion of the building area. In addition, high plasticity expansive clay, if encountered in the building site, shall also be removed, as determined by the engineer.

Prior to fill placement, the ground surface must be stripped of all vegetation, debris, soft, loose, wet, or otherwise unstable soils and such material should be removed. Depressions and sloped ground should be widened or benched as necessary to accommodate compaction equipment and provide a level base for placing fill.

Prior to fill placement, the exposed ground surface shall be scarified, moisture conditioned, and compacted to a minimum depth of 8 inches, to the specifications herein, except on exposed rock. Special attention shall be given to ensure adequate moisture is present throughout the entire 8-inch depth. The materials testing firm shall be contacted prior to fill placement to observe that the exposed ground surface has been adequately prepared.

All subbase fill required to bring the structured areas up to subgrade elevation shall be placed in horizontal lifts not exceeding 8 inches compacted thickness.

The low plasticity, granular site soils should be suitable for use as fill within the building site. Any high plasticity clay soils, if encountered, shall not be used for fill within the building area.

Engineered fill material shall be used for retaining wall backfill, and for floor slab fill inside of any building stem walls. Engineered fill, where required, shall be clean, granular soil free of vegetation, debris, organic soil, and shall conform to the following requirements, as approved by the engineer:

- 100 percent passing 4" sieve;
- 0 to 36 percent passing No. 200 sieve;
- 30 to 100 percent passing No. 4 sieve;
- Maximum Plasticity Index (PI) of 15; and
- Maximum expansion index of 20.

All soils should be compacted to meet the criteria listed in Table 5. ETC recommends the observation of the site grading operation with sufficient tests to verify proper compaction.

TABLE 5
SOIL COMPACTION CRITERIA
(ASTM D698)

	Operation	Moisture Content	Degree of Compaction
I	**Building Pad**		
	Clayey Subgrade	-1% to +3% of Optimum	Minimum of **95%** of Maximum Dry Density
	Granular Soils	±2 % of Optimum	Minimum of **95%** of Maximum Dry Density
II	**Utility Trench Backfill and Backfill Adjacent to Footings or Stem Walls**		
	Clayey Soils	-1% to +3% of Optimum	Minimum of **95%** of Maximum Dry Density
	Granular Soils	±2 % of Optimum	Minimum of **95%** of Maximum Dry Density
III	**Pavement Areas**		
	Clay Soils	-4% to Optimum	Minimum of **95%** of Maximum Dry Density
	Granular Soils	±2 % of Optimum	Minimum of **95%** of Maximum Dry Density

Constructed Slopes

All fill slopes and soil cut slopes shall be constructed at a maximum slope angle of 2H:1V, with a minimum building setback distance of 5 feet from the top of any slope.

As discussed herein, the depth to rock varies significantly. If applicable, lower cuts into rock may be constructed at a maximum slope angle of 1.5H:1V, up to a maximum height of 12 feet, as approved by the engineer.

Rock cut slopes, if constructed, shall be constructed with careful rock excavation. Zones of softer/decomposed, and/or highly-fractured/weathered rock may not be apparent until a cut slope is exposed. Such strata, if encountered during construction, may require local slope angles to be adjusted accordingly.

Large cobbles, boulders, or unstable rock exposed on the face or at the top of any cut slope shall be removed to prevent future dislodgement due to weathering. Soil in the top of cut slopes should be rounded back from the slope face to create a gradual transition to natural grade. *For design purposes, rounding at the top of slope should begin within 3 feet of top of slope.*

Water shall be intercepted and prevented from flowing down the face of any constructed slope.

Utility Excavation and Installation

As noted herein, shallow rock conditions are expected in areas of the site. The depth of dense and hard rock at different stages of weathering varied throughout the project site. At the locations explored, weathered rock was encountered below a depth of 7¼ feet in boring B-3. Borings B-4, B-5, and B-6 encountered rock at depths of 2 to 8.5 feet, with auger refusal on rock at depths as shallow as 5 to 8.5 feet.

Rock outcroppings are exposed on site, especially on the northern hillside. The Contractor should be prepared to encounter shallow, hard rock conditions at several locations.

Shoring, sloping, benching, etc, of temporary slopes used for construction should be excavated in strict compliance with the Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA), 29 CFR, Part 1926 to maintain stability of excavation sidewalls.

Subsurface water was not encountered during the exploration. However, due to the lower, dense strata and/or rock, seeping water conditions may be encountered, especially during times of inclement weather. The Contractor should be prepared to dewater trench excavations, as needed, if water is encountered.

As shown in Table 1, granular site soils were encountered by some borings that meet MAG Section 601 for granular bedding/shading material. The medium to high plasticity clayey soils will not be suitable for use.

If potential bedding/shade materials are encountered that are desired for use, ETC recommends that the Contractor create stockpiles of the screened material for sampling, testing, and approval prior to use. This would require special attention by the Contractor during the excavation process to sort soil types into separate stockpiles for general trench backfill and potential bedding/shading backfill.

The native materials encountered should be suitable for use as trench backfill above the pipe shading, provided that the material is screened to remove any rock pieces 3 inches or larger in size (Detail 200Q-1).

Backfill compaction shall be completed on moisture-conditioned soil by mechanical methods, in accordance with MAG Standards. Water consolidation shall not be used.

LATERAL DESIGN PARAMETERS

ETC recommends the following parameters be used for design of retaining walls, if needed. Wall foundations shall be constructed in accordance with the recommendations herein for shallow foundations.

Retaining wall backfill shall consist of granular, non-expansive, on-site or imported, engineered fill, as specified herein. Retaining walls shall be waterproofed prior to being backfilled against, and drains shall be installed to help prevent saturation of wall backfill.

[1] Foundation Toe Pressure	1.33 x allowable bearing pressure
[2] Lateral Backfill Pressure:	
unrestrained walls	37 psf/foot
restrained walls	57 psf/foot
Lateral Passive Pressures:	
Firm native / Compacted fill	375 psf/foot
Coefficient of Base Friction:	
Firm native / Compacted fill	0.37

[1] Increase in allowable foundation bearing pressure (provided herein) for foundation toe pressure due to eccentric or lateral loading. The entire footing-bearing surface should remain in compression.

[2] Equivalent fluid pressures for vertical walls and horizontal backfill surfaces (maximum 12-foot height). Pressures do not include temporary forces imposed during compaction of the backfill, swelling pressures developed by over compacted clayey backfill, hydrostatic pressures from inundation or saturation of backfill, or surcharge loads. Walls should be suitably braced during backfilling to prevent damage and deflection.

LIMITATIONS

The figures and recommendations in this report were prepared in accordance with accepted professional engineering principles and soil mechanics practices. We make no other warranty, either implied or expressed. If during subsequent planning and construction, conditions are different than as indicated, this firm should be notified for evaluation.

We like to inform our clients that Portland cement concrete is not a perfect construction material. Due to the characteristics of Portland cement itself, cracking of the concrete may occur. Cracking will be minimized, but not eliminated, by providing appropriate control, isolation, construction joints, and quality control testing. Drying and thermal shrinkage of the slabs with resultant hairline cracking or curling may occur even if the slabs are cured under optimum curing conditions. In short, there is no practical method of ensuring that all floor cracking is eliminated utilizing slab-on-grade construction at the site.

This report is not a bidding document. Any contractor reviewing this report must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

For your use. Should you have any questions or concerns, please contact us at (928) 778-9001.

Sincerely,
ENGINEERING & TESTING CONSULTANTS, INC.

Registered Professional Engineer (Civil) CERTIFICATE NO. 37900 MICHAEL PHILIP WILSON Date Signed 7-18-19 ARIZONA, U.S.A.

Michael P. Wilson, P.E.
Project Engineer

Registered Professional Engineer (Civil) CERTIFICATE NO. 26853 RICHARD G. KELLEY Date Signed 7/18/19 ARIZONA, U.S.A.

Reviewed by: Richard G. Kelley, P.E.
Project Manager

Attachments: Figure 1 and Appendix A

cc: ETC File No. 10115

Legend

Approximate Boring Location

Engineering & Testing Consultants, Inc. •Subsurface Drilling •Geotechnical •Environmental Support	**FIGURE 1** **BORING LOCATION MAP**	ETC
Drawn by: others Date: 06/25/19 Project No: ETC 10115 Page No:	Zone 41 Prescott, AZ	

APPENDIX A

FIELD EXPLORATION

GENERAL NOTES

DESCRIPTIVE SOIL CLASSIFICATION:

Soil Classification is based on the Unified Soil Classification System and ASTM Designations D-2487 and D-2488. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine grained soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: Clays, if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse grained soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

CONSISTENCY OF FINE-GRAINED SOILS:

N-Blows/ft.	Consistency
0-2	Very Soft
3-4	Soft
5-8	Medium
9-16	Stiff
17-32	Very Stiff
33+	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS:

N-Blows/ft.	Relative Density
0-3	Very Loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL:

Description Term(s) (of Components Also Present in Sampling)	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY:

Major Component of Sampling	Size Range
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES:

Description Term(s) (of Components Also Present in Sampling)	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

UNIFIED SOIL CLASSIFICATION SYSTEM*

				Soil Classification	
				Group Symbol	Group Name [B]
COARSE-GRAINED SOILS More than 50 % retained on No. 200 sieve	Gravels More than 50 % of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5 % fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines More than 12 % fines [C]	Fines classify as ML or MH	GM	Silty gravel [F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel [F,G,H]
	Sands 50 % or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5 % fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]	SP	Poorly graded sand [I]
		Sands with Fines More than 12 % fines [D]	Fines classify as ML or MH	SM	Silty sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey sand [G,H,I]
FINE-GRAINED SOILS 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay [K,L,M,N] / Organic silt [K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay [K,L,M]
			PI plots below "A" line	MH	Elastic silt [K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay [K,L,M,P] / Organic silt [K,L,M,Q]
HIGHLY ORGANIC SOILS		Primarily organic matter, dark in color, and organic odor		PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15 % sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15 % gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.

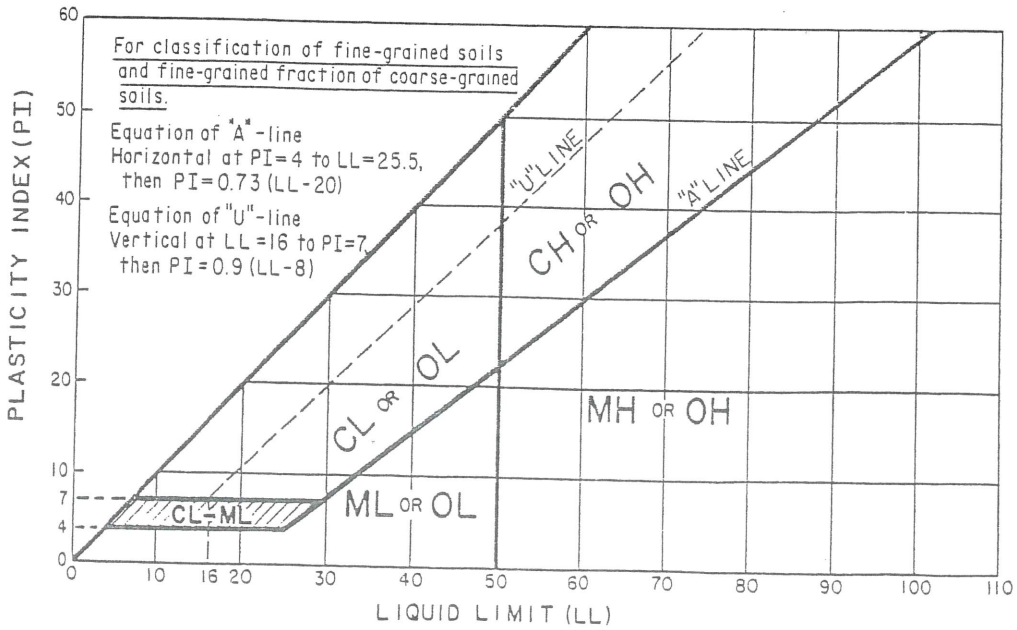
[M] If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



* ASTM 1996

LOG OF BORING NO. B-1

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS (Plastic Limit — Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50)	Remarks
	FILL - Clayey Sand with Gravel, brown, damp-moist, low PI, low to med fines, occasional cobble, Medium Dense	SC				LIKELY FILL
2						SPT=4/9/10
	CLAYEY SILTY SAND, low PI, medium fines, Medium Dense	SC-SM				LIKELY NATIVE - "Decomposed Granite" with odor of organics
4						
6						
8	WEATHERED GRANITE	ROCK				
10	Boring terminated at 10 feet depth.					
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

LOG OF BORING NO. B-2

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS	Remarks
	Gravel - Road embankment Fill	FILL				FILL
2	CLAYEY SAND, brown, damp, low to medium PI, some gravel, Medium Dense	SC				Likely Fill
	damp-moist					
4	SAND WITH CLAYEY SILT & GRAVEL, brown, damp, low PI, low fines, Medium Dense	SC-SM				Possibly Fill
	Occasional cobble					
6						
8						
10						
	Boring terminated at 10 feet depth.					
12						
14						

TEST RESULTS: Plastic Limit ⊢ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-5 PAGE 1 of 1

LOG OF BORING NO. B-3

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS (Plastic Limit — Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50)	Remarks
	3" ASPHALTIC CONCRETE	AC				Lower 1.5" weathered/ weak Likely Fill
	6" BASE COURSE MATERIAL	AB				
	CLAYEY SAND, reddish-brown, moist, med to high PI, high fines, Medium Dense	SC				
2	Brown, high fines & PI, some gravel	CH				Thin transition layer Likely Native
	SANDY CLAY, brown, moist, high PI, Stiff					
	CLAYEY SAND, reddish-brown, moist, high fines & PI, Medium Dense	SC				
4	Medium Dense to Dense					
	CLAYEY SAND WITH GRAVEL, brown, med to high PI, high fines, Medium Dense	SC				
6						
	CLAYEY SAND WITH GRAVEL, red, Dense	SC				Possibly weathered/ decomposed rock
8						
10	Boring terminated at 10 feet depth.					
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-6 PAGE 1 of 1

LOG OF BORING NO. B-4

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS: Plastic Limit — Liquid Limit; Water Content - ●; Penetration - ▨ (10 20 30 40 50)	Remarks
	CLAYEY SAND, dark brown, dry-damp, high fines & PI, Medium Dense	SC				"Decomposed Granite"
	CLAYEY SAND, med to high PI & fines, Medium Dense to Dense	SC				
2						SPT=6/12/21
	WEATHERED GRANITE	ROCK				
	Less weathered					
4						
	Relatively solid / more intact					
6						
8						
10						
	Boring terminated at 10 feet depth.					
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-7 PAGE 1 of 1

LOG OF BORING NO. B-5

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

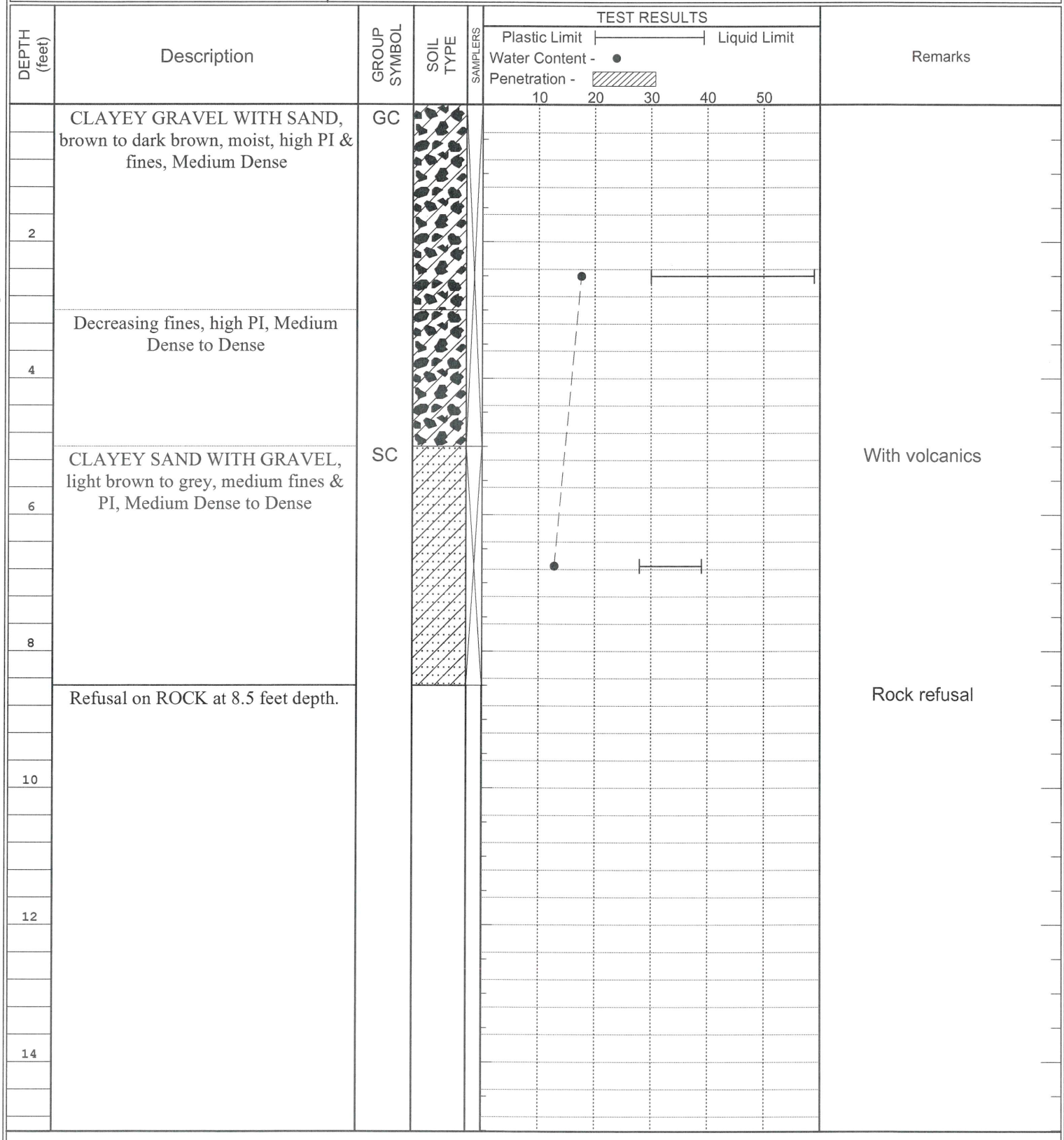
DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS: Plastic Limit ⊢ Liquid Limit; Water Content - ●; Penetration - ▨ (10 20 30 40 50)	Remarks
	CLAYEY SAND WITH GRAVEL, low to med PI	SC				Gravel/Cobbles/ Boulders accross surface
	CLAYEY SILTY SAND, low PI & fines	SC-SM				Transition layer to weathered basalt
2	HIGHLY WEATHERED BASALT ROCK	ROCK			● ⊢	
	Less weathered / more intact					
4	Refusal on ROCK at 4.5 feet depth.					Rock refusal
6						
8						
10						
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

LOG OF BORING NO. B-6

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-9 PAGE 1 of 1

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Clayey sand
	Poorly graded clayey silty sand
	Weatherd rock
	Fill
	Asphaltic Concrete
	Aggregate base material
	High plasticity clay
	Clayey gravel
Soil Samplers	
	Bulk sample taken from 4 in. auger
	Standard penetration test

Notes:

1. Exploratory borings were drilled on 6-25-19 using a 4-inch diameter continuous flight power auger.
2. No free water was observed at the time of drilling.
3. Boring locations provided to us were estimated from existing site features.
4. These logs are subject to the limitations, conclusions, and recommendations in this report.
5. Results of tests conducted on samples recovered are reported on the logs.

APPENDIX B

LABORATORY CHEMICAL ANALYSIS

Analytical Report 629530

for

Engineering & Testing Consultants

Project Manager: Jerid Ludwig

Brown & Caldwell Zone 41

ETC Project #10115

15-JUL-19

Collected By: Client

2525 West Huntington Drive, Suite 102
Tempe, AZ 85282
Ph: (480) 355-0900

Phoenix (EPA Lab Code: AZ00901): Arizona (AZ0757)
Xenco-Houston (EPA Lab code: TX00122): Arizona (AZ0765)
Xenco-Dallas (EPA Lab code: TX01468): Arizona (AZ0809)

15-JUL-19

Project Manager: **Jerid Ludwig**
Engineering & Testing Consultants
417 N. Arizona Ave.
Prescott, AZ 86301

Reference: TWA Report No(s): **629530**
Brown & Caldwell Zone 41
Project Address:

Jerid Ludwig:

We are reporting to you the results of the analyses performed on the samples received under the project name referenced above and identified with the TWA Report Number(s) 629530. All results being reported under this Report Number apply to the samples analyzed and properly identified with a Laboratory ID number. Subcontracted analyses are identified in this report with either the ADHS certification number of the subcontract lab in the analyst ID field, or the complete subcontracted report attached to this report.

Unless otherwise noted in a Case Narrative, all data reported in this Analytical Report are in compliance with ADHS standards. The uncertainty of measurement associated with the results of analysis reported is available upon request. Should insufficient sample be provided to the laboratory to meet the method and ADHS Matrix Duplicate and Matrix Spike requirements, then the data will be analyzed, evaluated and reported using all other available quality control measures.

The validity and integrity of this report will remain intact as long as it is accompanied by this letter and reproduced in full, unless written approval is granted by TransWest Analytical. This report will be filed for at least 5 years in our archives after which time it will be destroyed without further notice, unless otherwise arranged with you. The samples received, and described as recorded in Report No. 629530 will be filed for 45 days, and after that time they will be properly disposed without further notice, unless otherwise arranged with you. We reserve the right to return to you any unused samples, extracts or solutions related to them if we consider so necessary (e.g., samples identified as hazardous waste, sample sizes exceeding analytical standard practices, controlled substances under regulated protocols, etc).

We thank you for selecting TransWest Analytical to serve your analytical needs. If you have any questions concerning this report, please feel free to contact us at any time.

Respectfully,

Wendy Walfoort

Wendy Walfoort
Project Manager

Recipient of the Prestigious Small Business Administration Award of Excellence in 1994.
Certified and approved by numerous States and Agencies.
A Small Business and Minority Status Company that delivers SERVICE and QUALITY

Houston - Dallas - Midland - San Antonio - Phoenix - Oklahoma - Latin America

Sample receipt non conformances and comments:

Revised with corrected client.

Sample receipt non conformances and comments per sample:

None

Flagging Criteria

Arizona Flags

All method blanks, laboratory spikes, and/or matrix spikes met quality control objectives for the parameters associated with this Work Order except as detailed below or on the Data Qualifier page of this report. Data Qualifiers used in this report are in accordance with ADHS Data Qualifiers, Revision 4.0 9/05/2012.
Data qualifiers (flags) contained within this analytical report have been issued to explain a quality control deficiency, and do not affect the quality (validity) of the data unless noted otherwise in the case narrative.

Sample Cross Reference 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id	Matrix	Date Collected	Sample Depth	Lab Sample Id
B-1 3'-7 3/4'	S	06-19-19 12:01		629530-001
B-3 3'-5'	S	06-19-19 12:20		629530-002
B-6 0'-5'	S	06-25-19 11:08		629530-003

Certificate of Analytical Results 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id: **B-1 3'-7 3/4'**
Lab Sample Id: 629530-001

Matrix: Soil
Date Collected: 06.19.19 12.01

Date Received:06.28.19 14.20

Analytical Method: Metals, Total by SW 6010C
Tech: PJB
Analyst: DEP
Seq Number: 3094659

Date Prep: 07.05.19 11.35

Prep Method: SW3050B
% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Lead	7439-92-1	**5.24**	1.72	mg/kg	07.05.19 19.16		0.86

Analytical Method: Hexavalent Chromium by EPA 7196A
Tech: YAV
Analyst: YAV
Seq Number: 3094433

% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Chromium, Hexavalent	18540-29-9	<0.403	0.403	mg/kg	07.03.19 14.36		1.01

Certificate of Analytical Results 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id: **B-3 3'-5'**
Lab Sample Id: 629530-002

Matrix: Soil
Date Collected: 06.19.19 12.20

Date Received:06.28.19 14.20

Analytical Method: Metals, Total by SW 6010C
Tech: PJB
Analyst: DEP
Seq Number: 3094659

Date Prep: 07.05.19 11.35

Prep Method: SW3050B
% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Lead	7439-92-1	**7.67**	1.82	mg/kg	07.05.19 19.20		0.91

Analytical Method: Hexavalent Chromium by EPA 7196A
Tech: YAV
Analyst: YAV
Seq Number: 3094433

% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Chromium, Hexavalent	18540-29-9	<0.397	0.397	mg/kg	07.03.19 14.36		0.99

Certificate of Analytical Results 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id: **B-6 0'-5'**
Lab Sample Id: 629530-003

Matrix: Soil
Date Collected: 06.25.19 11.08

Date Received:06.28.19 14.20

Analytical Method: Metals, Total by SW 6010C
Tech: PJB
Analyst: DEP
Seq Number: 3094659

Date Prep: 07.05.19 11.35

Prep Method: SW3050B
% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Lead	7439-92-1	**10.8**	1.69	mg/kg	07.05.19 19.25		0.85

Analytical Method: Hexavalent Chromium by EPA 7196A
Tech: YAV
Analyst: YAV
Seq Number: 3094433

% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Chromium, Hexavalent	18540-29-9	<0.398	0.398	mg/kg	07.03.19 14.36		1

QC Summary 629530

Engineering & Testing Consultants

Brown & Caldwell Zone 41

Analytical Method: Metals, Total by SW 6010C — Prep Method: SW3050B
Seq Number: 3094659 — Matrix: Solid — Date Prep: 07.05.19
MB Sample Id: 7681430-1-BLK — LCS Sample Id: 7681430-1-BKS — LCSD Sample Id: 7681430-1-BSD

Parameter	MB Result	Spike Amount	LCS Result	LCS %Rec	LCSD Result	LCSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Lead	<0.476	100	101	101	101	101	75-125	0	20	mg/kg	07.05.19 18:26	

Analytical Method: Metals, Total by SW 6010C — Prep Method: SW3050B
Seq Number: 3094659 — Matrix: Soil — Date Prep: 07.05.19
Parent Sample Id: 629959-001 — MS Sample Id: 629959-001 S — MSD Sample Id: 629959-001 SD

Parameter	Parent Result	Spike Amount	MS Result	MS %Rec	MSD Result	MSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Lead	12.1	92.6	102	97	107	99	75-125	5	20	mg/kg	07.05.19 18:39	

Analytical Method: Hexavalent Chromium by EPA 7196A
Seq Number: 3094433 — Matrix: Solid
MB Sample Id: 3094433-1-BLK — LCS Sample Id: 3094433-1-BKS — LCSD Sample Id: 3094433-1-BSD

Parameter	MB Result	Spike Amount	LCS Result	LCS %Rec	LCSD Result	LCSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Chromium, Hexavalent	<0.400	16.0	16.2	101	16.2	101	85-115	0	20	mg/kg	07.03.19 14:36	

Analytical Method: Hexavalent Chromium by EPA 7196A
Seq Number: 3094433 — Matrix: Soil
Parent Sample Id: 629530-001 — MS Sample Id: 629530-001 S — MSD Sample Id: 629530-001 SD

Parameter	Parent Result	Spike Amount	MS Result	MS %Rec	MSD Result	MSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Chromium, Hexavalent	<0.403	16.1	16.2	101	16.2	101	85-115	0	20	mg/kg	07.03.19 14:36	

MS/MSD Percent Recovery
Relative Percent Difference
LCS/LCSD Recovery
Log Difference

[D] = 100*(C-A) / B
RPD = 200* | (C-E) / (C+E) |
[D] = 100 * (C) / [B]
Log Diff. = Log(Sample Duplicate) - Log(Original Sample)

LCS = Laboratory Control Sample
A = Parent Result
C = MS/LCS Result
E = MSD/LCSD Result

MS = Matrix Spike
B = Spike Added
D = MSD/LCSD % Rec

Chain of Custody

XENCO LABORATORIES

Houston,TX (281) 240-4200 Dallas,TX (214) 902-0300 San Antonio,TX (210) 509-3334
Midland,TX (432) 704-5440 EL Paso,TX (915) 585-3443 Lubbock,TX (806) 794-1296 Craslbad, NM (432) 704-5440
Phoenix,AZ (480) 355-0900 Atlanta,GA (770) 449-8800 Tampa,FL (813) 620-2000 West Palm Beach, FL (561) 689-6701

Work Order No: 629530

www.xenco.com Page 1 of 1

Project Manager:		Bill to: (if different)	
Company Name:	Brown + Caldwell	Company Name:	
Address:		Address:	
City, State ZIP:		City, State ZIP:	
Phone:	Email:		

Work Order Comments

Program: UST/PST ☐ PRP ☐ Brownfields ☐ RRC ☐ Superfund ☐
State of Project:
Reporting:Level II ☐ Level III ☐ PST/UST ☐ TRRP ☐ Level IV ☐
Deliverables: EDD ☐ ADaPT ☐ Other:

Project Name:	Brown + Caldwell, Zone 41	Turn Around	
Project Number:	ETC Project # 10115	Routine	☑
Project Location		Rush:	
Sampler's Name:		Due Date:	
PO #:	Quote #:		

SAMPLE RECEIPT				
Temperature (°C):	28.1	Temp Blank: Yes (No)	Wet Ice: Yes (No)	
Received Intact:	(Yes) No	Thermometer ID		
Cooler Custody Seals:	Yes No (N/A)	Correction Factor:		
Sample Custody Seals:	Yes No (N/A)	Total Containers:	3	

Preservative Codes

MeOH: Me
None: NO
HNO3: HN
H2S04: H2
HCL: HL
NaOH: Na
Zn Acetate+ NaOH: Zn

TAT starts the day recevied by the lab, if received by 4:00pm

Lab ID	Sample Identification	Matrix	Date Sampled	Time Sampled	Depth	Number of Containers	Total Lead	Hexavalent Chromium	Sample Comments
1	B-1 3'-7¾'	S	6/19/19	12:01		1	X	X	
2	B-3 3'-5'	S	6/19/19	12:20		1	X	X	
3	B-6 0'-5'	S	6/25/19	11:08		1	X	X	

Total 200.7 / 6010 200.8 / 6020: 8RCRA 13PPM Texas 11 Al Sb As Ba Be B Cd Ca Cr Co Cu Fe Pb Mg Mn Mo Ni K Se Ag SiO2 Na Sr Tl Sn U V Zn

Circle Method(s) and Metal(s) to be analyzed TCLP / SPLP 6010: 8RCRA Sb As Ba Be Cd Cr Co Cu Pb Mn Mo Ni Se Ag Tl U 1631 / 245.1 / 7470 / 7471 : Hg

Notice: Signature of this document and relinquishment of samples constitutes a valid purchase order from client company to Xenco, its affiliates and subcontractors. It assigns standard terms and conditions of service. Xenco will be liable only for the cost of samples and shall not assume any responsibility for any losses or expenses incurred by the client if such losses are due to circumstances beyond the control of Xenco. A minimum charge of $75.00 will be applied to each project and a charge of $5 for each sample submitted to Xenco, but not analyzed. These terms will be enforced unless previously negotiated.

Relinquished by: (Signature)	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Received by: (Signature)	Date/Time
1	Fedex		2		
3 Fedex		6/28/19 14:20	4		
5			6		

Revised Date 022619 Rev. 2019.1

Final 1.001

XENCO Laboratories
Prelogin/Nonconformance Report- Sample Log-In

Client: Brown & Caldwell

Date/ Time Received: 06/28/2019 02:20:00 PM

Work Order #: 629530

Acceptable Temperature Range: 0 - 6 degC
Air and Metal samples Acceptable Range: Ambient

Temperature Measuring device used : IR#1

Sample Receipt Checklist		Comments
#1 *Temperature of cooler(s)?	28.1	
#2 *Shipping container in good condition?	Yes	
#3 *Samples received on ice?	No	Cooling started upon receipt at laboratory.
#4 *Custody Seals intact on shipping container/ cooler?	N/A	
#5 Custody Seals intact on sample bottles?	N/A	
#6*Custody Seals Signed and dated?	N/A	
#7 *Chain of Custody present?	No	COC filled out by Xenco from verbal client information.
#8 Any missing/extra samples?	No	
#9 Chain of Custody signed when relinquished/ received?	No	
#10 Chain of Custody agrees with sample labels/matrix?	Yes	
#11 Container label(s) legible and intact?	Yes	
#12 Samples in proper container/ bottle?	Yes	
#13 Samples properly preserved?	No	Not on ice.
#14 Sample container(s) intact?	Yes	
#15 Sufficient sample amount for indicated test(s)?	Yes	
#16 All samples received within hold time?	Yes	
#17 Subcontract of sample(s)?	Yes	Xenco Stafford
#18 Water VOC samples have zero headspace?	N/A	

*** Must be completed for after-hours delivery of samples prior to placing in the refrigerator**

Analyst: EP

PH Device/Lot#:

Checklist completed by: Emily Petrunia Date: 06/28/2019

Checklist reviewed by: Wendy Walfoort Date: 07/14/2019

Wendy Walfoort

ENGINEERING & TESTING CONSULTANTS INC.

September 23, 2019

Ms. Tracy Moraca, PE, PMP
Brown and Caldwell
2 North Central Avenue
Suite 1600
Phoenix, AZ 85004

SUBJECT: ADDENDUM TO SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT - ZONE 41 PUMP STATION AND WATERLINE

Dear Ms. Moraca:

Engineering & Testing Consultants, Inc., (ETC) has prepared this report as an addendum to the soils report we prepared for the above referenced project, dated July 18, 2019.

The purpose of this addendum is to provide pavement structure recommendations for the maintenance driveway from Douglas Avenue, north to the tank site.

As discussed in the original report, the subsurface soils encountered at the site consist of moist, stiff, high plasticity, sandy clay (Unified Soil Classification CH).

Site grading for pavement areas should be performed as outlined in the original report, with the compaction modifications herein, to provide adequate subgrade support for the pavement structure.

The high plasticity clay subgrade soils encountered provide reduced structural support. Therefore, increased pavement sections are recommended. ETC recommends the pavement structural sections as described in Table 1 for the proposed development.

TABLE 1
PAVEMENT STRUCTURAL SECTION

Description	Alternative	Portland Cement Concrete Thickness (inches)	Asphaltic Concrete Thickness (inches)	Aggregate Base Thickness (inches)	Prepared Subgrade Thickness (inches)
Drives & Access	1	---	3	9	8
	2	---	4	6	8
	3	5	---	6	8
Parking Stalls (Optional)	1	5	---	4	8
	2	---	3	6	8

In accordance with ACI 325, Portland cement concrete pavement shall have a minimum 28-day compressive strength of 3,500 psi or greater with 4% to 6% entrained air, and a maximum slump of 4 inches.

A thickened edge is recommended for Portland cement concrete pavement on all sides without integral edge curb support. A thickened edge should be increased by at least 2 inches over a minimum distance of 3 feet.

It should be noted that for exterior concrete, the use of deicing salt within the first year of concrete placement can cause damage to the concrete surface. This can be avoided by using 4,500psi concrete with a water/cement ratio of 0.45 and a fly ash content of 18 percent.

The recommended pavement sections are expected to function with periodic maintenance or overlays when the subgrade, base, and pavement are constructed in accordance with MAG Construction Standards with Town of Prescott Valley modifications.

Efficient surface water drainage must be provided and maintained to help prevent moisture infiltration into the subgrade.

Prior to placement of aggregate base material, the exposed subgrade shall be proof-rolled to confirm stable subgrade soils.

Compaction

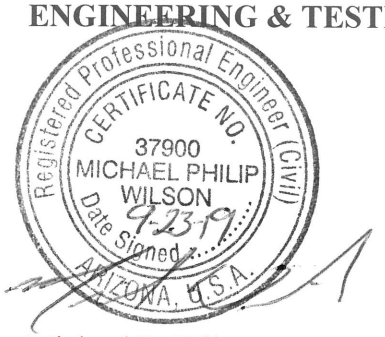
For pavement areas, ETC recommends all soils be compacted to a minimum relative dry density of 95% of maximum dry density (ASTM D698). Clay soils should be compacted at a moisture content range of -3% to +1% of Optimum Moisture. Granular soils should be compacted at a moisture content range of +/-2% of Optimum.

For your use. This addendum is part of a complete soils report and does not stand alone. Other comments and recommendations not specifically addressed herein shall remain applicable to the project.

Should you have any questions or concerns, please contact us at (928) 778-9001.

Sincerely,

ENGINEERING & TESTING CONSULTANTS, INC.



Michael P. Wilson, P.E.
Project Engineer

Reviewed by: Richard G. Kelley, P.E.
Project Manager

cc: ETC File No. 10115

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ENGINEERING & TESTING CONSULTANTS INC.

September 27, 2023

Brown and Caldwell
Attn: Ms. Theresa Muller
2 North Central Avenue, STE 1600
Phoenix, AZ 85004

SUBJECT: 2ND ADDENDUM TO SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT - ZONE 41 PUMP STATION AND WATERLINE

Dear Ms. Muller:

Engineering & Testing Consultants, Inc., (ETC) has prepared this addendum to provide project soil site classification for seismic considerations. The original report we prepared for the project is dated July 18, 2019

From review of the borings we previously performed in the area of the pump station, granite rock was encountered below a depth of approximately 7¾ feet.

*Due to the shallow rock conditions encountered by the site borings, it is ETC's recommendation that a Soil Site Class of "**B**" be used for seismic considerations, per 2018 IBC and ASCE 7.*

This addendum is part of a complete geotechnical report and does not stand-alone. Other comments and recommendations not specifically addressed in this addendum shall remain applicable to the project.

Should you have any questions or concerns, please contact us at (928) 778-9001.

Sincerely,

ENGINEERING & TESTING CONSULTANTS, INC.

Michael P. Wilson, P.E.
Project Engineer

Reviewed by: Richard G. Kelley, P.E.
Project Manager

cc: *TMuller@BrwnCald.com*
ETC File No. 10115

CIP: 17-009
Zone 41 (Mingus) Pump Station, Tank and Pipeline Project

Project Special Provisions

SPONSOR/OWNER:
CITY OF PRESCOTT, ARIZONA
DEPARTMENT OF PUBLIC WORKS

ENGINEER/CONSTRUCTION MANAGER:
BROWN AND CALDWELL
2 NORTH CENTRAL AVENUE, SUITE 1600
PHOENIX, ARIZONA 85004

July 2022

THE SPECIAL PROVISIONS SHALL MODIFY AND SUPERSEDE THE VARIOUS SECTIONS OF THE CITY OF PRESCOTT (COP) SUPPLEMENT TO THE MARICOPA ASSOCIATION OF GOVERNMENTS (MAG) UNIFORM STANDARD SPECIFICATIONS AND DETAILS FOR PUBLIC WORKS CONSTRUCTION, TECHNICAL SPECIFICATIONS DATED 2/14/19.

City of Prescott Public Works
433 N. Virginia Street, Prescott, Arizona 86301
Ph: 928.777.1130 | TDD: 928.777.1100 | Fax: 928.771.5929

SPECIAL PROVISIONS

104 SCOPE OF WORK

ADD the following:

Project Description and Location:

The project generally consists of replacing two existing 200,000-gallon water storage tanks and replacing with a single 750,000-gallon water storage tank. The project includes replacing the existing Mingus Pump Station to meet demands and upsize the pipeline between the pump station and the new tank.

All construction elements, as identified in the Bid Schedule, shown on the plans or details or described in the Special Provisions, are required for construction and are to include all costs associated with removals, earthwork, trenching, subgrade construction, water tank construction, pump station construction, valves, fittings, tapping sleeves, appurtenances, utility boxes, bedding, pavement replacement, hauling, placing, disposing of, start up, testing, certifying, or any other associated work and materials required for a complete in place and operable item of construction. All work items and materials not specifically itemized in the bid schedule and that are required for the construction are to be considered incidental to the total project bid amount.

104.1.6 Site Maintenance

To maintain a clean construction site, all demolished materials, to include but not limited to, asphalt pavement, concrete, rock, dirt, pipes, and so on shall be removed from the site by the end of each work shift. Stock piling of excess materials on site shall not be allowed. The only material to be stock piled on site shall be materials specifically intended for use or re-use the same work shift. Long term storage of water, sewer, and storm drainpipe and fittings shall not be stored on City streets. No more water, sewer, and storm drainpipe and fittings shall be delivered to the site than can be used the same week.

No separate payment shall be made for meeting these requirements.

106 CONTROL OF MATERIALS

ADD as follows:

106.1 Source of Materials and Quality

Asphaltic Concrete Hot Plant Reports shall be provided to the Owner for all daily production runs. Reports shall be submitted at the weekly construction meetings following the production runs.

107 LEGAL REGULATIONS AND RESPONSIBILITY TO PUBLIC

MODIFY as follows:

107.15 Public Relations

Delete Section 107.15.2 (B)

Pay Item:

107.15 SP	Public Relations (Allowance - ALL)

201 CLEARING AND GRUBBING

ADD the following:

The site shall be cleared and grubbed per the plans and the COP Supplement. The site shall be left clear of rocks, except 3-inch minus and rocks to be salvaged and reused as rip rap.

Payment shall be based on the lump sum basis and shall include removal of all vegetation, including trees, as shown on the plans.

The site shall be graded per the grading and construction plans. Any excess materials shall be removed from the site and properly disposed of.

Payment shall be based on the lump sum basis and shall include all grading as shown on the plans.

Pay Items:

201 SP	Clearing and Grubbing (LS)
201 SP	Site Grading per Grading Plan (LS)

205 ROADWAY EXCAVATION

SUPPLEMENT as follows:

205.2 Measurement:

The roadway prism shall include measurement from back of curb to back of curb in those areas where curbs are required. Where no curbs are required, measurement shall be from edge of pavement to edge of pavement. No measurement or separate payment will be made for driveways, parkways, and sidewalks which shall be considered incidental to those items of work.

Pay Item:

205.2 SP	Unsuitable Material - Provisionary Item - May Not Be Used (CY)

MAG 215 EARTHWORK FOR OPEN CHANNELS

ADD the following to MAG 215.3:

215.3.2a Earthwork for Sedimentation Pond

Measurement and payment include all necessary work to complete excavation of the Sedimentation Pond as illustrated on the Plans.

215.3.2b Earthwork for Berm/Sedimentation Pond

Measurement and payment include all necessary work to complete excavation and embankment to construct the Berm/Sedimentation Pond as illustrated on the Plans.

215.3.2c Earthwork for Slope Restoration

Measurement and payment include all necessary work to complete excavation and embankment for the slope restoration as illustrated on the Plans.

215.8 Payment

Pay Items:

215.3.2a SP Earthwork for Sedimentation Pond (CY)
215.3.2b SP Earthwork for Berm/Sedimentation Pond (LS)
215.3.2c SP Earthwork for Slope Restoration (LS)

MAG 220 RIP RAP CONSTRUCTION

ADD the following to MAG 220:

220.1 Rip Rap Construction

Rock rip rap shall be constructed using the sections and horizontal control shown on the plans. Rock rip rap shall have a D_{50} size of 6". The rip rap shall be placed a minimum of 12-inches thick on Filter Fabric

220.8 Payment

Pay Item:

220.1 SP Rip Rap Placement, D_{50} = 6" Placed 12" Thick Over Filter Fabric (CY)

301 SUBGRADE PREPARATION

MODIFY as follows:

301.7 Measurement

REPLACE the second sentence with the following:

The areas under concrete curb and gutter, sidewalk and concrete driveway entrances will be included.

Pay Item:

301 SP Subgrade Preparation (SY)

321 PLACEMENT AND CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

ADD as follows:

321.5 Mix Design

The mix design to be used for this project shall be a high traffic mix design meeting the requirements for a ¾" mix design per MAG Section 710. Mix design criteria shall be per Section 710.3.2 using a Marshall Mix Design.

321.12 (B) Payment

Pay Item:

321 SP Asphalt Concrete (AC) Pavement, 4" Thick – Two Lifts (SY)

340 CONCRETE CURB, GUTTER, SIDEWALK, SIDEWALK RAMPS, DRIVEWAY, & ALLEY ENTRANCE

SUPPLEMENT as follows:

340.2 Materials

All concrete used on the project shall be 4,000 psi. This applies to all concrete used on the project. Any references on the plans or standard details for the use of lower strength concrete shall be revised via this special provision to be 4,000 psi concrete.

The Concrete Stair with Handrail shall be constructed per the detail shown on the plans. Payment shall be per lump sum for a complete unit in place, to include the handrail.

The Concrete Valley Gutter shall be constructed as illustrated on the Plans and in compliance with Quad City Standard Detail 240Q-2.

340.6 Payment

Pay Items:

340.6(a) SP	Curb and Gutter per QCSD 220Q-1 (Type 'C') (LF)
340.6(b) SP	Curb and Gutter per QCSD 220Q-1 (Type 'D') (LF)
340.6(c) SP	Curb and Gutter Transition per QCSD 221Q (EA)
340.6(d) SP	Residential Driveway - 6" Thick Concrete Slab (SF)
340.6(e) SP	Concrete Stair with Handrail (LS)
340.6(f) SP	Concrete Valley Gutter per QCSD 240Q-2 (SF)

ADD the following:

340.9 Acceptance

The Contractor is responsible for protecting the finish surface of concrete by keeping footprints, tire impressions, graffiti, names, etc. from becoming part of the finished product. This may require special scheduling of materials, delivery and/or manpower. All defaced concrete shall be replaced by the Contractor at no extra cost to the Owner. Patching is not acceptable. Cracked concrete will also require replacement. The City will determine the removal and replacement limits of the cracked, damaged, or defaced concrete. Removal shall require a neat saw cut edge or removal to the nearest joint.

345 ADJUSTING FRAMES, COVERS AND VALVE BOXES

Pay Items:

345.3 SP	Adjust Sewer Cleanout Frame and Cover to Grade per Quad City Std. Detail 270Q (EA)
345.4 SP	Adjust Water Valve Box and Cover to Grade per Quad City Std. Detail 391Q (EA)

350 REMOVAL OF EXISTING IMPROVEMENTS

ADD the following:

350.4.1 Removal of Existing Tank Drain

The Contractor is responsible for removing the existing tank drain 18” CMP piping and catch basin as illustrated on the Plans.

Pay Item:

350.4.1 SP	Remove Existing Tank Drain 18” CMP piping/catch basin (LS)

ADD the following:

350.11 Existing Mailbox Removal and Reinstallation per Quad City Std. Detail 134Q-1

The Contractor is responsible for removing and reinstalling existing mailboxes. This work shall be coordinated with the owner and the USPS. The mailboxes shall be reinstalled in accordance with Quad City Standard Detail 134Q-1, USPS requirements and to the satisfaction of the mailbox owner.

Pay Item:

350.11 SP Existing Mailbox Removal and Reinstallation per Quad City Std. Detail 134Q-1 (EA)

401 TRAFFIC CONTROL

Pay Items:

401 SP Traffic Control Plan (LS)
401.2(a) SP Barricades and Storage (LS)
401.2(b) SP Incidental Traffic Related Items (LS)
401.3(a) SP Flaggers (HR)
401.3(b) SP Uniformed Off-Duty Law Enforcement Officers (Allowance – ALL)

MAG 420

MAG Section 420

ADD as follows:

Pay Item:

420 SP Chain Link Fence and Gates per MAG 420 (LF)

505 CONCRETE STRUCTURES

ADD the following:

505.1.1 Minor Structures

All concrete used on the project shall be Class AA, 4,000 psi. This applies to all concrete used on the project. Any references on the plans or standard details for the use of lower strength concrete shall be revised via this special provision to be Class AA, 4,000 psi concrete.

Exposed concrete retaining wall and headwalls shall include Natina stain concrete colorant. No separate measurement or payment shall be made for the concrete colorant and shall be included in the respective unit bid price for headwalls and retaining walls.

Pay Items:

505.1.1(a) SP Catch Basin – Type 'G' per MAG SD 537(EA)
505.1.1(b) SP Headwall Drop Inlet per MAG SD 501-5 (EA)
505.1.1(c) SP Outlet Headwall per MAG 501-1 (EA)
505.1.1(d) SP Concrete Retaining Wall (SF)

520 STEEL AND ALUMINUM HANDRAILS

Pay Item:

520 SP Safety Rail per QCSD 145Q (LF)

601 TRENCH EXCAVATION, BACKFILLING AND COMPACTION

ADD the following:

601.2.12 Backfill

Trench Stabilization

A. When high water levels cause saturated materials, or when unstable materials are encountered in the utility trenches, the Contractor shall contact the Public Works Director or his designee. The trench shall be over excavated to a depth 2 feet below the 6 inches of bedding for a total of 2.5 feet below the new utility pipe to be free of deleterious materials. Trench width shall be 2' wide plus outside diameter of the pipe. The trench bottom and sides in the over excavation area shall be lined with filter fabric approved by the City. The bottom 2 feet shall be backfilled with leach aggregate that is clean graded hard rock, volcanic rock or gravel of uniform size ¾" to 2-1/2" in diameter, washed or prepared to be free of fine materials. The filter fabric shall be folded over the top of the leach rock to prevent infiltration of fine materials from the bedding and shading material. Bedding material shall be placed over the fabric.
B. The over excavation shall be jointly measured by the Owner and Contractor. The pay item covers over excavation, removal and disposal of over excavated material, imported and placement of leach rock, filter fabric, all labor and equipment cost. The Contractor may not claim additional delay change order cost because of encountering saturated materials, or unstable materials but may claim additional time.

601.8 Measurement and Payment

Pay Item:

601.2.11(a) SP	Rock Excavation for Utility Construction (Water - Provisionary Item - May Not Be Used)
601.2.11(b) SP	Rock Excavation for Utility Construction (Drainage - Provisionary Item - May Not Be Used)
601.2.11(c) SP	Trench Stabilization (Water - Provisionary Item - May Not Be Used)
601.2.11(d) SP	Trench Stabilization (Storm Drain - Provisionary Item - May Not Be Used)

610 WATER LINE CONSTRUCTION

ADD the following:

610.4.5 Testing

The Contractor shall provide a testing, disinfecting and flushing plan for the water line construction for approval by the City Utility Manager prior to commencement of work.

610.16 Measurement and Payment

Pay Items:

610.3(a) SP	24" Restrained Joint DIP Water Main (LF)
610.3(b) SP	18" Restrained Joint DIP Water Main (LF)
610.3(c) SP	16" Restrained Joint DIP Water Main (LF)
610.3(d) SP	12" Restrained Joint DIP Water Main (LF)
610.3(e) SP	8" Restrained Joint DIP Water Main (LF)
610.3(f) SP	4" Restrained Joint DIP Water Main (LF)
610.13 SP	Water Service Connection per QCSD 316P (1") (EA)

612 TEMPORARY WATER MAINS (FLY LINES)

ADD the following:

The temporary water mains (fly lines) sizes shall be provided as indicated in Specification Section 01 12 16 and as shown in the Contract Drawings.

612 (E) Measurement and Payment

Pay Item:

612 SP	Temporary Water Main (Fly Lines) Sta 85+00 to 86+00 (LF)
612 SP	Temporary Water Main (Fly Lines) to existing water service meters (LF)

615 SANITARY SEWER LINE CONSTRUCTION

ADD the following:

615.2 Extra Protection at Water/Sewer Intersection at Douglas/Northside Intersection (Special Provision)

The new water main will be constructed under the existing sewer main at the intersection of Douglas Avenue and Northside Drive. The Contractor shall provide required water/sewer separation at this (and any other project locations) and furnish and install extra protection as required. Also, extra protection shall be provided per 405Q.

Pay Item:

615.2 SP	Extra Protection at Water/Sewer Intersection at Douglas/Northside Intersection (EA)

618 STORM DRAIN CONSTRUCTION

ADD the following:

Pay Items:

618(a) SP	Storm Drain per QCSD 200Q-1 (18" Ø HDPE) (LF)
618(b) SP	Storm Drain per QCSD 200Q-1 (24" Ø RCP) (LF)

630 TAPPING SLEEVES, VALVES AND VALVE BOXES ON WATER LINES

630.9 Payment

Pay Items:

630.4(a) SP	6” Tapping Sleeves and Valves (EA)
630.4(b) SP	8” Tapping Sleeves and Valves (EA)
630.5 SP	18” Butterfly Valve, Box and Cover per QCSD 301Q & 391Q (EA)
630.5(a) SP	12” Gate Valve, Box and Cover per QCSD 301Q & 391Q (EA)
630.5(b) SP	8” Gate Valve, Box and Cover per QCSD 301Q & 391Q (EA)
630.5(c) SP	6” Gate Valve, Box and Cover per QCSD 301Q & 391Q (EA)
630.5(d) SP	4” Gate Valve, Box and Cover per QCSD 301Q & 391Q (EA)
630.6 SP	Combination Valve Assembly (ARV) per QCSD 317Q (EA)
630.6.1 SP	Blow Off Assembly per QCSD 318P (EA)

650 ABANDONMENT AND REMOVAL OF WATER MAIN

650.3 Measurement

MODIFY the first paragraph as follows:

Measurement for abandonment of water main and laterals shall be by each location where abandonments are called for on the plans. Hydrants, valves, fittings, vaults, services, concrete end caps (12-inch minimum) and other appurtenances shall be considered incidental to water main abandonment.

650.4 Payment

Pay Items:

650.1 SP	Water Main Abandoned in Place (EA)
650.2 SP	Existing Water Main Removal (LF)

MAG 701

MAG Section 701.2

ADD as follows:

Pay Item:

701.2 SP	Fine Gravel (SY)

703 RIP RAP

ADD as follows:

MAG Section 703.2 (C)

MODIFY as follows:

The loss by abrasion in the Los Angeles Abrasion Machine, determined as described in ASTM C535, shall not exceed 40 percent (by weight) after 500 revolutions.

710 ASPHALTIC CONCRETE

ADD as follows:

710.2.2 Aggregate Fractured Faces

95% of the course aggregate shall have a minimum of one fractured face, and a minimum of 90% shall have 2 or more fractured faces. Historical L.A. Abrasion test results shall not be permitted.

710.3.1 General

The date of the mix design shall not be older than 1 year from the date of the submittal.

710.3.2.1 Marshall Mix Design

The minimum Tensile Strength Ration (TSR) shall be 75% and the minimum dry Tensile Strength shall be 125psi.

ENGINEERING & TESTING CONSULTANTS INC.

July 18, 2019

Ms. Tracy Moraca, PE, PMP
Brown and Caldwell
2 North Central Avenue
Suite 1600
Phoenix, AZ 85004

SUBJECT: SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT - ZONE 41 PUMP STATION AND WATERLINE

Dear Ms. Moraca:

Engineering & Testing Consultants, Inc., (ETC) has completed the geotechnical soil exploration for the above referenced project.

We understand that this phase of the project will include a new pump station and upsized pipeline installation.

The purpose of the geotechnical exploration is to evaluate the general subsurface soil and rock conditions at the locations provided to us. Representative samples were collected for laboratory testing and analysis in order to provide geotechnical recommendations for site grading, slabs-on-grade, foundation support, lateral design parameters, and slope stability for the proposed site improvements.

SITE & PROJECT INFORMATION

The Zone 41 site is generally located on the northeast corner of Willow Creek Road and Douglas Avenue.

We understand that the project will include a new pump station in the southwest corner of the facility. A smaller, existing structure is currently present near the west side of the proposed new building. The eastern portion of the proposed building area appears to be in an area that was somewhat low, and previously filled.

Boring B-1 - Area of proposed new Pump Station (Looking West)

In construction of the new pump station, any abandoned at-grade and underground site features associated with current and prior development shall be located and removed during the initial grading operation. As discussed herein, existing fills were also encountered, that will require removal and replacement, as needed, in controlled, compacted lifts.

Areas explored for the proposed new pipeline include Douglas Avenue, just west of Northside Drive, and the tank/towers access road along the east portion of the site. The access road north of Douglas Avenue slopes downward to the south at a relatively steep grade, with more moderate

to mild topography in the uphill portion of the site. Rock outcrops, and several trees and bushes were observed along the area of the existing access road.

Boring B-6 – Looking Northwest

Boring B-2 was performed on the eastern access road off Douglas Avenue in the southeast corner of the facility. An existing fill slope was observed just south of the boring and access road. The boring, B-2, encountered existing gravel fill.

Boring B-2 – Looking West (Fill slope west of fence)

SUBSURFACE CONDITIONS

ETC performed a total of six (6) exploratory test borings at locations provided to us. The exploratory borings were performed to determine general subsurface soil and rock conditions, and to collect representative subsurface soil samples for laboratory analysis. If soil conditions and/or project information differs from those described herein, ETC shall be contacted for review.

A more detailed description of the subsurface conditions encountered by each of the test borings is shown on the boring logs included in Appendix A. A Boring Location Map is attached as Figure 1.

Pump Station

Boring B-1 was performed in the area of the proposed pump station building. The eastern portion of the building site, where the boring was performed, appeared to a low area that was

previously filled to create a more level site. The upper 3 feet is likely fill, comprised of firm, low plasticity, Clayey Sand with Gravel (SC).

At a depth of 3 feet, boring B-1 encountered a medium dense, "decomposed granite" material, comprised of Clayey Silty Sand (SC-SM). An odor resembling decomposing organics was noted, confirming the observation that this area was likely a previous low area that was filled. Weathered Granite was encountered a depth of approximately 7¾ feet, to depths explored, 10 feet.

ETC is recommending that the existing fill in the area of the new building be removed to a minimum depth of 3 feet below existing grade, or finished pad grade, whichever depth is greater. Removal shall extend at least 5 feet outside of the building footprint. Any loose or otherwise unstable soils, if exposed at the bottom of the excavation, shall also be removed. The exposed ground surface shall be scarified, moisture conditioned, and compacted, except on rock. The removed soils may then be replaced in controlled, compacted lift, in accordance with the compaction criteria herein.

The soils encountered by boring B-1 are suitable for support of the proposed new building. However, high plasticity, expansive clay soils are present on the property. If encountered in the area of the building site, these clay soils will also require removal, as determined by the engineer.

Pipeline

The depth of dense and hard rock at different stages of weathering varied throughout the project site. Weathered rock was encountered below a depth of 7¼ feet in boring B-3. Borings B-4, B-5, and B-6 encountered rock at depths of 2 to 8.5 feet, with auger refusal on rock at depths as shallow as 5 to 8.5 feet.

Rock outcroppings are exposed on site, especially on the northern hillside. The Contractor should be prepared to encounter shallow, hard rock conditions at several locations.

Boring B-2 was performed near the southeast corner of the facility. Fill has previously been placed in this area of the site. This boring encountered approximately 1.5 feet of gravel road fill, underlain by firm, low to medium plasticity, Clayey Sand (SC). Medium dense, low plasticity, Sand with Clayey Silt and Gravel with occasional cobble was encountered below 4 feet, to depths explored, 10 feet.

The southeast boring, B-3, near Northside Drive, encountered 3 inches asphaltic concrete on 6 inches base course material. Subgrade soils consist of high plasticity Clayey Sand (SC) and Sandy Clay (CH). Medium dense to dense, Clayey Sand with Gravel (SC) was encountered below a depth of approximately 4.5 feet. Dense, decomposed/weathered rock material was encountered below 7¼ feet, to depths explored, 10 feet.

Borings B-4, B-5, and B-6 were drilled along the access road, north of Douglas Avenue. The overlying soils encountered by these borings typically consist of medium and high plasticity, Clayey Sand (SC) and Clayey Gravel (GC).

Weathered rock was encountered by boring B-4 at a depth of 3 feet, becoming more intact at 5.5 feet, to depths explored, 10 feet.

Lightly weathered rock was encountered by boring B-5 at a depth of 2 feet, with auger refusal on rock at 5 feet.

Boring B-6 encountered auger refusal on rock at 8.5 feet. However, basalt rock outcroppings were noted near to the boring location.

LABORATORY

Selected soil samples were collected for laboratory analysis to determine classification and general engineering properties of the soils encountered. Atterberg limits, gradation, and expansion index laboratory tests were performed for representative soil samples collected during the subsurface exploration.

Laboratory testing was performed in accordance with applicable ASTM standards. A summary of the laboratory test results is presented below in Table 1.

As shown in Table 1, low to high plasticity clayey soils were encountered at the site. The soils tested are typically granular, consisting of a majority sand and gravel. However, some soil with predominate clay was also encountered.

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

Boring	Depth (feet)	Liquid Limit (%)	Plasticity Index	Fines Content (%)	Gravel Content (%)	Moisture Content (%)	USCS
B-1	0 – 3	27	9	13	28	3.1	SC
B-1	3 – 7.5	22	6	19	10	4.2	SC-SM
B-2	1.5 – 4	31	12	19	12	4.7	SC
B-2	4 – 9	26	7	12	32	3.6	SP-SC-SM
B-3	1¾ – 3	60	37	53	1	24.1	CH
B-3	3 – 5	42	21	34	3	15.5	SC
B-4	1 – 2.5	53	27	36	5	16.8	SC
B-5	1 – 4	25	4	14	12	4.5	SC-SM
B-6	0 – 5	59	29	36	38	17.6	GC
B-6	5 – 8.5	39	11	19	35	12.8	SC

A summary of the in-place density testing is presented below in Table 2.

TABLE 2
IN-PLACE DENSITY TEST RESULTS

Boring	Depth (feet)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)
B-1	2.5 – 3	5.2	132.2	125.7
B-4	2 – 3	22.3	122.6	100.2

An expansion index test (ASTM D4829) was performed for a sample of the upper 3 feet of soil obtained from boring B-1, performed in the area of the pump station. The soil sample was compacted to approximately 48% saturation and inundated. Under a surcharge load of 144psf, the sample exhibited negligible swell, with a low expansion index of ***0***. The sample was tested at a remolded dry density of 120.3pcf, and compaction moisture content of 7.0%.

It is noted that expansive clay soils are present in the area. If encountered, ETC is recommending removal of any clay soil from the proposed building area.

Corrosivity

Selected samples of the on-site soils were collected for corrosion potential testing of the soils to buried pipeline.

Resistivity and pH testing were performed to evaluate the soil corrosivity. A summary of the test results is presented below in Table 3.

We are utilizing the 10-point scale developed by the American Water Works Association, Standard C105-05, and ASTM A888, Appendix X.

Resistivity values less than 1,500 ohm-cm add 10 points to the ten-point scale, indicating that the soil is corrosive to ductile iron pipe, and protection is recommended. As shown in Table 3, two of the samples tested meet this criterion. Values over 3,000 add 0 points.

The same specifications also state that pH values between 4 and 8.5 do not contribute to the corrosion potential of the soil.

TABLE 3
PH & RESISTIVITY TEST RESULTS

Boring	Depth (feet)	pH	Resistivity[1] (Ohm-cm)
B – 1	3 – 7¾	7.89	5,106
B – 3	3 – 5	7.52	973
B – 6	0 – 5	7.76	1,342

[1]Note: saturated (ASTM G57).

Using the above referenced standards, two of the three soil samples tested meet the 10 point criteria, *indicating that that the soil is corrosive to ductile-iron pipe, and protection is recommended.* Other

higher plasticity clayey soils were also encountered in other areas explored, which tend to be more corrosive.

Lead and Hexavalent Chromium

Selected samples of the on-site soils were also tested for Lead and Hexavalent Chromium levels. A summary of the test results is presented below in Table 4. More detailed test results are included in Appendix B.

TABLE 4
LEAD & HEXAVALENT CHROMIUM

Boring	Depth (feet)	Lead (mg/kg)	Hexavalent Chromium (mg/kg)
B – 1	3 – 7¾	5.24	<0.403
B – 3	3 – 5	7.67	<0.397
B – 6	0 – 5	10.8	<0.398

PUMP STATION

As discussed herein, the boring performed in the area of the pump station encountered some fill, approximately 3 feet. ETC is recommending existing fill, where encountered, be removed to a minimum depth of 3 feet below existing grade, or finished pad grade, whichever depth is greater.

Removal shall extend at least 5 feet outside of the building footprint. Any over-excavation may be terminated at a shallower depth where firm, granular, native soil is encountered.

High plasticity, expansive clay soils exist in the area. If encountered in the building site, clay shall also be removed, as determined by the engineer.

The exposed ground surface shall be scarified, moisture conditioned and compacted. The removed soils may be replaced in controlled, compacted lifts, per the compaction criteria herein.

Foundations

ETC recommends that all foundations be seated in firm, native, granular soils and/or compacted and tested fill.

All foundations shall be seated in the recommended bearing stratum at a minimum embedment depth of **1.5 feet**.

In determining foundation embedment depth, lowest, adjacent finished grade should be measured from within 5 feet of the foundations for exterior footings, and may be measured from finish floor for interior footings. Uncompacted fill and/or landscaping shall not be considered as finished grade.

Due to the anticipated varying foundation support conditions, ETC recommends a maximum allowable foundation pressure of **2,000 psf** be used for design.

Bottom of footing excavations shall be relatively level, and benched as needed. Footing excavations shall be free of loose, saturated, or otherwise unsuitable material.

The cavity between the footings/stem walls and trench sidewalls shall be adequately backfilled and compacted, to prevent the creation of a loose soil zone directly above or adjacent to foundations, which can allow moisture infiltration into foundation soils.

Continuous footings and stem walls should be reinforced to distribute stresses arising from small differential movements, and long exposed walls should be provided with control joints to accommodate these movements. Reinforcement and control joints are suggested to allow slight movement and minimize cracking.

Providing that site preparation is carried out as set forth herein, ETC has estimated differential movements to be less than ¾ inches. Increased movements may occur if adequate drainage is not maintained around the perimeter of the building, or foundation soils experience a significant increase in moisture content.

Special attention shall be given to design, final grading, and landscaping improvements to ensure efficient drainage away from foundations and slabs.

ETC shall be contacted to review the bottom of over-excavated areas prior to fill placement, to confirm adequate depth and extent of removal. ETC shall also be contacted to observe

foundation excavations to verify foundation-bearing soils and footing dimensions are in conformance with the construction documents and our recommendations presented herein.

Slabs-on-Grade

ETC recommends a minimum thickness of **6 inches** of processed aggregate base course in accordance with MAG Specifications, Section 702, be placed between the prepared subgrade and concrete slabs on grade.

A turndown edge is also recommended for exterior slabs, to help mitigate moisture infiltration into the underlying soils.

ETC recommends the American Concrete Institute (ACI) be used as a reference for placement, curing, and finishing of Portland cement concrete. Concrete should be placed at the appropriate slump determined by mix design, required strength, and application. After placement, concrete should be cured properly, and special attention shall be given to ensure adequate moisture is present during the initial curing process to prevent/reduce shrinkage and stress cracks.

Concrete slabs should be properly jointed, with maximum joint spacing of 24 to 36 times the slab thickness, unless noted otherwise. Any required saw cutting should be performed to an appropriate depth and in a timely manner, typically within 12 hours of concrete finishing.

It should be noted that for any exterior concrete, that the use of deicing salt within the first year of concrete placement can cause damage to the concrete surface. This can be avoided by using 4,500psi concrete with a water/cement ratio of 0.45 and a recommended fly ash content of 18%.

DRAINAGE

Positive drainage is critical to the successful performance of any foundation or slab system. Excess moisture infiltration into foundation soils is often the primary cause of soil-related problems below structures. Efficient surface and subsurface drainage should be established prior to and maintained during and after construction to prevent water from ponding and/or saturating the soils within or adjacent to building, pavements, concrete slabs, or other structural areas.

Due to the relatively shallow dense soil and/or rock conditions in areas of the site, storm water and heavy irrigation water may tend to flow at relatively shallow depths. Water may surface at the face of excavations, especially during times of inclement weather.

The design should intercept water seepage from cut slopes, and include drains that will intercept and adequately drain excessive water from any below grade levels, and behind retaining walls.

The design should divert water away from where it could penetrate the ground, particularly if granular fills are used. Care should be taken in design and construction to assure that water is contained to prevent seepage into the underlying soils. Roof water down pipes shall not discharge water adjacent to building foundations.

Special attention shall be given to providing for efficient surface drainage around the perimeter of the building, especially on the uphill side, and between the building and any adjacent cut slope.

ETC recommends that vegetation not be planted within 5 feet of buildings. Backfill against footings, exterior walls, and in utility trenches shall be adequately compacted to reduce the possibility of moisture infiltration through loose soil.

Special attention should be given to exterior grading to ensure efficient drainage away from the structures. Minimizing irrigation water near foundations and slabs, positive drainage of surface water away from the structures, and adequate compaction of soils around the structures and in utility trenches is very important for the long-term stability of foundation soils.

EARTHWORK

In construction of the new pump station, any abandoned at-grade and underground site features associated with current and prior development shall be located and removed during the initial grading operation. Any excavations made for removal shall be properly backfilled in controlled, compacted lifts.

As discussed herein, ETC is recommending existing fill, where encountered within the area of the proposed pump station building, be removed to a minimum depth of 3 feet below existing grade, or finished pad grade, whichever depth is greater.

Removal shall extend at least 5 feet outside of the building footprint. Over-excavation may be terminated at shallower depths wherever firm, granular, native soil is encountered, which is anticipated at least in the southwest portion of the building area. In addition, high plasticity expansive clay, if encountered in the building site, shall also be removed, as determined by the engineer.

Prior to fill placement, the ground surface must be stripped of all vegetation, debris, soft, loose, wet, or otherwise unstable soils and such material should be removed. Depressions and sloped ground should be widened or benched as necessary to accommodate compaction equipment and provide a level base for placing fill.

Prior to fill placement, the exposed ground surface shall be scarified, moisture conditioned, and compacted to a minimum depth of 8 inches, to the specifications herein, except on exposed rock. Special attention shall be given to ensure adequate moisture is present throughout the entire 8-inch depth. The materials testing firm shall be contacted prior to fill placement to observe that the exposed ground surface has been adequately prepared.

All subbase fill required to bring the structured areas up to subgrade elevation shall be placed in horizontal lifts not exceeding 8 inches compacted thickness.

The low plasticity, granular site soils should be suitable for use as fill within the building site. Any high plasticity clay soils, if encountered, shall not be used for fill within the building area.

Engineered fill material shall be used for retaining wall backfill, and for floor slab fill inside of any building stem walls. Engineered fill, where required, shall be clean, granular soil free of vegetation, debris, organic soil, and shall conform to the following requirements, as approved by the engineer:

- 100 percent passing 4" sieve;
- 0 to 36 percent passing No. 200 sieve;
- 30 to 100 percent passing No. 4 sieve;
- Maximum Plasticity Index (PI) of 15; and
- Maximum expansion index of 20.

All soils should be compacted to meet the criteria listed in Table 5. ETC recommends the observation of the site grading operation with sufficient tests to verify proper compaction.

TABLE 5
SOIL COMPACTION CRITERIA
(ASTM D698)

	Operation	Moisture Content	Degree of Compaction
I	**Building Pad**		
	Clayey Subgrade	-1% to +3% of Optimum	Minimum of **95%** of Maximum Dry Density
	Granular Soils	±2 % of Optimum	Minimum of **95%** of Maximum Dry Density
II	**Utility Trench Backfill and Backfill Adjacent to Footings or Stem Walls**		
	Clayey Soils	-1% to +3% of Optimum	Minimum of **95%** of Maximum Dry Density
	Granular Soils	±2 % of Optimum	Minimum of **95%** of Maximum Dry Density
III	**Pavement Areas**		
	Clay Soils	-4% to Optimum	Minimum of **95%** of Maximum Dry Density
	Granular Soils	±2 % of Optimum	Minimum of **95%** of Maximum Dry Density

Constructed Slopes

All fill slopes and soil cut slopes shall be constructed at a maximum slope angle of 2H:1V, with a minimum building setback distance of 5 feet from the top of any slope.

As discussed herein, the depth to rock varies significantly. If applicable, lower cuts into rock may be constructed at a maximum slope angle of 1.5H:1V, up to a maximum height of 12 feet, as approved by the engineer.

Rock cut slopes, if constructed, shall be constructed with careful rock excavation. Zones of softer/decomposed, and/or highly-fractured/weathered rock may not be apparent until a cut slope is exposed. Such strata, if encountered during construction, may require local slope angles to be adjusted accordingly.

Large cobbles, boulders, or unstable rock exposed on the face or at the top of any cut slope shall be removed to prevent future dislodgement due to weathering. Soil in the top of cut slopes should be rounded back from the slope face to create a gradual transition to natural grade. *For design purposes, rounding at the top of slope should begin within 3 feet of top of slope.*

Water shall be intercepted and prevented from flowing down the face of any constructed slope.

Utility Excavation and Installation

As noted herein, shallow rock conditions are expected in areas of the site. The depth of dense and hard rock at different stages of weathering varied throughout the project site. At the locations explored, weathered rock was encountered below a depth of 7¼ feet in boring B-3. Borings B-4, B-5, and B-6 encountered rock at depths of 2 to 8.5 feet, with auger refusal on rock at depths as shallow as 5 to 8.5 feet.

Rock outcroppings are exposed on site, especially on the northern hillside. The Contractor should be prepared to encounter shallow, hard rock conditions at several locations.

Shoring, sloping, benching, etc, of temporary slopes used for construction should be excavated in strict compliance with the Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA), 29 CFR, Part 1926 to maintain stability of excavation sidewalls.

Subsurface water was not encountered during the exploration. However, due to the lower, dense strata and/or rock, seeping water conditions may be encountered, especially during times of inclement weather. The Contractor should be prepared to dewater trench excavations, as needed, if water is encountered.

As shown in Table 1, granular site soils were encountered by some borings that meet MAG Section 601 for granular bedding/shading material. The medium to high plasticity clayey soils will not be suitable for use.

If potential bedding/shade materials are encountered that are desired for use, ETC recommends that the Contractor create stockpiles of the screened material for sampling, testing, and approval prior to use. This would require special attention by the Contractor during the excavation process to sort soil types into separate stockpiles for general trench backfill and potential bedding/shading backfill.

The native materials encountered should be suitable for use as trench backfill above the pipe shading, provided that the material is screened to remove any rock pieces 3 inches or larger in size (Detail 200Q-1).

Backfill compaction shall be completed on moisture-conditioned soil by mechanical methods, in accordance with MAG Standards. Water consolidation shall not be used.

LATERAL DESIGN PARAMETERS

ETC recommends the following parameters be used for design of retaining walls, if needed. Wall foundations shall be constructed in accordance with the recommendations herein for shallow foundations.

Retaining wall backfill shall consist of granular, non-expansive, on-site or imported, engineered fill, as specified herein. Retaining walls shall be waterproofed prior to being backfilled against, and drains shall be installed to help prevent saturation of wall backfill.

[1] Foundation Toe Pressure	1.33 x allowable bearing pressure
[2] Lateral Backfill Pressure:	
unrestrained walls	37 psf/foot
restrained walls	57 psf/foot
Lateral Passive Pressures:	
Firm native / Compacted fill	375 psf/foot
Coefficient of Base Friction:	
Firm native / Compacted fill	0.37

1 Increase in allowable foundation bearing pressure (provided herein) for foundation toe pressure due to eccentric or lateral loading. The entire footing-bearing surface should remain in compression.

2 Equivalent fluid pressures for vertical walls and horizontal backfill surfaces (maximum 12-foot height). Pressures do not include temporary forces imposed during compaction of the backfill, swelling pressures developed by over compacted clayey backfill, hydrostatic pressures from inundation or saturation of backfill, or surcharge loads. Walls should be suitably braced during backfilling to prevent damage and deflection.

LIMITATIONS

The figures and recommendations in this report were prepared in accordance with accepted professional engineering principles and soil mechanics practices. We make no other warranty, either implied or expressed. If during subsequent planning and construction, conditions are different than as indicated, this firm should be notified for evaluation.

We like to inform our clients that Portland cement concrete is not a perfect construction material. Due to the characteristics of Portland cement itself, cracking of the concrete may occur. Cracking will be minimized, but not eliminated, by providing appropriate control, isolation, construction joints, and quality control testing. Drying and thermal shrinkage of the slabs with resultant hairline cracking or curling may occur even if the slabs are cured under optimum curing conditions. In short, there is no practical method of ensuring that all floor cracking is eliminated utilizing slab-on-grade construction at the site.

This report is not a bidding document. Any contractor reviewing this report must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

For your use. Should you have any questions or concerns, please contact us at (928) 778-9001.

Sincerely,
ENGINEERING & TESTING CONSULTANTS, INC.

Registered Professional Engineer (Civil) CERTIFICATE NO. 37900 MICHAEL PHILIP WILSON Date Signed 7-18-19 ARIZONA, U.S.A.

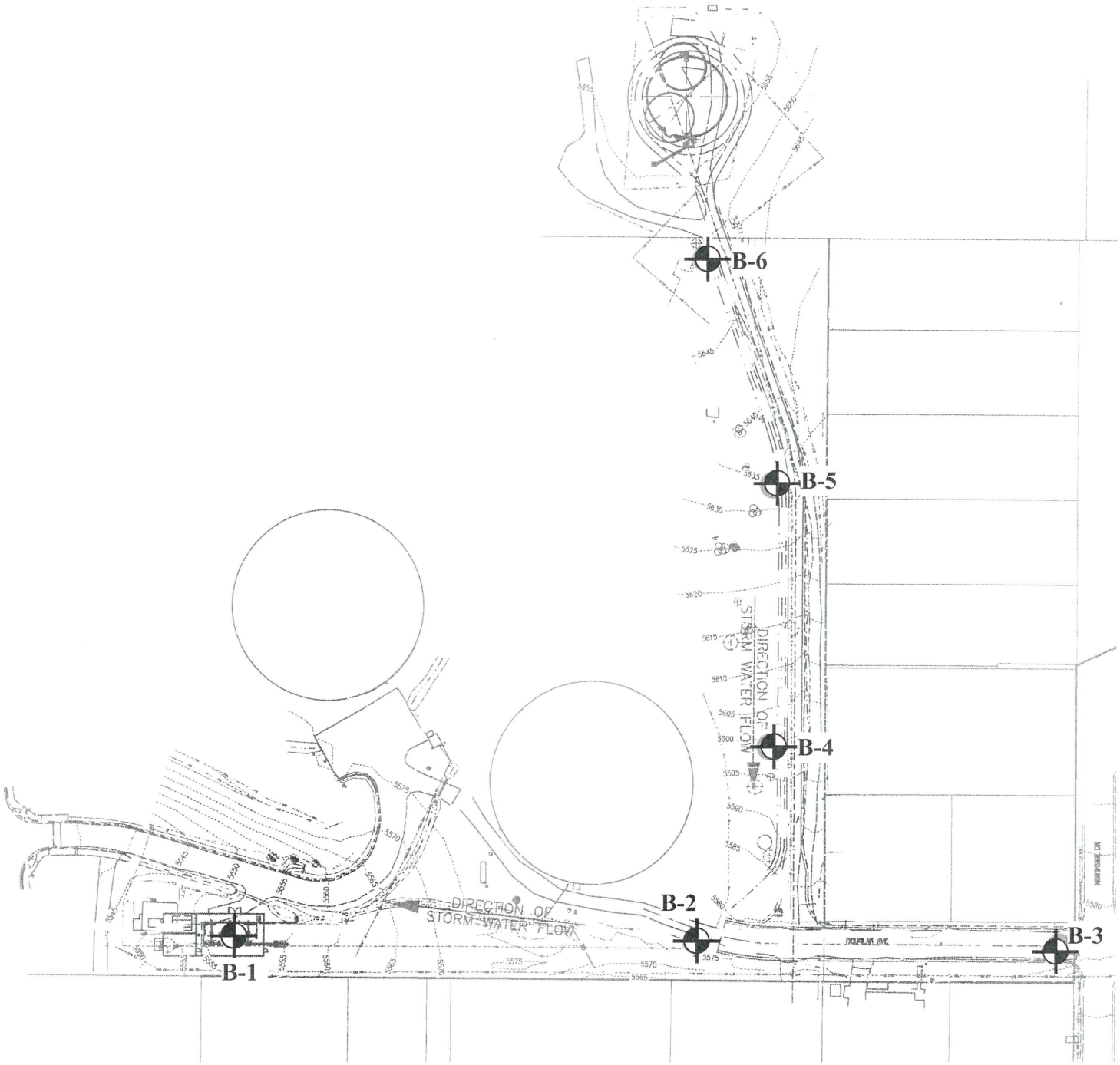
Michael P. Wilson, P.E.
Project Engineer

Registered Professional Engineer (Civil) CERTIFICATE NO. 26853 RICHARD G. KELLEY Date Signed 7/18/19 ARIZONA, U.S.A.

Reviewed by: Richard G. Kelley, P.E.
Project Manager

Attachments: Figure 1 and Appendix A

cc: ETC File No. 10115



Legend

Approximate Boring Location

Engineering & Testing Consultants, Inc. •Subsurface Drilling •Geotechnical •Environmental Support	**FIGURE 1** **BORING LOCATION MAP**	ETC
Drawn by: others Date: 06/25/19 Project No: ETC 10115 Page No:	Zone 41 Prescott, AZ	

APPENDIX A

FIELD EXPLORATION

GENERAL NOTES

DESCRIPTIVE SOIL CLASSIFICATION:

Soil Classification is based on the Unified Soil Classification System and ASTM Designations D-2487 and D-2488. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine grained soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: Clays, if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse grained soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

CONSISTENCY OF FINE-GRAINED SOILS:

N-Blows/ft.	Consistency
0-2	Very Soft
3-4	Soft
5-8	Medium
9-16	Stiff
17-32	Very Stiff
33+	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS:

N-Blows/ft.	Relative Density
0-3	Very Loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50+	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL:

Description Term(s) (of Components Also Present in Sampling)	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY:

Major Component of Sampling	Size Range
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES:

Description Term(s) (of Components Also Present in Sampling)	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

UNIFIED SOIL CLASSIFICATION SYSTEM*

				Soil Classification	
				Group Symbol	Group Name [B]
COARSE-GRAINED SOILS More than 50 % retained on No. 200 sieve	Gravels More than 50 % of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5 % fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines More than 12 % fines [C]	Fines classify as ML or MH	GM	Silty gravel [F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel [F,G,H]
	Sands 50 % or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5 % fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]	SP	Poorly graded sand [I]
		Sands with Fines More than 12 % fines [D]	Fines classify as ML or MH	SM	Silty sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey sand [G,H,I]
FINE-GRAINED SOILS 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay [K,L,M,N] / Organic silt [K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay [K,L,M]
			PI plots below "A" line	MH	Elastic silt [K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay [K,L,M,P] / Organic silt [K,L,M,Q]
HIGHLY ORGANIC SOILS		Primarily organic matter, dark in color, and organic odor		PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15 % sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15 % gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.

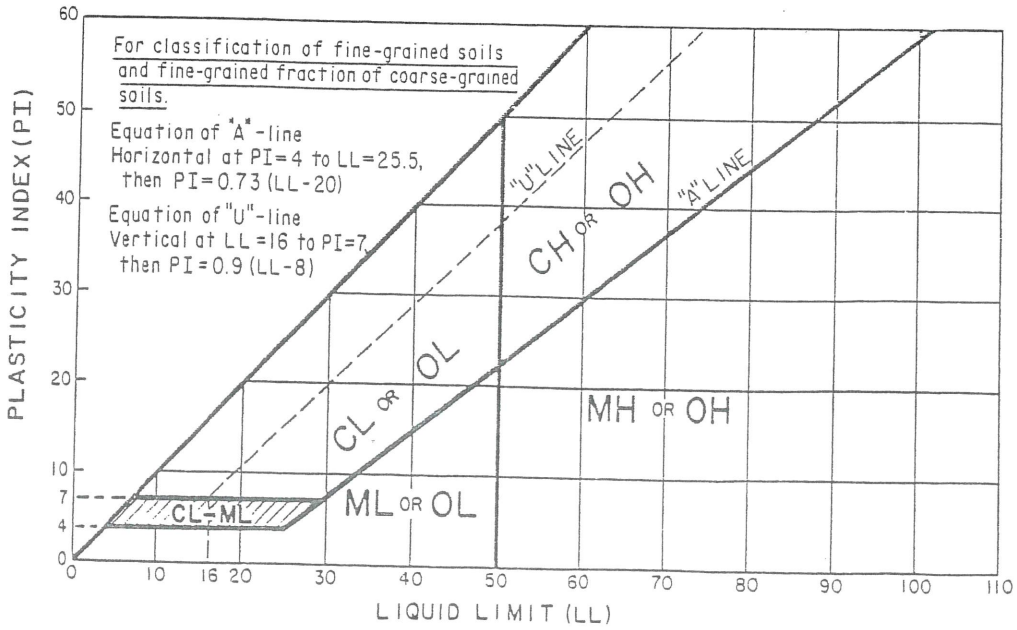
[M] If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



* ASTM 1996

LOG OF BORING NO. B-1

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS (Plastic Limit — Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50)	Remarks
	FILL - Clayey Sand with Gravel, brown, damp-moist, low PI, low to med fines, occasional cobble, Medium Dense	SC				LIKELY FILL
2						SPT=4/9/10
	CLAYEY SILTY SAND, low PI, medium fines, Medium Dense	SC-SM				LIKELY NATIVE - "Decomposed Granite" with odor of organics
4						
6						
8	WEATHERED GRANITE	ROCK				
10	Boring terminated at 10 feet depth.					
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-4 PAGE 1 of 1

LOG OF BORING NO. B-2

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS (Plastic Limit ⊢ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50)	Remarks
	Gravel - Road embankment Fill	FILL				FILL
2	CLAYEY SAND, brown, damp, low to medium PI, some gravel, Medium Dense	SC				Likely Fill
	damp-moist					
4	SAND WITH CLAYEY SILT & GRAVEL, brown, damp, low PI, low fines, Medium Dense	SC-SM				Possibly Fill
	Occasional cobble					
6						
8						
10	Boring terminated at 10 feet depth.					
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-5 PAGE 1 of 1

LOG OF BORING NO. B-3

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS (Plastic Limit — Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50)	Remarks
	3" ASPHALTIC CONCRETE	AC				Lower 1.5" weathered/ weak
	6" BASE COURSE MATERIAL	AB				Likely Fill
	CLAYEY SAND, reddish-brown, moist, med to high PI, high fines, Medium Dense	SC				
2	Brown, high fines & PI, some gravel	CH				Thin transition layer
	SANDY CLAY, brown, moist, high PI, Stiff					Likely Native
	CLAYEY SAND, reddish-brown, moist, high fines & PI, Medium Dense	SC				
4	Medium Dense to Dense					
	CLAYEY SAND WITH GRAVEL, brown, med to high PI, high fines, Medium Dense	SC				
6						
	CLAYEY SAND WITH GRAVEL, red, Dense	SC				Possibly weathered/ decomposed rock
8						
10	Boring terminated at 10 feet depth.					
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

LOG OF BORING NO. B-4

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS: Plastic Limit — Liquid Limit; Water Content - ●; Penetration - ▨ (10 20 30 40 50)	Remarks
	CLAYEY SAND, dark brown, dry-damp, high fines & PI, Medium Dense	SC				"Decomposed Granite"
	CLAYEY SAND, med to high PI & fines, Medium Dense to Dense	SC				
2						SPT=6/12/21
	WEATHERED GRANITE	ROCK				
	Less weathered					
4						
	Relatively solid / more intact					
6						
8						
10						
	Boring terminated at 10 feet depth.					
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-7 PAGE 1 of 1

LOG OF BORING NO. B-5

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger

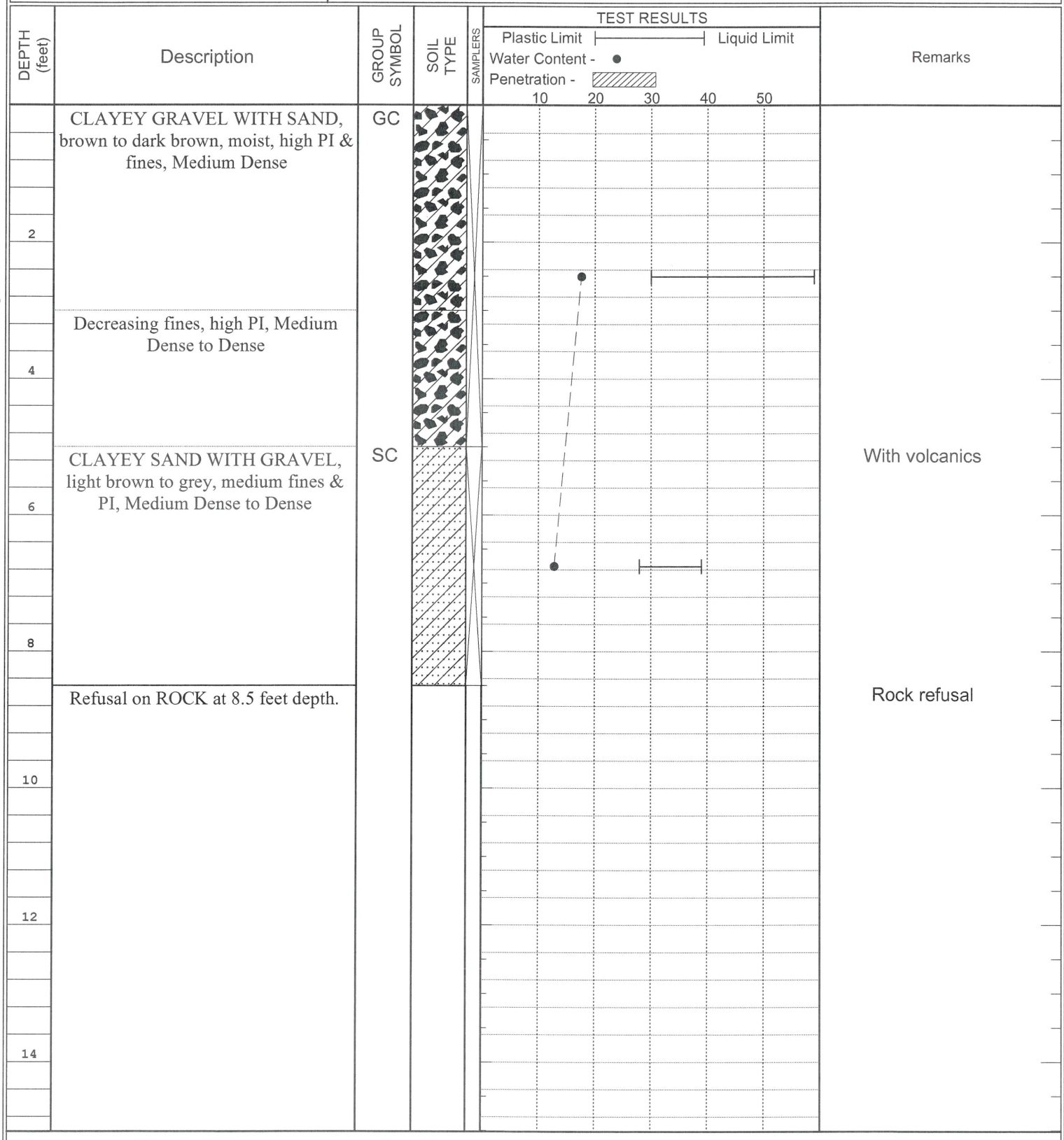
DEPTH (feet)	Description	GROUP SYMBOL	SOIL TYPE	SAMPLERS	TEST RESULTS (Plastic Limit ⊢ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50)	Remarks
	CLAYEY SAND WITH GRAVEL, low to med PI	SC				Gravel/Cobbles/ Boulders accross surface
	CLAYEY SILTY SAND, low PI & fines	SC-SM				Transition layer to weathered basalt
2	HIGHLY WEATHERED BASALT ROCK	ROCK			● ⊢	
	Less weathered / more intact					
4	Refusal on ROCK at 4.5 feet depth.					Rock refusal
6						
8						
10						
12						
14						

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

LOG OF BORING NO. B-6

ENGINEERING & TESTING CONSULTANTS, INC.

PROJECT: City of Prescott Zone 41 **PROJECT NO.:** 10115
CLIENT: Brown & Caldwell **DATE:** 6-25-19
LOCATION: See Boring Location Map **ELEVATION:** ---
DRILLER: Engineering & Testing Consultants **LOGGED BY:** M. Wilson
DRILLING METHOD: Continuous flight auger



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure A-9 PAGE 1 of 1

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Clayey sand
	Poorly graded clayey silty sand
	Weatherd rock
	Fill
	Asphaltic Concrete
	Aggregate base material
	High plasticity clay
	Clayey gravel
Soil Samplers	
	Bulk sample taken from 4 in. auger
	Standard penetration test

Notes:

1. Exploratory borings were drilled on 6-25-19 using a 4-inch diameter continuous flight power auger.
2. No free water was observed at the time of drilling.
3. Boring locations provided to us were estimated from existing site features.
4. These logs are subject to the limitations, conclusions, and recommendations in this report.
5. Results of tests conducted on samples recovered are reported on the logs.

APPENDIX B

LABORATORY CHEMICAL ANALYSIS

Analytical Report 629530

for

Engineering & Testing Consultants

Project Manager: Jerid Ludwig

Brown & Caldwell Zone 41

ETC Project #10115

15-JUL-19

Collected By: Client

2525 West Huntington Drive, Suite 102
Tempe, AZ 85282
Ph: (480) 355-0900

Phoenix (EPA Lab Code: AZ00901): Arizona (AZ0757)
Xenco-Houston (EPA Lab code: TX00122): Arizona (AZ0765)
Xenco-Dallas (EPA Lab code: TX01468): Arizona (AZ0809)

15-JUL-19

Project Manager: **Jerid Ludwig**
Engineering & Testing Consultants
417 N. Arizona Ave.
Prescott, AZ 86301

Reference: TWA Report No(s): **629530**
Brown & Caldwell Zone 41
Project Address:

Jerid Ludwig:

We are reporting to you the results of the analyses performed on the samples received under the project name referenced above and identified with the TWA Report Number(s) 629530. All results being reported under this Report Number apply to the samples analyzed and properly identified with a Laboratory ID number. Subcontracted analyses are identified in this report with either the ADHS certification number of the subcontract lab in the analyst ID field, or the complete subcontracted report attached to this report.

Unless otherwise noted in a Case Narrative, all data reported in this Analytical Report are in compliance with ADHS standards. The uncertainty of measurement associated with the results of analysis reported is available upon request. Should insufficient sample be provided to the laboratory to meet the method and ADHS Matrix Duplicate and Matrix Spike requirements, then the data will be analyzed, evaluated and reported using all other available quality control measures.

The validity and integrity of this report will remain intact as long as it is accompanied by this letter and reproduced in full, unless written approval is granted by TransWest Analytical. This report will be filed for at least 5 years in our archives after which time it will be destroyed without further notice, unless otherwise arranged with you. The samples received, and described as recorded in Report No. 629530 will be filed for 45 days, and after that time they will be properly disposed without further notice, unless otherwise arranged with you. We reserve the right to return to you any unused samples, extracts or solutions related to them if we consider so necessary (e.g., samples identified as hazardous waste, sample sizes exceeding analytical standard practices, controlled substances under regulated protocols, etc).

We thank you for selecting TransWest Analytical to serve your analytical needs. If you have any questions concerning this report, please feel free to contact us at any time.

Respectfully,

Wendy Walfoort

Wendy Walfoort
Project Manager

Recipient of the Prestigious Small Business Administration Award of Excellence in 1994.
Certified and approved by numerous States and Agencies.
A Small Business and Minority Status Company that delivers SERVICE and QUALITY

Houston - Dallas - Midland - San Antonio - Phoenix - Oklahoma - Latin America

Sample receipt non conformances and comments:

Revised with corrected client.

Sample receipt non conformances and comments per sample:

None

Flagging Criteria

Arizona Flags

All method blanks, laboratory spikes, and/or matrix spikes met quality control objectives for the parameters associated with this Work Order except as detailed below or on the Data Qualifier page of this report. Data Qualifiers used in this report are in accordance with ADHS Data Qualifiers, Revision 4.0 9/05/2012.
Data qualifiers (flags) contained within this analytical report have been issued to explain a quality control deficiency, and do not affect the quality (validity) of the data unless noted otherwise in the case narrative.

Sample Cross Reference 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id	Matrix	Date Collected	Sample Depth	Lab Sample Id
B-1 3'-7 3/4'	S	06-19-19 12:01		629530-001
B-3 3'-5'	S	06-19-19 12:20		629530-002
B-6 0'-5'	S	06-25-19 11:08		629530-003

Certificate of Analytical Results 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id: **B-1 3'-7 3/4'**
Lab Sample Id: 629530-001

Matrix: Soil
Date Collected: 06.19.19 12.01

Date Received:06.28.19 14.20

Analytical Method: Metals, Total by SW 6010C
Tech: PJB
Analyst: DEP
Seq Number: 3094659

Date Prep: 07.05.19 11.35

Prep Method: SW3050B
% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Lead	7439-92-1	**5.24**	1.72	mg/kg	07.05.19 19.16		0.86

Analytical Method: Hexavalent Chromium by EPA 7196A
Tech: YAV
Analyst: YAV
Seq Number: 3094433

% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Chromium, Hexavalent	18540-29-9	<0.403	0.403	mg/kg	07.03.19 14.36		1.01

Certificate of Analytical Results 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id: **B-3 3'-5'**
Lab Sample Id: 629530-002

Matrix: Soil
Date Collected: 06.19.19 12.20

Date Received:06.28.19 14.20

Analytical Method: Metals, Total by SW 6010C
Tech: PJB
Analyst: DEP
Seq Number: 3094659

Date Prep: 07.05.19 11.35

Prep Method: SW3050B
% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Lead	7439-92-1	**7.67**	1.82	mg/kg	07.05.19 19.20		0.91

Analytical Method: Hexavalent Chromium by EPA 7196A
Tech: YAV
Analyst: YAV
Seq Number: 3094433

% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Chromium, Hexavalent	18540-29-9	<0.397	0.397	mg/kg	07.03.19 14.36		0.99

Certificate of Analytical Results 629530

Engineering & Testing Consultants, Prescott, AZ

Brown & Caldwell Zone 41

Sample Id: **B-6 0'-5'**
Lab Sample Id: 629530-003

Matrix: Soil
Date Collected: 06.25.19 11.08

Date Received:06.28.19 14.20

Analytical Method: Metals, Total by SW 6010C
Tech: PJB
Analyst: DEP
Seq Number: 3094659

Date Prep: 07.05.19 11.35

Prep Method: SW3050B
% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Lead	7439-92-1	**10.8**	1.69	mg/kg	07.05.19 19.25		0.85

Analytical Method: Hexavalent Chromium by EPA 7196A
Tech: YAV
Analyst: YAV
Seq Number: 3094433

% Solids:
Basis: Wet Weight
SUB: AZ0765

Parameter	Cas Number	Result	RL	Units	Analysis Date	Flag	Dil
Chromium, Hexavalent	18540-29-9	<0.398	0.398	mg/kg	07.03.19 14.36		1

QC Summary 629530

Engineering & Testing Consultants

Brown & Caldwell Zone 41

Analytical Method: Metals, Total by SW 6010C — Prep Method: SW3050B
Seq Number: 3094659 — Matrix: Solid — Date Prep: 07.05.19
MB Sample Id: 7681430-1-BLK — LCS Sample Id: 7681430-1-BKS — LCSD Sample Id: 7681430-1-BSD

Parameter	MB Result	Spike Amount	LCS Result	LCS %Rec	LCSD Result	LCSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Lead	<0.476	100	101	101	101	101	75-125	0	20	mg/kg	07.05.19 18:26	

Analytical Method: Metals, Total by SW 6010C — Prep Method: SW3050B
Seq Number: 3094659 — Matrix: Soil — Date Prep: 07.05.19
Parent Sample Id: 629959-001 — MS Sample Id: 629959-001 S — MSD Sample Id: 629959-001 SD

Parameter	Parent Result	Spike Amount	MS Result	MS %Rec	MSD Result	MSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Lead	12.1	92.6	102	97	107	99	75-125	5	20	mg/kg	07.05.19 18:39	

Analytical Method: Hexavalent Chromium by EPA 7196A
Seq Number: 3094433 — Matrix: Solid
MB Sample Id: 3094433-1-BLK — LCS Sample Id: 3094433-1-BKS — LCSD Sample Id: 3094433-1-BSD

Parameter	MB Result	Spike Amount	LCS Result	LCS %Rec	LCSD Result	LCSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Chromium, Hexavalent	<0.400	16.0	16.2	101	16.2	101	85-115	0	20	mg/kg	07.03.19 14:36	

Analytical Method: Hexavalent Chromium by EPA 7196A
Seq Number: 3094433 — Matrix: Soil
Parent Sample Id: 629530-001 — MS Sample Id: 629530-001 S — MSD Sample Id: 629530-001 SD

Parameter	Parent Result	Spike Amount	MS Result	MS %Rec	MSD Result	MSD %Rec	Limits	%RPD	RPD Limit	Units	Analysis Date	Flag
Chromium, Hexavalent	<0.403	16.1	16.2	101	16.2	101	85-115	0	20	mg/kg	07.03.19 14:36	

MS/MSD Percent Recovery — [D] = 100*(C-A) / B — LCS = Laboratory Control Sample — MS = Matrix Spike
Relative Percent Difference — RPD = 200* | (C-E) / (C+E) | — A = Parent Result — B = Spike Added
LCS/LCSD Recovery — [D] = 100 * (C) / [B] — C = MS/LCS Result — D = MSD/LCSD % Rec
Log Difference — Log Diff. = Log(Sample Duplicate) - Log(Original Sample) — E = MSD/LCSD Result

Chain of Custody

XENCO LABORATORIES

Houston,TX (281) 240-4200 Dallas,TX (214) 902-0300 San Antonio,TX (210) 509-3334
Midland,TX (432) 704-5440 EL Paso,TX (915) 585-3443 Lubbock,TX (806) 794-1296 Craslbad, NM (432) 704-5440
Phoenix,AZ (480) 355-0900 Atlanta,GA (770) 449-8800 Tampa,FL (813) 620-2000 West Palm Beach, FL (561) 689-6701

Work Order No: 629530

www.xenco.com Page 1 of 1

Project Manager:		Bill to: (if different)	
Company Name:	Brown + Caldwell	Company Name:	
Address:		Address:	
City, State ZIP:		City, State ZIP:	
Phone:	Email:		

Work Order Comments

Program: UST/PST ☐ PRP ☐ Brownfields ☐ RRC ☐ Superfund ☐
State of Project:
Reporting:Level II ☐ Level III ☐ PST/UST ☐ TRRP ☐ Level IV ☐
Deliverables: EDD ☐ ADaPT ☐ Other:

Project Name:	Brown + Caldwell, Zone 41	Turn Around	
Project Number:	ETC Project # 10115	Routine	☑
Project Location		Rush:	
Sampler's Name:		Due Date:	
PO #:	Quote #:		

SAMPLE RECEIPT				
Temp Blank:	Yes (No)	Wet Ice:	Yes (No)	
Temperature (°C):	28.1	Thermometer ID		
Received Intact:	(Yes) No			
Cooler Custody Seals:	Yes No (N/A)	Correction Factor:		
Sample Custody Seals:	Yes No (N/A)	Total Containers:	3	

ANALYSIS REQUEST

Preservative Codes

MeOH: Me
None: NO
HNO3: HN
H2S04: H2
HCL: HL
NaOH: Na
Zn Acetate+ NaOH: Zn

TAT starts the day recevied by the lab, if received by 4:00pm

Lab ID	Sample Identification	Matrix	Date Sampled	Time Sampled	Depth	Number of Containers	Pres. Code	Total Lead	Hexavalent Chromium	Sample Comments
1	B-1 3'-7¾'	S	6/19/19	12:01		1		X	X	
2	B-3 3'-5'	S	6/19/19	12:20		1		X	X	
3	B-6 0'-5'	S	6/25/19	11:08		1		X	X	

Total 200.7 / 6010 200.8 / 6020: 8RCRA 13PPM Texas 11 Al Sb As Ba Be B Cd Ca Cr Co Cu Fe Pb Mg Mn Mo Ni K Se Ag SiO2 Na Sr Tl Sn U V Zn

Circle Method(s) and Metal(s) to be analyzed TCLP / SPLP 6010: 8RCRA Sb As Ba Be Cd Cr Co Cu Pb Mn Mo Ni Se Ag Tl U 1631 / 245.1 / 7470 / 7471 : Hg

Notice: Signature of this document and relinquishment of samples constitutes a valid purchase order from client company to Xenco, its affiliates and subcontractors. It assigns standard terms and conditions of service. Xenco will be liable only for the cost of samples and shall not assume any responsibility for any losses or expenses incurred by the client if such losses are due to circumstances beyond the control of Xenco. A minimum charge of $75.00 will be applied to each project and a charge of $5 for each sample submitted to Xenco, but not analyzed. These terms will be enforced unless previously negotiated.

Relinquished by: (Signature)	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Received by: (Signature)	Date/Time
1	Fedex		2		
3 Fedex		6/28/19 14:20	4		
5			6		

Revised Date 022619 Rev. 2019.1

Final 1.001

XENCO Laboratories
Prelogin/Nonconformance Report- Sample Log-In

Client: Brown & Caldwell

Date/ Time Received: 06/28/2019 02:20:00 PM

Work Order #: 629530

Acceptable Temperature Range: 0 - 6 degC
Air and Metal samples Acceptable Range: Ambient

Temperature Measuring device used : IR#1

Sample Receipt Checklist		Comments
#1 *Temperature of cooler(s)?	28.1	
#2 *Shipping container in good condition?	Yes	
#3 *Samples received on ice?	No	Cooling started upon receipt at laboratory.
#4 *Custody Seals intact on shipping container/ cooler?	N/A	
#5 Custody Seals intact on sample bottles?	N/A	
#6*Custody Seals Signed and dated?	N/A	
#7 *Chain of Custody present?	No	COC filled out by Xenco from verbal client information.
#8 Any missing/extra samples?	No	
#9 Chain of Custody signed when relinquished/ received?	No	
#10 Chain of Custody agrees with sample labels/matrix?	Yes	
#11 Container label(s) legible and intact?	Yes	
#12 Samples in proper container/ bottle?	Yes	
#13 Samples properly preserved?	No	Not on ice.
#14 Sample container(s) intact?	Yes	
#15 Sufficient sample amount for indicated test(s)?	Yes	
#16 All samples received within hold time?	Yes	
#17 Subcontract of sample(s)?	Yes	Xenco Stafford
#18 Water VOC samples have zero headspace?	N/A	

*** Must be completed for after-hours delivery of samples prior to placing in the refrigerator**

Analyst: EP

PH Device/Lot#:

Checklist completed by: Emily Petrunia Date: 06/28/2019

Checklist reviewed by: Wendy Walfoort Date: 07/14/2019

Wendy Walfoort

ENGINEERING & TESTING CONSULTANTS INC.

September 23, 2019

Ms. Tracy Moraca, PE, PMP
Brown and Caldwell
2 North Central Avenue
Suite 1600
Phoenix, AZ 85004

SUBJECT: ADDENDUM TO SUBSURFACE SOIL EXPLORATION FOR CITY OF PRESCOTT - ZONE 41 PUMP STATION AND WATERLINE

Dear Ms. Moraca:

Engineering & Testing Consultants, Inc., (ETC) has prepared this report as an addendum to the soils report we prepared for the above referenced project, dated July 18, 2019.

The purpose of this addendum is to provide pavement structure recommendations for the maintenance driveway from Douglas Avenue, north to the tank site.

As discussed in the original report, the subsurface soils encountered at the site consist of moist, stiff, high plasticity, sandy clay (Unified Soil Classification CH).

Site grading for pavement areas should be performed as outlined in the original report, with the compaction modifications herein, to provide adequate subgrade support for the pavement structure.

The high plasticity clay subgrade soils encountered provide reduced structural support. Therefore, increased pavement sections are recommended. ETC recommends the pavement structural sections as described in Table 1 for the proposed development.

TABLE 1
PAVEMENT STRUCTURAL SECTION

Description	Alternative	Portland Cement Concrete Thickness (inches)	Asphaltic Concrete Thickness (inches)	Aggregate Base Thickness (inches)	Prepared Subgrade Thickness (inches)
Drives & Access	1	---	3	9	8
	2	---	4	6	8
	3	5	---	6	8
Parking Stalls (Optional)	1	5	---	4	8
	2	---	3	6	8

In accordance with ACI 325, Portland cement concrete pavement shall have a minimum 28-day compressive strength of 3,500 psi or greater with 4% to 6% entrained air, and a maximum slump of 4 inches.

A thickened edge is recommended for Portland cement concrete pavement on all sides without integral edge curb support. A thickened edge should be increased by at least 2 inches over a minimum distance of 3 feet.

It should be noted that for exterior concrete, the use of deicing salt within the first year of concrete placement can cause damage to the concrete surface. This can be avoided by using 4,500psi concrete with a water/cement ratio of 0.45 and a fly ash content of 18 percent.

The recommended pavement sections are expected to function with periodic maintenance or overlays when the subgrade, base, and pavement are constructed in accordance with MAG Construction Standards with Town of Prescott Valley modifications.

Efficient surface water drainage must be provided and maintained to help prevent moisture infiltration into the subgrade.

Prior to placement of aggregate base material, the exposed subgrade shall be proof-rolled to confirm stable subgrade soils.

Compaction

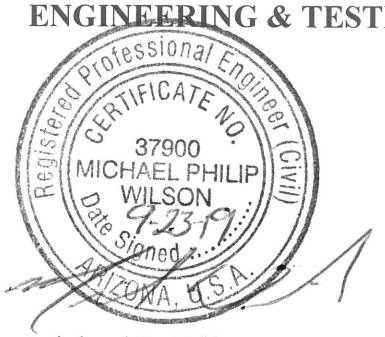
For pavement areas, ETC recommends all soils be compacted to a minimum relative dry density of 95% of maximum dry density (ASTM D698). Clay soils should be compacted at a moisture content range of -3% to +1% of Optimum Moisture. Granular soils should be compacted at a moisture content range of +/-2% of Optimum.

For your use. This addendum is part of a complete soils report and does not stand alone. Other comments and recommendations not specifically addressed herein shall remain applicable to the project.

Should you have any questions or concerns, please contact us at (928) 778-9001.

Sincerely,

ENGINEERING & TESTING CONSULTANTS, INC.



Michael P. Wilson, P.E.
Project Engineer

Reviewed by: Richard G. Kelley, P.E.
Project Manager

cc: ETC File No. 10115