



**NOTICE TO CONTRACTORS,
PROPOSAL,
AGREEMENT, &
SPECIAL PROVISIONS**

FOR CONSTRUCTION ON
**Project No: 23-046
Well 29 Chlorination**

IN STANISLAUS COUNTY,
TURLOCK, CALIFORNIA.

Engineering Division

Contact Person: Stephen Fremming
Phone: 209-668-5417
Email: Stephen Fremming

William D. Morris, RCE 55910
City Engineer

Proposals shall be delivered to Turlock, California
at or before 2:00 PM on Wednesday, February 5, 2025
at the office of the City Engineer,
Engineering Division
156 S. Broadway, Suite 150
Turlock, CA 95380

LICENSEES RESPONSIBLE FOR SPECIFICATIONS

Contract documents prepared by or under the direction of the following registered persons:

City Engineer (Front End Specifications)

William D. Morris
Engineering Division
156 S. Broadway Suite 150
Turlock, CA 95380



DATE SIGNED 1/7/2025

Civil Engineer

Alex Gong
Provost & Pritchard
455 W. Fir Avenue
Clovis, CA 93611-9166
559-449-2700



DATE SIGNED 12/17/2024

Electrical Engineer

Kevin L. Pezzoni
Pezzoni Engineering, Inc.
1150 9th Street Suite #1415
Modesto, CA 95354
209-554-4602



DATE SIGNED 12/17/2024

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CITY OF TURLOCK, CALIFORNIA
NOTICE TO CONTRACTORS

Sealed proposals will be received by the City Engineer of the City of Turlock, Engineering Division, 156 S. Broadway, Suite 150, Turlock, California 95380, until 2:00 PM on Wednesday, February 5th, 2025, for:

City Project No. 23-046
Well 29 Chlorination

In accordance with and as described and provided in the plans, specifications and the proposed form of contract therefore, all of which are on file in the office of the City Engineer, and to which special reference is hereby made.

No verbal, telegraphic, electronic mail, facsimile, or telephone Proposals shall be considered.

An Optional Pre-Bid meeting will be held on Wednesday, January 22, 2025 at 9:00 AM at Turlock City Hall, 156 S. Broadway Suite 150, Turlock, CA 95380. The purpose of the pre-bid meeting is to provide a venue for bidders to view the site of work and ask questions of the designer and City staff.

Proposals are required to be complete and for the entire work, materials and improvements unless the contrary is indicated in the specifications.

In accordance with the provisions of California Business and professions Code, Section 7028, Contractor shall possess one of the following Contractor license(s) at the time of bid and for the duration of the contract:

1. A-General Engineering Contractor

Failure to possess a specified license shall render the Bid as non-responsive, shall act as a bar to award of the contract to any Bidder not possessing said license(s) at the time of Bid opening and shall result in the forfeiture of the security of said Bidder. Furthermore, any Bidder or Contractor not so licensed shall be subject to all legal penalties imposed by law, including, but not limited to, any appropriate disciplinary action by the Contractor's License Board.

Each proposal must be accompanied by cash, cashier's check, or check certified by a responsible bank, or by a bid bond, the proposed form of which is on file in the office of the City Engineer of said City and to which special reference is hereby made in a sum not less than ten percent (10%) of the total amount bid, payable to the City of Turlock as liquidated damages in the case the bidder is awarded the contract and fails within ten (10) days after the date of mailing to him by the City Engineer of a notice of award of the contract and that the contract is ready for signature to execute the above-mentioned written contract and file with the City Engineer satisfactory insurance certificates as required by the terms of said contract and satisfactory bonds as required by law for the faithful performance of said contract and

for the protection of material, men and laborers. Special reference is hereby made to Sections 5100, et. seq., of the Public Contracts Code of the State of California and to the proposed forms for said bonds now on file in the office of the said City Engineer for further particulars regarding bonds.

Pursuant to Section 1773 of the Labor Code, the general prevailing wage rates in the county Stanislaus in which the work is to be done have been determined by the Director of the California Department of Industrial Relations. These wages are set forth in the General Prevailing Wage Rates for this project, available at 156 S. Broadway St, Turlock, CA 95380 and available from the California Department of Industrial Relations' Internet web site at <http://www.dir.ca.gov/DLSR/PWD>.

Bidders' attention is directed to the insurance requirements in the contract. It is highly recommended that bidders confer with their respective insurance carriers or brokers to determine in advance of bid submission the availability of insurance certificates and endorsements prescribed and provided herein. If an apparent low bidder fails to comply strictly with the insurance requirements, that bidder may be disqualified from award of the contract.

No proposal will be considered unless made on forms furnished by the City Engineer of said City at his office of said City. Each proposal must be sealed, and the envelope containing the same must be addressed to the City Engineer of the City of Turlock and must be plainly marked. Each proposal shall clearly identify the bidders name and address on the sealed envelope.

Each bid shall separately state in figures the price offered for the approximate quantity of each item set forth and shall also state in words and figures the total contract price. Quantities set forth in the proposal form and in the specifications are approximate only, being given as a basis for comparison of bids, and the City of Turlock does not expressly or implied agree that the actual amount of work or materials will correspond therewith, but reserves the right to increase or decrease the amount of any class or portion of the work or materials as may be deemed necessary by the City Engineer.

Proposals may not be withdrawn for a period of sixty (60) days after the time fixed for opening of proposals. The City Council of the City of Turlock reserves the right to reject any and all proposals or any part thereof and to waive any errors or informalities in any proposals and to set and act as sole judge of the merit and qualifications of the equipment, supplies or services offered.

At the request and expense of Contractor, pursuant to Division 2, Part 5, Section 22300, et. seq., of the Public Contracts Code, securities equivalent to any funds withheld as retention from progress payments made under this contract may be deposited with the City of Turlock or with a State or Federally chartered bank as escrow agent, who shall pay such moneys to Contractor upon completion of the contract.

Copies of the Contract Documents, including Instructions to Bidders, Bid Proposal Forms, Plans and Specifications, may be downloaded from the engineering division's web site or purchased for a non-refundable fee of **One Hundred Seventy dollars (\$170)** at the Office of the City Engineer, 156 S. Broadway, Ste. 150, Turlock, CA 95380, Phone (209) 668-5520. For additional information, go to <http://www.cityofturlock.org/capitalprojects>

The U.S. Department of Transportation (DOT) provides a toll-free “hotline” service to report bid rigging activities. Bid rigging activities can be reported Mondays through Fridays, between 8:00 a.m. and 5:00 p.m., Eastern Time, Telephone No. 1-800-424-9071. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should use the “hotline” to report these activities. The “hotline” is part of the DOT’s continuing effort to identify and investigate highway construction contract fraud and is operated under the direction of the DOT Inspector General. All information will be treated confidentially and caller anonymity will be respected.


No contractor or subcontractor may be listed on a bid proposal for a public works project unless registered with the Department of Industrial Relations pursuant to Labor Code Section 1725.5. No contractor or subcontractor may be awarded a contract for public work on a public works project unless registered with the Department of Industrial Relations pursuant to Labor Code Section 1725.5.

This project is subject to compliance monitoring and enforcement by the Department of Industrial Relations. The contractors and subcontractors must furnish electronic certified payroll records to the Labor Commissioner.

The contractor shall post job site notices prescribed by regulation. (*See* 8 Calif. Code Reg. §16451(d) for the notice that previously was required for projects monitored by the CMU.)

DATED: 1/7/2025

CITY OF TURLOCK

By: 
William D. Morris, RCE 55910
City Engineer

PROPOSAL SUBMITTAL CHECKLIST

The bidder shall provide a complete proposal in a sealed envelope before
2:00 PM on Wednesday, February 5, 2025

at the address shown on the cover sheet of these specifications. FAILURE TO PROVIDE ALL THE REQUIRED DOCUMENTS LISTED IN THE TABLE BELOW MAY CAUSE THE PROPOSAL TO BE CONSIDERED NON-RESPONSIVE.

Complete Proposal

Page No.

<input type="checkbox"/> PROPOSAL AND BIDDING FORM.....	5-9
<input type="checkbox"/> AFFIDAVIT	10
<input type="checkbox"/> INFORMATION REQUIRED OF BIDDER	11-12
<input type="checkbox"/> BIDDER'S BOND	13-14
<input type="checkbox"/> LIST OF SUBCONTRACTORS.....	15
<input type="checkbox"/> MATERIAL SUPPLIERS INFORMATION.....	16

PROPOSAL

Project No. 23-046

Well 29 Chlorination

City of Turlock, California

DATED: _____

To: The Honorable City Council of the City of Turlock, California:

NAME OF BIDDER: _____

BUSINESS ADDRESS: _____

PLACE OF RESIDENCE: _____

Bids are to be submitted for the entire work. The amount of the bid for comparison purposes will be the total of all items. The bidder shall set forth for each unit basis item of work a unit price and a total for the item, and for each lump sum item a total for the item, all in clearly legible figures in the respective spaces provided for that purpose.

In the case of unit basis items, the amount set forth under the "Item Total" column shall be the product of the unit price bid and the estimated quantity for the item. In case of discrepancy between the unit price and the total set forth for a unit basis item, the unit price shall prevail except as provided in (a) or (b), as follows:

(a) If the amount set forth as unit price is unreadable or otherwise unclear, or is omitted, or is the same as the amount as the entry in the item total column, then the amount set forth in the item total column for the item shall prevail and shall be divided by the estimated quantity for the item and the price thus obtained shall be the unit price;

(b) (Decimal Errors) If the product of the entered unit price and the estimated quantity is exactly off by a factor of ten, one hundred, etc., or one-tenth, or one-hundredth, etc. from the entered total, the discrepancy will be resolved by using the entered unit price or item total, whichever most closely approximates percentage wise the unit price or item total in the Department's Final Estimate of Cost.

In accordance with the annexed Notice to Contractors, the undersigned, as bidder, declares that he has carefully examined the location of the proposed work, the plans, specifications and technical requirements therefore, and the proposed forms of contract and bonds mentioned or referred to in said Notice and on file in the Office of the City Engineer of the City of Turlock, together with the prevailing rate of per diem wages for each craft or type of workmen needed to execute said contract; and he proposes and agrees that if this proposal is accepted, he will furnish all labor, materials, equipment, plant transportation, service, sales taxes, permit fees and other costs necessary to complete the construction in strict conformity to the plans and specifications and he will enter into a written contract

with the City of Turlock in the form of contract on file in the Office of the City Engineer for such purposes, and that he will execute and/or provide all bonds and insurance certificates required by law and/or by said contract and/or mentioned in said Notice to Contractors all in accordance with and subject to all applicable laws, and that he will take in full payment therefore the following unit prices, to wit:

BIDDER'S FORM

PROJECT TITLE: Well 29 Chlorination

PROJECT NUMBER: 23-046

OPENING DATE: February 5, 2025

OPENING TIME: 2:00 PM

Item No.	Item Description	Unit of Measure	Estimated Quantity	Unit Price	Total
1	Mobilization and Demobilization	LS	1		
2	Traffic Control	LS	1		
3	Site Piping	LS	1		
4	Chemical Storage Building and Pad	LS	1		
5	Chlorination Equipment (Pumps, Tanks, Analyzers)	LS	1		
6	Electrical, Instrumentation, and Controls	LS	1		
7	Site Civil Improvements	LS	1		
8	Startup and Testing	LS	1		
9	Operations and Maintenance Manuals	LS	1		
10	As-Built Drawings	LS	1		
Subtotal					

Bidder has examined and carefully studied the Bidding documents and other related data identified in the Bidding Documents and the following Addenda, receipt of which is hereby acknowledged

ADDENDA

No. _____	Date _____	Signed _____
No. _____	Date _____	Signed _____
No. _____	Date _____	Signed _____
No. _____	Date _____	Signed _____
No. _____	Date _____	Signed _____

TOTAL BID WRITTEN IN FIGURES: \$ _____, _____, _____ . _____

TOTAL BID WRITTEN IN WORDS: _____

CONTRACTOR: _____

COMPANY'S NAME: _____

BY: _____

ADDRESS: _____

(Number)

(Street)

(City)

(State)

(ZIP)

CONTRACTOR'S PHONE #: _____

CONTRACTOR'S EMAIL: _____

NOTE: CONTRACTOR WILL BE REQUIRED TO LIST THEIR LICENSE NUMBER, EXPIRATION DATE, AND APPROPRIATE STATEMENT REGARDING PERJURY AND SIGNED BY INDIVIDUAL AUTHORIZED TO DO SO. FAILURE TO INCLUDE THE ABOVE ITEMS MAY CAUSE SAID CONTRACTOR'S BID TO BE REJECTED.

_____, Contractor's License # _____, Class _____
(Company's Name)

Expires _____ . DIR #: _____

This information is true, is provided as per Section 7028.15 of the Business and Professions Code, and is made herein under penalty of perjury.

X _____
(Bidder's Signature) (Date)

If the proposal is accepted and the undersigned shall fail to contract as aforesaid and fail to file with the City insurance certificates as required by said contract, within fourteen (14) days after the bidder has received notice from the City Engineer or his representative of the City of Turlock that the contract has been awarded to bidder and is ready for signature, the City of Turlock may, at its option, determine that the bidder has abandoned his contract, and thereupon this proposal and the acceptance thereof shall be null and void.

Also accompanying this proposal is an affidavit of non-collusion and questionnaire to general contractors, a statement of proposed subcontractors, if any, the address of mill, shop or office of any subcontractor, and a statement of work to be performed by subcontractors.

The names and addresses of persons interested in the foregoing proposal as principals are as follows:

(IMPORTANT NOTICE: If bidder or other interested person is a corporation, state legal name of corporation, also names of the president, secretary, treasurer, and manager thereof; if a partnership,

state true name of firm, also names of all individual co-partners composing firm; if bidder or other interested person is an individual, state first and last name in full.)

Licensed in accordance with an act providing for the registration of Contractors,
License No. _____ Expiration Date _____.

DATED: _____, 20 _____

Address: _____

Phone: _____

Email: _____

X _____
Signature of Bidder

NOTE: If bidder is a corporation, the legal name of the corporation shall be set forth above together with the signature of the officers authorized to sign contracts on behalf of the corporation; if bidder is a co partnership, the true name of the firm shall be set forth above together with the signature of the partner or partners authorized to sign contracts in behalf of the co partnership; and, if bidder is an individual, his signature shall be placed above. If a signature is by an agent other than an officer of a corporation or a member of the partnership, a Power of Attorney must be on file with the City Clerk prior to opening or submitted with the bid; otherwise, the bid will be disregarded as irregular and unauthorized.

AFFIDAVIT

The undersigned bidder, being first duly sworn, deposes and says that he/she are the party making the foregoing proposal or bid, that this bid is genuine and not collusive or sham, that said bidder has not colluded, conspired, connived or agreed, directly or indirectly, with any other person or bidder, to put in a sham bid, or that said other person shall refrain from bidding, and has not in any manner sought by collusion to secure any advantage against the said City or any person interested in said improvement, for him/herself or any other person.

X _____
Signature of Bidder

Jurat (Government Code Section 8202)

State of California

County of _____

Subscribed and sworn to (or affirmed) before me on this _____ day of _____, 20_____

by _____ proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me.

(AFFIX SEAL)

NOTARY PUBLIC SIGNATURE

NOTARY PUBLIC PRINTED NAME

INFORMATION REQUIRED OF BIDDER

The bidder is required to provide the following information. Additional sheets may be attached if necessary.

Contractor's mailing address: _____

Contractor's telephone number: _____

Number of years' experience as a contractor in construction work or installation work similar to that required in these specifications:

Name of person who inspected the site of the proposed work for your firm:

Date of Inspection: _____

List at least four projects completed as of recent date:

Project No. and Title: _____

Class and Type of Work: _____

Name, Address, and Phone No. of Owner _____

Registered Engineer in Charge of Project: _____

Total Contract amount: _____

Contract amount you performed: _____

Name of Prime Contractor if you were Sub: _____

Date Completed: _____

Liquidated Damages Assessed: _____

Project No. and Title: _____

Class and Type of Work: _____

Name, Address, and Phone No. of Owner _____

Registered Engineer in Charge of Project: _____

Total Contract amount: _____
Contract amount you performed: _____
Name of Prime Contractor if you were Sub: _____
Date Completed: _____
Liquidated Damages Assessed: _____

Project No. and Title: _____
Class and Type of Work: _____
Name, Address, and Phone No. of Owner _____
Registered Engineer in Charge of Project: _____
Total Contract amount: _____
Contract amount you performed: _____
Name of Prime Contractor if you were Sub : _____
Date Completed: _____
Liquidated Damages Assessed: _____

Project No. and Title: _____
Class and Type of Work: _____
Name, Address, and Phone No. of Owner _____
Registered Engineer in Charge of Project: _____
Total Contract amount: _____
Contract amount you performed: _____
Name of Prime Contractor if you were Sub : _____
Date Completed: _____
Liquidated Damages Assessed: _____

BIDDER'S BOND

KNOW ALL MEN BY THESE PRESENTS:

That we _____ as
BIDDER, and _____ as
SURETY a corporation duly organized under the laws of the State of _____
and duly licensed to become sole Surety on bonds required and authorized by the State of California, as
SURETY, are held and firmly bound unto the City of Turlock, hereinafter called the City, in the penal
sum of TEN PERCENT (10%) OF THE TOTAL AMOUNT OF THE BID of the Bidder above named,
submitted by said Bidder to the City, for the work described below, for the payment of which sum in
lawful money of the United States, well and truly to be made, we bind ourselves, our heirs, executors,
administrators and successors, jointly and severally, firmly by these presents. In no case shall the liability
of the Surety hereunder exceed the sum _____

Dollars (\$ _____).

THE CONDITION OF THIS OBLIGATION IS SUCH THAT, whereas the bidder has submitted the
above-mentioned bid to the City for certain construction specifically described as follows for which bids
are to be opened at Engineering Division, City Hall, 156 S. Broadway Suite 150, Turlock, California,
on

_____, _____, 20____, at _____.
(day) (date) (time)

for **Project No. 23-046, "Well 29 Chlorination ."**

NOW, THEREFORE, if the aforesaid Bidder is awarded the contract and, within the time manner
required under the specifications after the prescribed forms are presented to him for signature, enters
into a written contract in the prescribed form in accordance with the bid, and files the two bonds with
the City, one to guarantee faithful performance and the other to guarantee payment for labor and
materials as required by law, then obligation shall be null and void; otherwise, it shall be and remain in
full force and virtue.

In the event suit is brought upon this bond by the Obligee and judgment is recovered, the Surety shall
pay all costs incurred by the Obligee in such a suit, including a reasonable attorney's fee to be fixed by
the court.

IN WITNESS WHEREOF, we have hereunto set our hands and seals on
this _____ day of _____, 20__.

BIDDER

(Bidder's Name and Corporate Seal)

(Signature)

(Print Name and Title)

(ATTACH ACKNOWLEDGMENT OF BIDDER)

SURETY

(Surety's Name and Corporate Seal)

(Signature)

(Print Name and Title)

**(ATTACH ACKNOWLEDGMENT OF SURETY'S
ATTORNEY-IN-FACT)**

NOTE: ATTACH CERTIFIED COPY OF POWER OF ATTORNEY

SUBCONTRACTORS
City Project No. 23-046
Well 29 Chlorination

Prime Contractor: _____ DIR NUMBER: _____

Pursuant to California Public Contract Code §4100, the Bidder shall list each subcontractor who will perform Work or Labor or who will render service to the Prime Contractor in or about the construction of the Work or Improvement, or a subcontractor duly licensed who, under subcontract to the Prime Contractor, specially fabricates and installs a portion of the Work or Improvement according to detailed Drawings contained in the Contract Documents, in an amount in excess of 1/2 of 1 percent of the Prime Contractor's Total Bid or, in the case of Bids or Offers for the construction of streets or highways, including bridges, in excess of 1/2 of 1 percent of the Prime Contractor's total Bid or \$10,000 whichever is greater. After the opening of Bids, no changes or substitutions will be allowed except as otherwise provided by law. The listing of more than one subcontractor for each item of Work to be performed with the words "and/or" will not be permitted.

IF NO SUBCONTRACTORS WILL FURNISH WORK, THEN WRITE "NONE" BELOW IN THE SPACE PROVIDED.

NAME	LICENSE NUMBER	DIR NUMBER	ADDRESS	WORK ITEMS TO BE PERFORMED AND % OF ITEM

MATERIAL SUPPLIERS INFORMATION

Prime Contractor: _____

The Bidder shall indicate opposite each item of equipment or material listed below the name of the manufacturer or supplier of the equipment or material proposed to be furnished under the Bid.

	<u>Equipment/Material</u>	<u>Manufacturer/Model</u>	<u>Alternate Manufacturer/Model</u>
1	Programmable Logic Controller	Rockwell Automation CompactLogix 5380	N/A
2	Programmable Logic Controller Software	Rockwell RSLogix5000	N/A
3	Radio	General Electric Orbit LN4 MCR/ECR	N/A
4	Surge Protection Device	Endress + Hauser HAW569-CB2C	N/A
5	Chlorine Analyzer	Hach CLF10sc with sc200 controller, pH sensor and SS Panel	N/A
6	Chemical Metering Pumps	Grundfos DDA 17-7 FCM-PVC/V/C-F-31U7U7B	N/A
7	Chemical Storage Tanks		
8			
9			

Manufacturers and models that are pre-populated in the bidding documents are sole source items with no equal. No substitution will be permitted after award of contract unless equipment or material of the listed manufacturer or supplier is determined to not meet the specifications or if the material is not available within a reasonable timeline and Owner agrees to approve an alternate product. Awarding of a contract under this bid will not imply approval by the Owner of the manufacturers or suppliers listed by the Bidder.



AGREEMENT

FOR PUBLIC IMPROVEMENT

City Project No. 23-046

Well 29 Chlorination

THIS PUBLIC IMPROVEMENT AGREEMENT (the "Agreement") is entered into by and between the CITY OF TURLOCK, a California municipal corporation ("City"), and _____, a _____ ("Contractor"), on this ____ day of _____ 20__ (the "Effective Date"). City and Contractor may be collectively referred to herein as the "Parties" or individually as "Party." There are no other parties to this Agreement.

RECITALS

- A. City seeks a duly qualified and licensed firm experienced in the construction of _____ (the "Project").
- B. The Project involves the expenditure of funds in excess of \$5,000 and constitutes a "public project" pursuant to Public Contract Code section 20161.
- C. Contractor has made a proposal to City to provide construction services, a copy of which is attached and incorporated hereto as **Exhibit A** (the "Services").
- D. City has determined it is necessary and desirable to employ the services of Contractor to perform construction work on the Project.
- E. City has taken appropriate proceedings to authorize construction of the Project and execution of this contract pursuant to Public Contract Code section 20160 et seq.; specifically, on _____, 20____, at a duly noticed meeting of the City Council of the City of Turlock, this contract for the construction of the improvements hereinafter described was awarded to Contractor as the lowest responsive and responsible bidder for said improvements.

NOW, THEREFORE, in consideration of the promises and covenants set forth below, the Parties agree as follows:

AGREEMENT

1. Contract Documents: This Agreement, together with the following documents, are collectively referred to herein as the “Contract Documents”:

- i. Notice to Bidders;
- ii. Contractor’s Bid or Proposal accepted by City;
- iii. Special Provisions of the City of Turlock for Well 29 Chlorination ;
- iv. Plans and detailed drawings prepared for this Project and approved by City (“Project Plans”);
- v. All bonds and insurance required in any of the Contract Documents;
- vi. Any and all supplemental agreements amending, decreasing, or extending the work contemplated or which may be required to complete the work in a substantial and acceptable manner; and
- vii. The current edition of the City of Turlock Standard Specifications and Drawings.

All of the Contract Documents are intended to incorporate the terms of the others so that any work called for in one and not mentioned in the other, or vice versa, is to be executed the same as if mentioned in all said documents. The documents comprising the complete contract will hereinafter be referred to as the “Contract.” In case of any dispute regarding the terms of the Contract, the decision of the City Engineer shall be final.

2. Term. The Contract shall be effective as of the Effective Date first stated above. Contractor shall not commence work on the Project until it has been given notice by City (“Notice to Proceed”). The Contract shall terminate one (1) year(s) after City accepts Contractor’s performance of the Services by recording a Notice of Completion with the County of Stanislaus Clerk Recorder (the “Term”), unless the Parties mutually agree in writing to terminate the Contract earlier or extend the Term in an agreed writing executed by both Parties.

3. Scope of Work.

(a) *Services.* Contractor shall perform the Services described in Exhibit A, subject to all terms and conditions in the Contract. Contractor shall not receive additional compensation for the performance of any Services not described therein.

(b) *Modification.* City, at any time, by written order, may make changes within the general scope of the work under this Agreement or issue additional instructions, require additional work or direct deletion of work. Contractor shall not proceed with any change involving an increase or decrease in the Contract Price, as defined in Section 4 of this Agreement, without prior written authorization from City. Contractor shall not be entitled to compensation for the performance of any such unauthorized work. Contractor further waives any and all right or remedy by way of restitution or quantum meruit for any

and all extra or changed work performed without express and prior written authorization of City. Notwithstanding the foregoing, Contractor shall promptly commence and diligently complete any change to the work subject to City's written authorization issued pursuant to this Section; Contractor shall not be relieved or excused from its prompt commencement of diligent completion of any change subject to City's written authorization by virtue of the absence or inability of Contractor and City to agree upon the extent of any adjustment to the completion schedule or Contract Price on account of such change. The issuance of a change order pursuant to this Section 3 in connection with any change authorized by City shall not be deemed a condition precedent to Contractor's obligation to promptly commence and diligently complete any such change authorized by City hereunder. City's right to make changes shall not invalidate the Contract nor relieve Contractor of any liability or other obligations under the Contract. Any requirement of notice of changes in the scope of work to Contractor's surety shall be the responsibility of Contractor.

(c) *Specific Materials & Performance of Work.* Contractor shall furnish all tools, equipment, facilities, labor, and materials necessary to perform and complete, in good workmanlike manner, the work of general construction as called for and in the manner designated in, and in strict conformity with, the plans and specifications for said work entitled, “**Special Provisions for Well 29 Chlorination .**” The equipment, apparatus, facilities, labor, and material shall be furnished, and said work performed and completed as required by the Contract under the direction and supervision, and subject to the approval, of the City Engineer or City Engineer’s designated agent.

(d) *Exhibits.* All “Exhibits” referred to below or attached hereto are, by this reference, incorporated into the Contract.

	<u>Exhibit Designation</u>	<u>Exhibit Title</u>
1.	Exhibit A	Contractor’s Proposal for Services
2.	Exhibit B	Payment by Force Account
3.	Exhibit C	Workers’ Compensation Insurance Certification
4.	Exhibit D	Performance Bond
5.	Exhibit E	Payment Bond

4. Contract Price. City shall pay, and Contractor shall accept in full payment for the work set forth above in Section 3, Scope of Work, an amount not to exceed _____ **Dollars (\$_____ .00)** (the “Contract Price”). Said amount shall be paid pursuant to Section 8 of this Agreement. The Contract Price may only be changed by a contract change order. The value of any work covered by a contract change order for an adjustment in the Contract Price will be determined in the sole discretion of City as follows:

(a) If the work performed is on the basis of unit prices contained in the Contract Documents, the change order will be determined in accordance with the provisions in Section 4-1.05, “Changes and Extra Work”, of the Caltrans Standard Specifications, as applicable; or

(b) If the work performed is not included on the engineer’s estimate associated with a unit price, the change order will be by a mutually agreed lump sum; or

(c) If the change order is not determined as described above in either subdivision (a) or (b), the change order will be determined on the basis of force account in accordance with the provisions set forth in **Exhibit B**, "Payment by Force Account," attached hereto and incorporated herein by reference.

5. Time for Performance. The time fixed for the commencement of work under the Contract is within ten (10) working days after the Notice to Proceed has been issued. The work on this project shall be substantially completed on or before the expiration of **one hundred twenty (120)** working days (the "Substantial Completion Due Date") beginning on the first day of work or no later than the tenth day after the Notice to Proceed has been issued. All work on this project, including all punch list items, shall be completed on or before the expiration of **one hundred thirty (130)** working days (the "Final Completion Due Date") beginning on the first day of work or no later than the tenth day after the Notice to Proceed has been issued.

(a) *Right of City to Increase Working Days:* If Contractor fails to complete the Services by the Substantial and Final Completion Due Dates, the City Engineer shall have the right to increase the number of working days in the amount the City Engineer may determine will best serve the interests of City, and if the City Engineer desires to increase said number of working days, the City Engineer shall have the further right to charge Contractor and deduct from the final payment for the work the actual cost of engineering, inspection, superintendence, and other overhead expenses which are directly chargeable to Contractor, and which accrue during the period of such extension, except that the cost of the final service and preparation of the final estimates shall not be included in such charges. No extension of time for completion of Services under the Contract shall be considered unless requested by Contractor at least twenty (20) calendar days prior to the Substantial and Final Completion Due Dates, in writing, to the City Engineer.

The Substantial and Final Completion Due Dates may only be changed by a contract change order. The value of any work covered by a contract change order for an adjustment in the Substantial and Final Completion Due Dates will be determined as follows:

- i. Additional working days will be awarded where the amount of time is mutually agreed upon by Contractor and the City Engineer; or
- ii. Additional working days will be awarded where Contractor is prevented from completing any part of the work identified on the critical path and:
 1. where the delay is caused by acts of public enemy, fire, floods, tsunamis, earthquakes, epidemics, quarantine restrictions, strikes, labor disputes, shortage of materials and freight embargos, provided that Contractor shall notify Engineer in writing of the causes of delay within fifteen (15) days from the beginning of that delay; or
 2. where the delay is caused by actions beyond the control of Contractor; or
 3. where the delay is caused by actions or failure to act by the City Engineer.

Contractor shall not be entitled to an adjustment in the Substantial and Final Completion Due Dates for delays within the control of Contractor. Delays resulting from and within the control of a subcontractor or supplier of Contractor shall be deemed to be delays within the control of Contractor.

(b) *Excusable Delays.* Contractor shall not be in breach of the Contract in the event that performance of Services is temporarily interrupted or discontinued due to a “Force Majeure” event which is defined as: riots, wars, sabotage, civil disturbances, insurrections, or explosions; natural disasters, such as floods, earthquakes, landslides, and fires; strikes, lockouts, and other labor disturbances; or other catastrophic events, which are beyond the reasonable control of Contractor. Force Majeure does not include Contractor’s financial inability to perform, Contractor’s failure to obtain any necessary permits or licenses from other governmental agencies, or Contractor’s failure to obtain the right to use the facilities of any public utility where such failure is due solely to the acts or omissions of Contractor. If Contractor’s performance of the Services is delayed by an excusable delay, the Substantial and Final Completion Due Dates shall be extended for such reasonable time as determined by the City Engineer. Extensions in time must be requested by Contractor within fifteen (15) calendar days of the excusable delay in order to receive consideration.

(c) *Emergency - Additional Time for Performance - Procurement of Materials.* If, because of war or other declared national emergency, the federal or state government restricts, regulates, or controls the procurement and allocation of labor or materials, or both, and if solely because of said restrictions, regulations or controls, Contractor is, through no fault of Contractor, unable to perform the Services, or the work is thereby suspended or delayed, any of the following steps may be taken:

- i. City may, pursuant to resolution of the City Council, grant Contractor additional time for the performance of the Contract, sufficient to compensate in time, for delay or suspension.

To qualify for such extension in time, Contractor within ten (10) days of Contractor's discovering such inability to perform, shall notify the City Engineer in writing thereof, and give specific reasons therefore; the City Engineer shall thereupon have sixty (60) days within which to procure such needed materials or labor as is specified in this agreement, or permit substitution, or provide for changes in the work in accordance with subdivision (b) of this Section.

Substituted materials, or changes in the work, or both, shall be ordered in writing by the City Engineer, and the concurrence of the City Council shall not be necessary. All reasonable expenses of such procurement incurred by the City Engineer shall be defrayed by the Contractor; or

- ii. If such materials or labor cannot be procured through legitimate channels within sixty (60) days after the filing of the aforesaid notice, either Party may, upon thirty (30) days' written notice to the other, terminate this agreement. In such event, Contractor shall be compensated for all work executed upon a unit basis in proportion to the amount of the work completed, or upon a cost-plus-ten-percent (10%) basis, whichever is the lesser. Materials on the ground, in process of fabrication or in route upon the date of notice of termination specially ordered for the Project and which

cannot be utilized by Contractor, shall be compensated for by City at cost, including freight, provided Contractor shall take all steps possible to minimize this obligation; or

- iii. The City Council, by resolution, may suspend the Contract until the cause of inability to perform is removed for a period of not to exceed sixty (60) days.

If the Contract is not canceled, and the inability of Contractor to perform continues without fault on Contractor's part, beyond the time during which the Contract may have been suspended, as herein above provided, the City Council may further suspend the Contract, or either Party hereto may, without incurring any liability, elect to declare the Contract terminated upon the ground of impossibility of performance. In the event City declares this agreement terminated, such declaration shall be authorized by the City Council by resolution, and Contractor shall be notified in writing thereof within five (5) days after the adoption of such resolution. Upon such termination, Contractor shall be entitled to proportionate compensation at the Contract Price for such portion of the Contract as may have been performed; or

- iv. City may terminate the Contract, in which case Contractor shall be entitled to proportionate compensation at the agreed rate for such portion of the Contract as may have been performed. Such termination shall be authorized by resolution of the City Council. Notice thereof shall be forthwith given in writing to Contractor, and the Contract shall be terminated upon receipt by Contractor of such notice.

In the event of the termination provided in this sub-paragraph (iv), none of the covenants, conditions or provisions hereof shall apply to the Services not performed, and City shall be liable to Contractor for the proportionate compensation last herein mentioned.

(d) *Delay Damages.* In the event Contractor, for any reason, fails to perform the Services to the satisfaction of the City Engineer by the Substantial Completion Due Date, City may, in accordance with Section 7203 of the Public Contract Code, in lieu of any other of its rights authorized by Section 6 of this agreement, deduct from payments or credits due Contractor after such breach a sum equal to **Seven Hundred Fifty** and no/100ths Dollars (**\$750.00**) for each calendar day beyond the Substantial Completion Due Date. Upon Substantial Completion of the work, and in the event Contractor, for any reason, fails to perform the Services to the satisfaction of the City Engineer by the Final Completion Due Date, City may, in accordance with Section 7203 of the Public Contract Code, in lieu of any other of its rights authorized by Section 6 of this agreement, deduct from payments or credits due Contractor after such breach a sum equal to **Three Hundred** and no/100ths Dollars (**\$300.00**) for each calendar day beyond the Final Completion Due Date. This deduction shall not be considered a penalty but shall be considered as delay damages. The aforementioned rate of deduction is an amount agreed to by the Parties as reasonably representing additional construction engineering costs incurred by City if Contractor fails to complete the Services by the Substantial and Final Completion Due Dates. However, any deduction assessed as delay damages shall not relieve Contractor from liability for any damages or costs resulting from delays to other contractors on the project or other projects caused by a failure of the assessed Contractor to complete the Services by the Substantial and Final Completion Due Dates. Due account

shall be taken of any time extensions granted to Contractor by City. Permitting Contractor to continue work beyond the Substantial and Final Completion Due Dates shall not operate as a waiver on the part of City of any of its rights under the Contract nor shall it relieve Contractor from liability for any damages or costs resulting from delays to other contractors on the project or other projects caused by a failure of the assessed Contractor to complete the Services by the Substantial and Final Completion Due Dates.

6. Termination.

(a) *Option of City to Terminate Contract for Failure to Complete Services.* If a Party should fail to perform any of its obligations hereunder within the time and in the manner herein provided, or otherwise violates any of the terms of the Contract (the “Defaulting Party”), the other Party shall give notice to the Defaulting Party and allow the Defaulting Party ten (10) days to correct such deficiency. If the Defaulting Party does not correct such deficiency, the other Party may immediately terminate the Contract by giving written notice of such termination, stating the reason for such termination. In such event, Contractor shall be entitled to receive payment for all Services satisfactorily rendered until such termination, provided, however, there shall be deducted from such amount the amount of damage, if any, sustained by virtue of any breach of the Contract by Contractor, including Delay Damages. If payment under the Contract is based upon a lump sum in total or by individual task, payment for Services satisfactorily rendered shall be an amount which bears the same ratio to the total fees specified in this Agreement as the Services satisfactorily rendered hereunder by Contractor to the total services otherwise required to be performed for such total fee, provided, however, that there shall be deducted from such amount the amount of damage, if any sustained by City by virtue of any breach of the Contract by Contractor. Upon termination, Contractor shall deliver copies of all Work Product, as defined in Section 19 of this Agreement, to City. If District terminates the Contract before Contractor commences any Services hereunder, City shall not be obligated to make any payment to Contractor.

(b) If Contractor should be adjudged bankrupt or if it should make a general assignment for the benefit of its creditors, or if a receiver should be appointed on account of its insolvency, or if it or any of its subcontractors should violate any of the provisions of the Contract, City may serve written notice upon it and its surety of its intention to terminate the Contract. Such notice shall contain the reasons for City’s intention to terminate the Contract, and unless such violations shall cease within five (5) calendar days after serving of such notice, the Contract shall cease and terminate upon the expiration of said five (5) calendar days. In the event of any such termination, City shall immediately serve written notice thereof upon the surety and Contractor, and the surety shall have the right to take over and perform the Contract; provided however, that, if the surety does not give City written notice of its intention to take over and perform the Contract or does not commence performance thereof within thirty (30) calendar days from the date of the service of such notice, City may take over the work and prosecute the same to completion by contract or any other method it may deem advisable, for the account and at the expense of Contractor, and Contractor and its surety shall be jointly liable to City for any excess cost occasioned City thereby, and in such event City may, without liability for so doing, take possession of and utilize in completing the work, such materials, appliances, and other property belonging to Contractor as may be on the Project site and necessary thereof.

7. Liability for Breach: Neither Party waives the right to recover direct damages against the other for breach of the Contract, including any amount necessary to compensate City for all detriment proximately caused by Contractor's failure to perform its obligations hereunder or which in the ordinary

course of things would be likely to result therefrom. City reserves the right to offset such damages against any payments owed to Contractor. City shall not, in any manner, be liable for special or consequential damages, including but not limited to Contractor's actual or projected lost profits had Contractor completed the Services required by the Contract. In the event of termination by either Party, copies of all finished or unfinished Work Product, as defined in Section 19 of this Agreement, shall become the property of City. Notwithstanding the foregoing, in no event shall City be liable, regardless of whether any claim is based on contract or tort, for any special, consequential, indirect or incidental damages, including, but not limited to, lost profits or revenue, arising out of or in connection with the Contract or the Services performed in connection with the Contract.

8. Compensation: City shall make payments to Contractor in accordance with the provisions of Section 9 of the City Standards in legally executed and regularly issued warrants of City, drawn on the appropriate fund or funds as required by law and order of the City Council thereof. Contractor shall be administered a progress payment approximately every thirty (30) calendar days from the time work begins according to the payment schedule furnished by the City Engineer at the time work begins. Contractor shall provide access at all reasonable times to all reports, contract records, contract documents, contract files, and personnel necessary to audit and verify Contractor's charges to City under this Contract.

Monthly progress payments in the amount of 95 percent (95%) of the value of the work will be made to Contractor based on the Contractor's estimate and the schedule of prices contained in the accepted bid. The remaining 5 percent (5%) will be retained by City as partial security for the fulfillment of the Contract except that at any time after 50 percent (50%) of the work has been completed, if the City Engineer finds that satisfactory progress is being made and the Project's critical path of work are on schedule, City may discontinue any further retention. Such discontinuance will only be made upon the written request of Contractor. City may, at any time the City Engineer finds that satisfactory progress is not being made, again institute retention of 5 percent (5%) as specified above. Payment will be made as soon as possible after the preparation of the Contractor's estimate. City shall pay the remaining 5 percent (5%) of the value of the Services completed under this Contract, if unencumbered by retentions for claims, not sooner than the expiration of thirty-five (35) calendar days from the date of recordation of the Notice of Completion, pursuant to Section 2 of this agreement, and not later than sixty (60) days from the "completion" of the Services as said term is defined in Public Contract Code section 7107(c).

No estimate or payment shall be made if, in the judgment of the City Engineer, the work is not proceeding in accordance with the provisions of the Contract, or when, in his judgment, the total value of the work done since the last estimate amounts to less than \$1,000. No progress payments will be made if the time allotted for the job is thirty (30) working days or less. Payment of any progress payment, or the acceptance thereof by Contractor, shall not constitute acceptance of the work performed under this Contractor, or any portion thereof, and shall in no way reduce the liability of Contractor to replace unsatisfactory work or materials, though the unsatisfactory character of such work or materials may not have been apparent or detected at the time such payment was made.

Additionally, as a precondition to City's progress payments hereunder, Contractor shall provide to City, prior to payment, unconditional waivers and releases of stop notices pursuant to Civil Code section 8128 et seq. from each subcontractor and materials supplier. The form of said waivers and releases shall be as set forth in Civil Code section 3262(d)(2).

Pursuant to Public Contract Code section 22300 et seq., Contractor may request the right to substitute securities for any moneys withheld by City to ensure the performance required of Contractor under the Contract, or that City make payment of retentions earned directly into an escrow account established at the expense of Contractor.

9. Disputes Pertaining to Payment for Work: Should any dispute arise respecting the true value of any work performed, of any work omitted, or of any extra work which Contractor may be required to do, or respecting the size of any payment to Contractor during the performance of the Contract, such dispute shall be decided by the City Engineer, and the decision of the latter shall be final and conclusive. The Parties agree to comply with the claims resolution procedures set forth in Public Contract Code section 9204 when applicable.

(a) *Claims Processing.* Any submission of a claim by Contractor must comply with the requirements of Public Contract Code section 9204. Upon receipt of a claim pursuant to this section, City shall conduct a reasonable review of the claim and, within a period not to exceed forty-five (45) days, shall provide Contractor a written statement identifying what portion of the claim is disputed and what portion is undisputed. Upon receipt of a claim, the Parties may, by mutual agreement, extend the time period provided in this subdivision. Contractor shall furnish reasonable documentation to support the claim. Any payment due on an undisputed portion of the claim shall be processed and made within sixty (60) days after City issues its written statement. If Contractor disputes City's written response, or if City fails to respond to a claim issued pursuant to this section within the time prescribed, Contractor may demand in writing an informal conference to meet and confer for settlement of the issues in dispute.

(b) *Meet-and-Confer Conference.* Upon receipt of a demand in writing sent by registered mail or certified mail, return receipt requested, City shall schedule a meet-and-confer conference within thirty (30) days for settlement of the dispute. Within ten (10) business days following the conclusion of the meet-and-confer conference, if the claim or any portion of the claim remains in dispute, City shall provide the claimant a written statement identifying the portion of the claim that remains in dispute and the portion that is undisputed. Any payment due on an undisputed portion of the claim shall be processed and made within sixty (60) days after the City issues its written statement.

(c) *Nonbinding Mediation.* Any disputed portion of the claim, as identified by Contractor in writing, shall be submitted to nonbinding mediation, with the Parties sharing the associated costs equally. The Parties shall mutually agree to a mediator within ten (10) business days after the disputed portion of the claim has been identified in writing. If the Parties cannot agree upon a mediator, each party shall select a mediator and those mediators shall select a qualified neutral third party to mediate with regard to the disputed portion of the claim. Each Party shall bear the fees and costs charged by its respective mediator in connection with the selection of the neutral mediator. If mediation is unsuccessful, the parts of the claim remaining in dispute shall be subject judicial review pursuant to Section 23 of this Agreement.

Notwithstanding any claim, dispute, or other disagreement between the Parties regarding performance under the Contract, the scope of work hereunder, or any other matter arising out of or related to, in any manner, the Contract, Contractor shall proceed diligently with performance of the Services in accordance with City's written direction, pending any final determination or decision regarding any such claim, dispute, or disagreement.

10. Permits and Care of Work: Contractor shall, at Contractor's expense, obtain all necessary permits and licenses for the construction of each improvement, give all necessary notices and pay all fees and taxes required by law, except those City fees set forth in Section 1 of the Special Provisions. Contractor has examined the Project site and is familiar with its topography and condition, location of property lines, easements, building lines, and other physical factors and limitations affecting the performance of the Contract. Contractor, at Contractor's expense, shall obtain any permission necessary for any operations conducted off the property owned or controlled by City. Contractor shall be responsible for the proper care and protection of all materials delivered and work performed until completion and final acceptance.

11. Public Works and Payment of Prevailing Wage:

(a) *Monitoring and Enforcement.* In accordance with the provisions of Sections 1725.5, 1771.1, 1771.3, and 1771.4 of the Labor Code, all work performed under the Contract is subject to compliance monitoring and enforcement by the Department of Industrial Relations (“DIR”). All work performed by Contractor or its subcontractors under the Contract is subject to the requirements of Labor Code section 1720 et seq. It is not a violation of this section for an unregistered contractor to submit a bid that is authorized by Section 7029.1 of the Business and Professions Code or by Section 10164 or 20103.5 of the Public Contract Code, provided the contractor is registered to perform public work pursuant to Section 1725.5 of the Labor Code at the time the contract is awarded. Contractor and its subcontractors shall furnish the records specified in Section 1776 of the Labor Code directly to the Labor Commissioner, at least monthly, in the format prescribed by the Labor Commissioner.

In accordance with the provisions of Section 1773.3 of the Labor Code, City shall provide notice to DIR of the award of this Contract within thirty (30) working days of the award. The notice shall be transmitted electronically in a format specified by DIR and shall include the name of Contractor, any subcontractor listed on the successful bid, the bid and contract award dates, the contract amount, the estimated start and completion dates, Project location, and any additional information DIR specifies that aids in the administration and enforcement of Section 1720 et seq. of the Labor Code.

(b) *Wages & Hours of Employment:* In the performance of the Services under the Contract, eight (8) hours shall be the maximum hours of labor on any calendar day, and the minimum wages of compensation of persons performing labor in the execution of this agreement shall be the current prevailing scale of wages determined by DIR for the community. Contractor shall forfeit as penalty Twenty-five and no/100ths Dollars (\$25.00) to be paid to City for each workman employed in the execution of the Contract by Contractor or its subcontractor(s), for each calendar day during which any workman is required or permitted to labor more than eight (8) hours, in violation of provisions of Labor Code section 1810 et seq. Contractor shall post prevailing wage rates at the Project no later than the first day Contractor commences performance of the Services under the Contract.

12. Superintendence by Contractor: Contractor shall give personal superintendence to the work on the Project or have a competent foreman or superintendent satisfactory to the City Engineer on the Project at all times during construction and performance of work under the Contract, with authority to act for Contractor.

13. Inspection and Testing by City: Contractor shall at all times maintain proper facilities and provide safe access for inspection by City to all parts of the work performed on the Project and to the shops wherein the work is in preparation. Contractor shall notify City with sufficient time in advance of the manufacture of production materials to be supplied by Contractor under the Contract in order for City to arrange for mill or factory inspection and testing of same. Any materials shipped by Contractor from factory prior to having satisfactorily passed such testing and inspection by City's representative or prior to the receipt of notice from such representative that such testing and inspection will not be required shall not be incorporated on the Project. Contractor shall also furnish to City, in triplicate, certified copies of all factory and mill test reports upon request.

14. Conformity with Law and Safety: Contractor shall observe and comply with all applicable laws, ordinances, codes, and regulations of governmental agencies, including federal, state, municipal, and local governing bodies having jurisdiction over any or all of the scope of Services, including all provisions of the Occupational Safety and Health Act of 1979 as amended, all California Occupational Safety and Health Regulations, the California Building Code, the American with Disabilities Act, any copyright, patent, or trademark law, and all other applicable federal, state, municipal, and local safety regulations, appropriate trade association safety standards, and appropriate equipment manufacturer instructions. All Services performed by Contractor or its subcontractors must be in accordance with these laws, ordinances, codes, and regulations. Contractor's failure to comply with any laws, ordinances, codes, or regulations applicable to the performance of the Services hereunder shall constitute a breach of contract. In cases where standards conflict, the standard providing the highest degree of protection shall prevail.

If a death, serious personal injury or substantial property damage occurs in connection with the performance of the Contract, Contractor shall immediately notify City's risk manager by telephone. If any accident occurs in connection with the Contract, Contractor shall promptly submit a written report to City, in such form as City may require. This report shall include the following information: (a) name and address of the injured or deceased person(s); (b) name and address of Contractor's subcontractor, if any; (c) name and address of Contractor's liability insurance carrier; and (d) a detailed description of the accident, including whether any of City's equipment, tools, or materials were involved.

If a release of a hazardous material, substance, or waste occurs in connection with the performance of the Contract, Contractor shall immediately notify City. Contractor shall not store hazardous materials or hazardous waste within City limits without a proper permit from City.

15. Other Contracts: City may award other contracts for additional work on the Project, and Contractor shall fully cooperate with such other contractors and carefully fit Contractor's own work to that provided under other contracts as may be directed by the City Engineer. Contractor shall not commit or permit any act which will interfere with the performance of work by any other contractor.

16. Bonds: Concurrently with the execution hereof, Contractor shall furnish, on the forms provided herein as **Exhibits D and E**, respectively, corporate surety bonds to the benefit of City, issued by a surety company acceptable to City and authorized and admitted to do business in the state of California, as follows:

(a) *Faithful Performance Bond.* In an amount equal to at least one hundred percent (100%) of the Contract Price as security for the faithful performance of the Contract. The bond shall contain a provision that the surety thereon waives the provisions of Sections 2819 and 2845 of the Civil Code.

(b) *Payment Bond.* In an amount equal to at least one hundred percent (100%) of the Contract Price as security for the payment of all persons performing labor and furnishing materials in connection with the Contract. The bond shall be in accordance with the provisions of Sections 3225, 3226, and 3247 through 3252, inclusive, of the Civil Code and Section 13020 of the Unemployment Insurance Code of California. Said bond shall also contain a provision that the surety thereon waives the provisions of Sections 2819 and 2845 of the Civil Code.

The surety companies shall familiarize themselves with all provisions and conditions of the Contract. It is understood and agreed that the surety or sureties waive the right of special notification of any modification or alterations, omissions or reductions, extra or additional work, extensions of time, or any other act or acts by City or its authorized agents under the terms of this Contract and failure to so notify the surety or sureties of such changes shall in no way relieve the surety or sureties of their obligations under the Contract.

17. Indemnification:

(a) *Indemnity for Professional Liability.* When the law establishes a professional standard of care for Contractor's Services, to the fullest extent permitted by law, Contractor shall indemnify, protect, defend, and hold harmless City and any and all of its elective and appointive boards, officers, officials, agents, employees or volunteers ("City's Agents") from and against any and all losses, liabilities, damages, costs, and expenses, including legal counsel's fees and costs but only to the extent Contractor or its subcontractors are responsible for such damages, liabilities and costs on a comparative basis of fault between Contractor or its subcontractors and City in the performance of professional services under the Contract. Contractor shall not be obligated to defend or indemnify City for City's own negligence or for the negligence of others.

(b) *Indemnity for other than Professional Liability.* Other than in the performance of professional services and to the full extent permitted by law, Contractor shall indemnify, defend, and hold harmless City and any and City's Agents from and against any liability, including liability for claims, suits, actions, arbitration proceedings, administrative proceedings, regulatory proceedings, losses, expenses or costs of any kind, whether actual, alleged or threatened, including legal counsel's fees and costs, court costs, interest, defense costs, and expert witness fees, where the same arise out of, are a consequence of, or are in any way attributable to, in whole or in part, the performance of the Contract by Contractor or by any individual or agency for which Contractor is legally liable, including, but not limited to, officers, agents, employees, or subcontractors of Contractor.

18. Contractor's Insurance: Concurrently with the execution hereof, Contractor shall furnish City with satisfactory proof of carriage of the insurance required under this section, and that Contractor shall give City at least sixty (60) days prior notice of the cancellation of any policy during the Term of this contract. Contractor shall not commence work under this Agreement until Contractor has obtained City's approval regarding all insurance requirements, forms, endorsements, amounts, and carrier ratings, nor shall Contractor allow any subcontractor to commence work on a subcontract until all similar

insurance required of the subcontractor shall have been so obtained and approved. Contractor shall procure and maintain for the duration of the Contract insurance against claims for injuries to persons or damages to property which may arise from or in connection with the performance of the Services hereunder by Contractor, its agents, representatives, employees or subcontractors. Failure to maintain or renew coverage or to provide evidence of renewal may constitute a material breach of the Contract. Any available insurance proceeds in excess of the specified minimum limits and coverage shall be available to City.

(a) *General Liability Insurance.* Contractor shall maintain commercial general liability insurance with coverage at least as broad as Insurance Services Office form CG 00 01, in an amount not less than Two Million Dollars (\$2,000,000.00) per occurrence, Four Million Dollars (\$4,000,000.00) general aggregate, for bodily injury, personal injury, and property damage, including, without limitation, blanket contractual liability and coverage for explosion, collapse, and underground property damage hazards. Contractor's general liability policies shall be primary and not seek contribution from City's coverages and be endorsed using Insurance Services Office form CG 20 10 to provide that City and its officers, officials, employees, and agents shall be additional insureds under such policies. For construction contracts, an endorsement providing completed operations to the additional insured, ISO form CG 20 37, is also required. The policy shall contain, or be endorsed to contain, the following provisions:

- (1) City, its elective and appointive boards, officers, agents, employees, and volunteers are to be covered as additional insureds with respect to liability arising out of work or operations performed by or on behalf of Contractor, including materials, parts or equipment furnished in connection with such work or operations, which coverage shall be maintained in effect for at least three (3) years following the completion of the work specified in the Contract. General liability coverage can be provided in the form of an endorsement to Contractor's insurance (at least as broad as CG 20 10 for ongoing operations and CG 20 37 for products/completed operations), or as a separate Owners and Contractors Protective Liability policy providing both ongoing operations and completed operations coverage.
- (2) For any claims related to the Project, Contractor's insurance coverage shall be primary insurance as respects City and any insurance or self-insurance maintained by City shall be excess of Contractor's insurance and shall not contribute with it.
- (3) In the event of cancellation, non-renewal, or material change that reduces or restricts the insurance coverage afforded to City under the Contract, the insurer, broker/producer, or Contractor shall provide City with thirty (30) days' prior written notice of such cancellation, non-renewal, or material change.
- (4) Coverage shall not extend to any indemnity coverage for the active negligence of the additional insured in any case where an agreement to indemnify the additional insured would be invalid under Subdivision (b) of Section 2782 of the Civil Code.

(b) *Workers' Compensation Insurance.* Contractor shall maintain Workers' Compensation Insurance (Statutory Limits) and Employer's Liability Insurance with limits of at least One Million Dollars

(\$1,000,000.00). Contractor shall submit to City, along with the certificate of insurance, a Waiver of Subrogation endorsement in favor of City, its officers, agents, employees, and volunteers.

(c) *Auto Insurance.* Contractor shall provide auto liability coverage for owned, non-owned, and hired autos using ISO Business Auto Coverage form CA 00 01, or the exact equivalent, with a limit of no less than Two Million Dollars (\$2,000,000.00) per accident. If Contractor owns no vehicles, this requirement may be met through a non-owned auto endorsement to the CGL policy.

(d) *Builder's Risk Insurance.* [Intentionally Omitted]

(e) *Contractors Pollution Insurance.* Pollution Coverage shall be provided on a Contractors Pollution Liability form, or other form acceptable to City, providing coverage for liability arising out of sudden, accidental, and gradual pollution and remediation. The policy limit shall be no less than Two Million Dollars (\$2,000,000.00) per claim. All activities contemplated in the Contract shall be specifically scheduled on the policy as "covered operations." The policy shall provide coverage for the hauling of waste from the Project site to the final disposal location, including non-owned disposal sites.

(f) *Professional Liability Insurance.* [Intentionally Omitted]

(g) *Umbrella or Excess Policy.* Contractor may use Umbrella or Excess Policies to provide the liability limits as required in this agreement. This form of insurance will be acceptable provided that all of the Primary and Umbrella or Excess Policies shall provide all of the insurance coverages herein required. The Umbrella or Excess policies shall be provided on a true "following form" or broader coverage basis, with coverage at least as broad as provided on the underlying Commercial General Liability and automobile Liability insurance. No insurance policies maintained by the Additional Insureds, whether primary or excess, and which also apply to a loss covered hereunder, shall be called upon to contribute to a loss until the Contractor's primary and excess liability policies are exhausted.

(h) *Deductibles and Self-Insured Retentions.* Upon request of City, any deductibles or self-insured retentions must be declared to and approved by City. At the option of City, either: (1) the insurer shall reduce or eliminate such deductibles or self-insured retentions as respects City and City's Agents; or (2) Contractor shall provide a financial guarantee satisfactory to City guaranteeing payment of losses and related investigations, claim administration, and defense expenses.

(i) *Acceptability of Insurers.* Insurance is to be placed with insurers with a current A.M. Best's rating of no less than A-:VII or with an insurer to which City has provided prior approval.

(j) *Verification of Coverage.* Contractor shall furnish City with original certificates and amendatory endorsements or copies of the applicable policy language effecting coverage required by this Section 18. All certificates and endorsements are to be received and approved by City before work commences. However, failure to obtain the required documents prior to the work beginning shall not waive Contractor's obligation to provide them. City reserves the right, at any time, to require complete, certified copies of all required insurance policies and endorsements.

(k) *Waiver of Subrogation.* With the exception of professional liability, Contractor hereby agrees to waive subrogation which any insurer of Contractor may acquire from Contractor by virtue of

the payment of any loss. The commercial general liability policy and workers' compensation policy shall be endorsed to contain a waiver of subrogation in favor of City for all work performed by Contractor, its agents, employees, independent contractors and subcontractors. Contractor agrees to obtain any endorsement that may be necessary to affect this waiver of subrogation.

(l) *Subcontractors.* Contractor shall include all subcontractors as insureds under its policies or shall furnish separate certificates and endorsements for each subcontractor. All coverages for subcontractors shall be subject to all of the requirements stated herein.

19. Ownership of Work Product: Any and all work, artwork, copy, posters, billboards, photographs, videotapes, audiotapes, systems designs, software, reports, designs, specifications, drawings, diagrams, surveys, source codes, professional or technical information or data, photographs, notes, letters, emails, or any original works of authorship created by contractor or its subcontractors or subcontractors in connection with Services performed under the Contract ("Work Product") shall be works for hire as defined under Title 17 of the United States Code, and all copyrights in such works are the property of City. In the event that it is ever determined that any Work Product created by Contractor or its subcontractors or subcontractors under the Contract are not works for hire under U.S. law, Contractor hereby assigns all copyrights to such Work Product to City. With the prior written approval of the City Engineer, Contractor may retain and use copies of such Work Product for reference and as documentation of its experience and capabilities.

All Work Product shall become the property of City irrespective of where located or stored and Contractor agrees to deliver all such documents and information to City, without charge and in whatever form it exists, upon the Final Completion Date, as may be extended. Contractor shall have no ownership interest in such Work Product.

All Work Product of Contractor under the Contract, including written information which City will cause to be distributed for either internal or public circulation, including both preliminary and final drafts, shall be delivered to City in both printed and electronic form, or as may be specific in Exhibit A.

When the Contract is terminated, Contractor agrees to return to City all documents, drawings, photographs, and other written or graphic material, however produced, that it received from City or City's Agents, in connection with the performance of its Services under the Contract. All materials shall be returned in the same condition as received.

20. Taxes: Payment of any taxes, including California sales and use taxes, levied upon the Contract, the transaction, or the Services or goods delivered pursuant hereto, shall be the obligation of Contractor. Contractor shall cooperate with City to the full extent possible to maximize the local allocation of California sales and use tax to City. Such cooperation shall include, but not be limited to:

(a) *Use Tax Direct Payment Permits.* Contractor shall apply for, obtain, and utilize, to the maximum extent reasonable, a California Use Tax Direct Payment Permit.

(b) *Purchases of \$500,000 or More.* Contractor shall require vendors and suppliers located outside California from whom Contractor makes purchases of \$500,000 or more to allocate the use tax to City.

21. Independent Contractor: At all times during the Term of the Contract, Contractor shall be deemed to be an independent contractor and shall be wholly responsible for the manner in which Contractor performs the Services required under the Contract. Contractor shall be liable for its acts and omissions, and those of its employees, contractors, subcontractors, representatives, volunteers, and its agents. Nothing contained herein shall be construed as creating an employment, agency, or partnership relationship between City and Contractor. City shall have the right to control Contractor only insofar as the result of Contractor's Services rendered pursuant to the Contract; however, City shall not have the right to control the means by which Contractor accomplishes Services rendered pursuant to the Contract.

22. Contractor Not Agent: Except as City may specify in writing, Contractor shall have no authority, express or implied, to act on behalf of City in any capacity whatsoever as an agent. Contractor shall have no authority, express or implied, pursuant to the Contract to bind City to any obligation whatsoever.

23. Arbitration of Disputes: All claims, disputes, and other matters in question between City and Contractor arising out of, or relating to, this Contract or the breach thereof, including claims of Contractor for extra compensation of Services related to the project, shall be decided by arbitration before a single arbitrator in accordance with the provisions of Sections 1281 through 1284.2 of the Code of Civil Procedure (the "Arbitration Laws") unless the Parties mutually agree otherwise. The provisions of Section 1283.05 of the Arbitration Laws apply to any arbitration proceeding except as otherwise provided in the Contract. The arbitrator shall have authority to decide all issues between the Parties including, but not limited to, claims for extras, delay, and liquidated damages, if any, provided for the Contract, matters involving defects in the Services performed by Contractor or its subcontractors, rights to payment, and whether the necessary procedures for arbitration have been followed. The award rendered by the arbitrator shall be final and judgment may be entered upon it in accordance with applicable law in any court having competent jurisdiction thereof.

Notice of the demand for arbitration shall be filed in writing with the other Party. The demand for arbitration shall be made within a reasonable time after the claim, dispute, or other matter in question has arisen, and in no event shall it be made after the date when institution of legal or equitable proceedings based on such claim, dispute, or other matter in question would be barred by the applicable statute of limitations.

The parties shall jointly appoint an arbitrator within fifteen (15) calendar days of the date of giving the notice of the demand for arbitration. If the Parties are unable to jointly agree upon the appointment of an arbitrator within said fifteen (15) calendar day period, and do not agree in writing to extend said period for a fixed period, then either Party may seek to have the arbitrator appointed by the Superior Court of Stanislaus County in accordance with the Arbitration Laws.

If any proceeding is brought to contest the right to arbitrate and it is determined that such right exists, the losing Party shall pay all costs and attorney's fees incurred by the prevailing Party.

In addition to the other rules of law which may be applicable to any arbitration hereunder, the following shall apply:

(a) Promptly upon the filing of the arbitration, each Party shall be required to set forth in writing and to serve upon each other Party a detailed statement of its contentions of fact and law.

(b) All Parties to the arbitration shall be entitled to the discovery procedures provided under Section 1283.05 of the California Code of Civil Procedure.

(c) The arbitration shall be commenced and conducted as expeditiously as possible consistent with affording reasonable discovery as provided herein.

(d) These additional rules shall be implemented and applied by the arbitrator.

The costs of arbitration shall be borne by the Parties as determined by the arbitrator, but each Party shall bear its own attorney's fees associated with the dispute with the other Party and to the arbitration.

All administrative remedies required under Section 9 of this Agreement or pursuant to Public Contract Code section 9204, or required by any other law, shall be exhausted prior to commencement of any arbitration under this Section 23.

24. Provisions Cumulative: The provisions of the Contract are cumulative, and in addition to and not in limitation of, any other rights or remedies available to City.

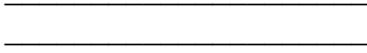
25. Notices: All notices shall be in writing and delivered in person or transmitted by certified mail, postage prepaid. Any Party hereto may at any time, by giving ten (10) days' written notice to the other Party hereto, designate any other address in substitution of the address to which such notice or communication shall be given. Such notices or communications shall be given to the Parties at their addresses set forth below.

If to City: **City of Turlock**
Attn: City Engineer
156 S. Broadway, Suite 150
Turlock, CA 95380-5461

With courtesy copies to: **City of Turlock, City Attorney's Office**
Attn: George A. Petrulakis, City Attorney
156 S. Broadway, Suite 230
Turlock, CA 95380-5456

If to Contractor: _____

If to Contractor's Sureties: _____



26. City Contract Administrator: The City’s contract administrator and contact person for this Agreement is:

Stephen Fremming
City of Turlock Engineering Division
156 S. Broadway, Suite 150
Turlock, California 95380-5461
Telephone: (209) 668-5417
E-mail: sfremming@turlock.ca.us

27. Interpretation: As used herein, any gender includes each other gender, the singular includes the plural and vice versa.

28. Antitrust Claims: Contractor or its subcontractors offer and agree to assign to City all rights, title, and interest to any causes of action under Section Four of the Clayton Act and the Cartwright Act concerning antitrust claims.

29. Use of City Project Number: Contractor or its subcontractors agree to use the aforementioned City project number on all maps, drawings, submittals, billing, and written correspondence that involve City staff or contracted consultants. Nothing in this section shall preclude Contractor or its subcontractors from using their own project numbers for their own internal use.

30. No Conflict of Interest: Contractor represents that no conflict of interest will be created under state or federal law by entering into or in carrying out the Contract.

31. Confidentiality: Contractor understands and agrees that, in the performance of Services under the Contract, or in the contemplation thereof, Contractor may have access to private or confidential information that may be owned or controlled by City and that such information may contain proprietary or confidential details, the disclosure of which to third parties may be damaging to City (“Confidential Information”). Contractor shall not, either during or after the Term, disclose to any third party any Confidential Information without the prior written consent of City. If City gives Contractor written authorization to make any such disclosure, Contractor shall do so only within the limits and to the extent of that authorization. Contractor may be directed or advised by the City Attorney on various matters relating to the performance of Services on the Project or on other matters pertaining to the Project, and in such event, Contractor agrees that it will treat all communications between itself, its employees, and its subcontracts as being communications which are within the attorney-client privilege.

32. Modification. No alteration, amendment, modification, or termination of the Contract shall be valid unless made in writing and executed by all Parties to the Contract.

33. Waiver: No covenant, term, or condition or the breach thereof shall be deemed waived, except by written consent of the Party against whom the waiver is claimed, and any waiver of the breach of any covenant, term, or condition shall not be deemed to be a waiver of any preceding or succeeding breach of the same or any other covenant, term, or condition.

34. Assignment: No Party to the Contract shall assign, transfer, or otherwise dispose of this Agreement in whole or in part to any individual, firm, or corporation without the prior written consent of the other Party. Subject to the foregoing provisions, the Contract shall be binding upon, and inure to the benefit of, the respective successors and assigns of the Parties hereto.

35. Authority: All Parties to this Agreement warrant and represent that they have the power and authority to enter into this Agreement and the names, titles, and capacities herein stated on behalf of any entities, persons, states, or firms represented or purported to be represented by such entities, person, states, or firms and that all former requirements necessary or required by state or federal law in order to enter into the Contract have been fully complied with. Further, by entering into this Agreement, neither Party hereto shall have breached the terms or conditions of any other contract or agreement to which such Party is obligated, which such breach would have a material effect hereon.

36. Governing Law: The Contract shall be governed and construed in accordance with the laws of the state of California.

37. Severability: If the Contract in its entirety is determined by an arbitrator or a court of competent jurisdiction to be invalid or unenforceable, the Contract shall automatically terminate as of the date of final entry of judgment. If any provision of the Contract shall be determined to be invalid and unenforceable, or if any provision of the Contract is rendered invalid or unenforceable according the terms of any federal or state statute, which becomes effective after the Effective Date of this Agreement, the remaining provisions shall continue in full force and effect and shall be construed to give effect to the intent of this Agreement.

38. Execution and Counterparts: This Agreement may be executed simultaneously and, in several counterparts, each of which shall be deemed an original but together shall constitute one and the same instrument. The Parties agree that this Agreement and any other documents to be delivered in connection herewith may be electronically signed utilizing services such as DocuSign and Nitro Sign, or by transmitting signatures in pdf or similar format, and that any electronic signatures appearing on this Agreement or such other documents are the same as handwritten signatures for the purposes of validity, enforceability, and admissibility.

39. Mandatory and Permissive: “Shall” and “will” and “agrees” are mandatory. “May” and “can” are permissive.

40. Headings: Headings used in this Agreement are for reference purposes only and shall not be considered in construing this Agreement.

41. Attorney’s Fees and Costs: Except as expressly provided for in Section 23 of this Agreement, if any action at law or in equity, including action for declaratory relief, is brought to enforce or interpret

the provisions of the Contract, the prevailing Party shall be entitled to reasonable attorney's fees and costs, which may be set by the court in the same action or in a separate action brought for that purpose, in addition to any other relief to which such Party may be entitled.

42. Necessary Acts and Further Assurances: The Parties shall, at their own cost and expense, execute and deliver such further documents and instruments and shall take such other actions as may be reasonably required or appropriate to evidence or carry out the intent and purposes of the Contract.

43. Recitals: The recitals set forth above ("Recitals") are true and correct and are hereby incorporated into and made part of this Agreement by this reference. In the event of any inconsistency between the Recitals and Section 1 through 43 of this Agreement, Sections 1 through 43 shall prevail.

[Signatures on Following Page]

IN WITNESS WHEREOF, two identical counterparts of this agreement, consisting of a total of ____ pages, each of which counterparts shall for all purposes be deemed an original of said agreement, have been duly executed by the parties hereinabove named, on the day and year first herein above written.

CONTRACTOR

CITY OF TURLOCK, a municipal corporation

By: _____

By: _____

Reagan M. Wilson, City Manager

Print Name

Date: _____

Address: _____

APPROVED AS TO SUFFICIENCY:

Phone: _____

By: _____

William D. Morris, RCE, PLS, City Engineer

Date: _____

By: _____

Christopher Fisher, Municipal Services Director

Federal Tax ID or Social Security No:

APPROVED AS TO FORM:

By: _____

George A. Petrulakis, City Attorney

DIR Registration Number:

ATTEST:

By: _____

Nichole Fiez, City Clerk

Affix Contractor's Seal Here

EXHIBIT A
CONTRACTOR'S PROPOSAL FOR SERVICES

EXHIBIT B
PAYMENT BY FORCE ACCOUNT

For work paid by force account, the City Engineer compares City's records to Contractor's daily force account work report. When the City Engineer and Contractor agree on the contents of the daily force account work reports, the City Engineer accepts the report and City pays for the work. If the records differ, City pays for the work based only on the information shown on City's records. If a subcontractor performs work at force account, work paid at force account will be accepted at an additional 2 percent (2%) markup to the total cost of that work, including markups, as reimbursement for additional administrative costs. The markups specified in labor, materials, and equipment includes compensation for all delay costs, overhead costs, and profit. If an item's unit price is adjusted for work-character changes, City excludes Contractor's cost of determining the adjustment. Payment for owner-operated labor and equipment is made at the market-priced invoice submitted.

A. Labor. Labor payment is full compensation for the cost of labor used in the direct performance of the work plus a fifteen percent (15%) markup, as set forth below, and consistent with California Labor Code section 1770 et seq. Force account labor payment consists of:

1. Employer payment to the worker for:
 - 1.1 Basic hourly wage
 - 1.2 Health and welfare
 - 1.3 Pension
 - 1.4 Vacation
 - 1.5 Training
 - 1.6 Other State and federal recognized fringe benefit payments

2. Labor surcharge percentage in *Labor Surcharge and Equipment Rental Rates* current during the work paid at force account for:
 - 2.1 Workers' compensation insurance
 - 2.2 Social security
 - 2.3 Medicare
 - 2.4 Federal unemployment insurance
 - 2.5 State unemployment insurance
 - 2.6 State training taxes

3. Subsistence and travel allowances paid to the workers

4. Employer payment to supervisors, if authorized

The fifteen percent (15%) markup consists of payment for all overhead costs related to labor but not designated as costs of labor used in the direct performance of the work including:

- (a) Home office overhead
- (b) Field office overhead
- (c) Bond costs
- (d) Profit

- (e) Labor liability insurance
- (f) Other fixed or administrative costs that are not costs of labor used in the direct performance of the work

B. Materials. Material payment is full compensation for materials the Contractor furnishes and uses in the work. The City Engineer determines the cost based on the material purchase price, including delivery charges, except:

- 1. A fifteen percent (15%) markup is added;
- 2. Supplier discounts are subtracted whether the Contractor takes them or not;
- 3. If the City Engineer believes the material purchase prices are excessive, City pays the lowest current wholesale price for a similar material quantity;
- 4. If Contractor procured the materials from a source Contractor wholly or partially own, the determined cost is based on the lower of the:
 - 4.1 Price paid by the purchaser for similar materials from that source on Contract items; and
 - 4.2 Current wholesale price for those materials;
- 5. If Contractor does not submit a material cost record within thirty (30) days of billing, the determined cost is based on the lowest wholesale price:
 - 5.1 During that period
 - 5.2 In the quantities used

C. Equipment Rental. Equipment rental payment is full compensation for:

- 1. Rental equipment costs, including moving rental equipment to and from the change order work site using its own power.
- 2. Transport equipment costs for rental equipment that cannot be transported economically using its own power. No payment is made during transport for the transported equipment.
- 3. Fifteen percent (15%) percent markup.

If Contractor wants to return the equipment to a location other than its original location, the payment to move the equipment must not exceed the cost of returning the equipment to its original location. If Contractor uses the equipment for work other than work paid by force account, the transportation cost is included in the other work.

Before moving or loading the equipment, Contractor must obtain authorization for the equipment rental's original location.

The City Engineer determines rental costs:

1. Using rates in *Labor Surcharge and Equipment Rental Rates*:
 - 1.1. By classifying equipment using manufacturer's ratings and manufacturer-approved changes.
 - 1.2. Current during the work paid by force account.
 - 1.3. Regardless of equipment ownership but City uses the rental document rates or minimum rental cost terms if:
 - 1.3.1. Rented from equipment business Contractor does not own.
 - 1.3.2. The Labor Surcharge and Equipment Rental Rates hourly rate is \$10.00 per hour or less.

2. Using rates established by the City Engineer for equipment not listed in *Labor Surcharge and Equipment Rental Rates*. Contractor may submit cost information that helps the City Engineer establish the rental rate but City uses the rental document rates or minimum rental cost terms if:
 - 2.1. Rented from equipment business Contractor does not own.
 - 2.2. The City Engineer establishes a rate of \$10.00 per hour or less.

3. Using rates for transport equipment not exceeding the hourly rates charged by established haulers.

Equipment rental rates include the cost of:

- | | |
|---|----------------------------|
| 1. Fuel | 7. Repairs and maintenance |
| 2. Oil | 8. Depreciation |
| 3. Lubrication | 9. Storage |
| 4. Supplies | 10. Insurance |
| 5. Small tools that are not consumed by use | 11. Incidentals |
| 6. Necessary attachments | |

City pays for small tools consumed by use. The City Engineer determines payment for small tools consumed by use based on Contractor-submitted invoices.

The City Engineer may authorize rates in excess of those in the *Labor Surcharge and Equipment Rental Rates* if:

1. Contractor submits a request to use rented equipment
2. Equipment is not available from Contractor's normal sources or from one of Contractor's subcontractors
3. Rented equipment is from an independent rental company
4. Proposed equipment rental rate is reasonable
5. The City Engineer authorizes the equipment source and the rental rate before Contractor uses the equipment

D. Equipment on the Job Site. For equipment on the job site at the time required to perform work paid by force account, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to move the equipment to another location on the job site when the work paid by force account is completed
2. To load and unload equipment
3. Equipment is operated to perform work paid by force account and:
 - 3.1. Hourly rates are paid in 1/2-hour increments
 - 3.2. Daily rates are paid in 1/2-day increments

E. Equipment Not on the Job Site Required for Original-Contract Work. For equipment not on the job site at the time required to perform work paid by force account and required for original-Contract work, the time paid is the time the equipment is operated to perform work paid by force account and the time to move the equipment to a location on the job site when the work paid by force account is completed.

The minimum total time paid is:

1. 1 day if daily rates are paid
2. 8 hours if hourly rates are paid

If daily rates are recorded, equipment:

1. Idled is paid as 1/2 day
2. Operated four (4) hours or less is paid as 1/2 day
3. Operated four (4) hours or more is paid as one (1) day

If the minimum total time exceeds eight (8) hours and if hourly rates are listed, City rounds up hours operated to the nearest 1/2-hour increment and pays based on the hours shown in the following table. The table does not apply when equipment is not operated due to breakdowns, in which case rental hours are the hours the equipment was operated.

Equipment Rental Hours

Hours operated	Hours paid
0.0	4.00
0.5	4.25
1.0	4.50
1.5	4.75
2.0	5.00
2.5	5.25
3.0	5.50
3.5	5.75
4.0	6.00
4.5	6.25
5.0	6.50
5.5	6.75
6.0	7.00

6.5	7.25
7.0	7.5
7.5	7.75
≥8.0	hours used

F. Equipment Not on the Job Site Not Required for Original-Contract Work. For equipment not on the job site at the time required to perform work paid by force account and not required for original-Contract work, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to return the equipment to its source when the work paid by force account is completed
2. To load and unload equipment
3. Equipment is operated to perform work paid by force account

G. Non-Owner-Operated Dump Truck Rental. Contractor shall submit the rental rate for non-owner-operated dump truck rental to City. The City Engineer shall determine the payment rate. Payment for non-owner-operated dump truck rental is for the cost of renting a dump truck, including its driver. For the purpose of markup payment only, the non-owner-operated dump truck is rental equipment and the owner is a subcontractor.

The above markups shall constitute full compensation for all home office overhead, field office overhead, bond costs, profit, labor liability insurance, and other fixed or administrative costs that are not costs specifically designated as cost or equipment rental as stated above. The total payment made as provided above shall be deemed to be the actual cost of the work and shall constitute full compensation therefor.

When extra work to be paid for on a force account basis is performed by a subcontractor, an additional markup of 2 percent (2%) will be added to the total cost of that extra work including all markups specified in this Section. The additional 2 percent (2%) markup shall reimburse Contractor for additional administrative costs, and no other additional payment will be made by reason of performance of the extra work by a subcontractor.

EXHIBIT C
WORKERS' COMPENSATION INSURANCE CERTIFICATION

Pursuant to Section 18(b) of the Agreement, Contractor certifies as follows:

I am aware of the provisions of Section 3700 of the Labor Code which require every employer to be insured against liability for worker's compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the work of this contract.

Signed: _____

Date: _____

(Typed or Printed Name)

Business Address (Street Address, City, State & Zip Code):

Business Phone: () _____

EXHIBIT D
PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS:

WHEREAS, the **City of Turlock**, State of California, has awarded to _____, hereinafter designated as the "Principal," a contract for **Project No. 23-046, "Well 29 Chlorination"**; and,

WHEREAS, said Principal is required under the terms of said contract to furnish a bond for the faithful performance of said contract.

NOW, THEREFORE, we the Principal, and _____ as Surety, are held and firmly bound unto the City of Turlock in the penal sum of _____ (\$_____), lawful money of the United States for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, or assigns jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that if the above bounden Principal, or Principal's heirs, executors, administrators, successors, or assigns, shall in all things stand to and abide by, and well and truly keep and perform the covenants, conditions, and agreements in said contract and any alteration thereof made as therein provided, on the Principal's part, to be kept and performed at the time and in the manner therein specified and in all respects according to their true intent and meaning; and shall defend, indemnify and save harmless the City of Turlock, its officers and agents as therein stipulated, then this obligation shall become null and void; otherwise it shall be and remain in full force and virtue.

And the Surety, for value received hereby stipulates and agrees that, in accordance with the Plans, Standard Specifications, Special Provisions, and other contract documents, no change, extension of time, alteration, or addition to the terms of the contract, or to the work to be performed hereunder, or to the specifications accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration of additions to the terms of the Contract to the work, or to the specifications.

The City of Turlock reserves the right to refuse use of any Contractor assigned by any surety to complete the work.

[Signatures on Following Page]

IN WITNESS WHEREOF, the above-bound parties have executed this instrument under their seals this _____ day of _____, 20__, the name and corporate seals of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

(Corporate Seal)

Principal _____

By _____

Title _____

(Attach Notarial Acknowledgment)

(Corporate Seal)

Surety _____

Address _____

Phone No.: () _____ Fax No.: () _____

By _____

Attorneys-in-Fact

Title _____

(Attach Notarial Acknowledgment)

NOTE TO SURETY COMPANY: There must be submitted a certified copy of unrevoked resolution of authority for the attorneys-in-fact.

(Seal)

Witness _____

Approved as to form:

Risk Manager

EXHIBIT E
PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS:

WHEREAS, the **City of Turlock**, a municipal corporation, has awarded to _____, hereinafter designated as the “Principal”, a contract for **Project No. 23-046, “Well 29 Chlorination”**; and

WHEREAS, said Principal is required to furnish a bond in connection with said contract, to secure payment of claims of laborers, mechanics, or materialmen employed on work under said contract, as provided by law.

NOW, THEREFORE, we the undersigned Principal and Surety are held and firmly bound unto the City of Turlock in the sum of _____ (\$_____), said sum being equal to the estimated amount payable by said City of Turlock under the terms of the contract, for which payment well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, or assigns jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH that if said Principal, or Principal’s heirs, executors, administrators, successors, or assigns, or subcontractors shall fail to pay for any material, provisions, provender, or other supplies, implements, or machinery used in, upon, for or about the performance of the work contracted to be done, or for any work or labor thereon of any kind, or for amounts due under the Unemployment Insurance Code with respect to such work or labor, or for any amounts required to be deducted, withheld, and paid over to the Franchise Tax Board from these wages of employees of the Contractor and Contractor’s subcontractors pursuant to the Revenue and Taxation Code, with respect to such work and labor, the Surety or Sureties hereon will pay for the same in an amount not exceeding the sum specified in this bond, otherwise the above obligation shall be void. In case suit is brought upon this bond, said Surety will pay a reasonable attorney’s fee to be fixed by the court.

This bond shall inure to the benefit of any and all persons, companies, and corporations entitled to file claims under Section 3138 of the Civil Code of the State of California so as to give a right of action to them or their assigns in any suit brought upon this bond.

Said Surety, for value received, hereby stipulates and agrees that, in accordance with the Plans, Standard Specifications, Special Provisions, and other Contract Documents, no change, extension of time, alteration or addition to the terms of the contract, or to the work to be performed there under, or to the specifications accompanying the same, shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract, or to the work, or to the specifications.

[Signatures on Following Page]

IN WITNESS WHEREOF, the above-bound parties have executed this instrument under their seals this _____ day of _____, 20__, the name and corporate seals of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

(Corporate Seal)

Principal _____

By _____

Title _____

(Attach Notarial Acknowledgment)

(Corporate Seal)

Surety _____

Address _____

Phone No.: () _____ Fax No.: () _____

By _____

Attorneys-in-Fact

Title _____

(Attach Notarial Acknowledgment)

NOTE TO SURETY COMPANY: There must be submitted a certified copy of unrevoked resolution of authority for the attorneys-in-fact.

(Seal)

Witness _____

Approved as to form:

Risk Manager

SPECIAL PROVISIONS

City Project No: 23-046

Well 29 Chlorination

SECTION 1 SPECIFICATIONS AND PLANS

SPECIAL NOTES:

1. Official bid documents including plans and specifications are available online at <http://www.cityofturlock.org/capitalprojects>. All bids submitted for this project must conform to the requirements of the official bid documents.
2. An optional pre-bid meeting will be held on Wednesday, January 22, 2025 at 9:00 AM in the Engineering Conference Room at Turlock City Hall located at 156 S. Broadway Suite 150.

1.01 HIERARCHY OF CONTRACT DOCUMENTS:

The work described herein shall be done in accordance with the current City of Turlock Standard Specifications and the current edition of the State of California, Department of Transportation Standard Specifications and Standard Plans in effect on the date that the bid was submitted by the Contractor and in accordance with the following Special Provisions.

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

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

Clarifications and interpretations of the Contract Documents shall be issued by Engineer.

In case of conflict or discrepancy between any of the Contract Documents, the order of documents listed below shall be the order of precedence for the purpose of claims review, with the first item listed having the highest precedence. Contractor shall submit a Request for Information (RFI) to the Engineer immediately upon discovery of conflicting information in any of the Contract Documents prior to proceeding with the work that may be impacted by such conflicting information.

1. Contract Change Order (Modifications or changes last in time are first in precedence).
2. Addenda to Contract Agreement
3. Contract Agreement
4. Permits
5. Special Provisions
6. Technical Specifications included in bid specifications as an appendix
7. Notice Inviting Bids and Instructions to Bidders

8. Project Drawings
9. City of Turlock Standard Specifications
10. City of Turlock Standard Drawings
11. Caltrans Standard Specifications
12. Caltrans Standard Plans

With regards to discrepancies or conflicts between written dimensions given on drawings and the scaled measurements, the written dimensions shall govern.

With regards to discrepancies or conflicts between large-scale drawings and small-scale drawings, the larger scale shall govern.

With regards to discrepancies or conflicts between detailed drawings and referenced standard drawings or plans, the detailed drawings shall govern.

In the event where provisions of codes, safety orders, contract documents, referenced manufacturer's specifications or industry standards are in conflict, the more restrictive and higher quality shall govern.

Should it appear that the work to be done or any of the matters relative thereto are not sufficiently detailed or explained in these specifications, the special provisions, or the plans, the Contractor shall apply to the Engineer in writing for such further explanations as may be necessary and shall conform to them as part of the contract. All responses from the Engineer shall also be in writing. In the event of any doubt or question arising respecting the true meaning of these specifications, the special provisions or the plans, reference shall be made to the Engineer, whose decision thereon shall be final.

1.02 CONTRACTOR'S RESPONSIBILITY:

The Contractor shall examine carefully the site of the work and the plans and specifications therefore. The Contractor shall investigate to their satisfaction as to conditions to be encountered, the character, quality and quantity of surface, subsurface materials or obstacles to be encountered, the work to be performed, materials to be furnished, and as to the requirements of the bid, plans and specifications of the contract.

1.03 COMPLETENESS AND ACCURACY OF PLANS AND SPECIFICATIONS:

Pursuant to the California Public Contract Code, the bidder is required to review architectural or engineering plans and specifications prior to submission of a bid, and report any errors and omissions noted by Contractor to the Architect, Engineer or Owner five days prior to the bid opening date.

SECTION 2 PROPOSAL REQUIREMENTS AND CONDITIONS

2.01 GENERAL:

The Contractor's attention is directed to the "Notice to Contractor" for the date, time and location of the mandatory Pre-Bid meeting, if applicable.

The bidder's attention is directed to the provisions in Proposal for this bid for the requirements and conditions which the bidder must observe in the preparation of and the submission of the bid.

The bidder's bond shall conform to the bond form in the Bid book for the project and shall be properly filled out and executed. The bidder's bond form included in that book must be used.

In conformance with Public Contract Code Section 7106, a Non-Collusion Affidavit is included in the Bid book. Signing the Bid book shall also constitute signature of the Non-Collusion Affidavit.

The contractor, sub recipient, or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of Title 49 CFR (Code of Federal Regulations) part 26 in the award and administration of US DOT assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy, as the recipient deems appropriate. Each subcontract signed by the bidder must include this assurance.

Failure of the bidder to fulfill the requirements of the Special Provisions for submittals required to be furnished after bid opening, including but not limited to escrowed bid documents, where applicable, may subject the bidder to a determination of the bidder's responsibility in the event it is the apparent low bidder on future public works contracts.

2.02 EXISTING UTILITIES, FACILITIES, AND SITE CONDITIONS:

The actual sizes, locations and materials of existing utilities and facilities shown on the plans may vary from what is shown on the plans. Attention is directed to the possible existence of underground facilities not indicated on the plans or in the special provisions. Contractor shall be responsible for verifying the locations and nature of the existing utilities, protecting them from damage and notifying Engineer of their location and nature.

Contractor shall examine carefully the site of the work. It is assumed that Contractor has investigated and is satisfied as to the conditions to be encountered as to the character, quality and quantities of work to be performed.

Unless otherwise noted in a geotechnical report made available to the Contractor for the project, Contractor shall assume for bidding purposes that near surface native soil material is generally homogenous and that soil meets the uniform soil classification of a silty sand (SM) without cementation.

If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

1. is of such a nature as to establish that any technical data on which Contractor is entitled to rely is materially inaccurate; or
2. is of such a nature as to require a change in the Contract Documents; or
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith, notify Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith until instructed in writing to do so. After receipt of written notice, Engineer will promptly

review the pertinent condition and advise in writing (with a copy to Contractor) of Engineer's findings and conclusions.

The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; provided that such condition meets any one or more of the categories described in the paragraphs above.

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

1. Contractor knew of the existence of such conditions prior to the submission of a Bid; or
2. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's submittal of a bid; or
3. Contractor failed to give the written notice as required above.

Full compensation for furnishing all labor, materials, tools, equipment (including dewatering devices), and incidentals, and for doing all the work involved with and/or in verifying existing utilities, facilities, site and subsurface conditions as specified above, shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefore

SECTION 3 AWARD AND EXECUTION OF CONTRACT

3.01 GENERAL:

The Contractor's attention is directed to the provisions in the Contract for the requirements and conditions concerning award and execution of contract.

The award of the contract, if it be awarded, will be to the lowest responsible bidder whose bid complies with all the requirements prescribed.

The contract shall be executed by the successful bidder and shall be returned, together with the contract bonds and insurance, to the City so that it is received within 10 working days after the bidder has received the contract for execution. Failure to do so shall be just cause for forfeiture of the proposal guaranty. The executed contract documents shall be delivered to the following address:

Attention: Gloria Aguilar
City of Turlock, Engineering Division
156 S Broadway, Suite 150
Turlock, CA 95380

3.02 PRE-AWARD PROTEST PROCEDURES:

Failure to strictly comply with the protest procedures delineated below with respect to timeliness or protest contents will render a protest untimely and/or inadequate and will result in rejection thereof by the City. Only responsive bidders may submit a pre-award protest for consideration. Written protests may be either hand delivered or sent by mail. In the case of hand delivery, the protest must be received

no later than five (5) calendar days after the bid opening. In case of mail, the written protest must be postmarked no later than five (5) calendar days after the bid opening. Pre-award protests shall be delivered to the following address:

Attention: William Morris, RCE, PLS, City Engineer
City of Turlock Engineering Division
156 S Broadway Suite 150
Turlock, CA 95380

The pre-award protest shall include all of the following: the name of the protester, City project number, a detailed description of the specific grounds for protest, any supporting documentation, and the specific ruling or relief requested. The City will respond to the pre-award protest and will provide a written determination within ten (10) working days after receiving the pre-award protest.

SECTION 4 BEGINNING OF WORK, TIME OF COMPLETION AND DELAY DAMAGES

4.01 NOTICE TO PROCEED:

The Notice to Proceed is defined as a letter issued by the City to the Contractor indicating that the Work may begin at the designated site and outlines the anticipated construction start and end dates. The Notice to Proceed is issued after award of the Contract by the City Council and after the Contractor has provided all bonds, insurance documentation, and any other information required by the project specifications prior to beginning the Work. At no time shall construction begin prior to the issuance of the Notice to Proceed. Any work performed prior to issuance of the Notice to Proceed shall be done at the Contractor's own risk.

Attention is directed to Section 5, "Time For Performance," of the Contract.

Attention is directed to Section 6, "Delay Damages," of the Contract.

4.02 PRE-CONSTRUCTION MEETING:

A pre-construction meeting will be held between Contractor and City prior to the beginning of construction. The exact time and place of this conference will be determined by City after award of the construction contract. Contractor's superintendent, Contractor's project manager(s), City's project manager, City's public works inspector, major subcontractors and others involved in performance of the Work, are required to be present.

The purpose of the meeting is to establish a working understanding between parties and to discuss the construction schedule, review the process for the review of submittals, RFIs, Change Order Requests, applications for payment, and other subjects pertinent to execution of the Work.

4.03 COPIES OF CONTRACT DOCUMENTS:

At the request of the Contractor, City shall furnish up to five (5) hard copies of the project plans and specifications. Contractor may produce additional copies as needed at Contractor's expense.

4.04 STAGING OF MATERIALS AND EQUIPMENT:

Contractor shall coordinate, arrange, and pay for leasing of area(s) for the staging materials and equipment, as necessary. Any areas utilized for staging shall be included in the Contractor's Erosion and Sediment Control Plan or Storm Water Pollution Prevention Plan (SWPPP). Contractor shall take pre-construction photos of staging area(s) to use of the area and shall restore the areas to pre-construction conditions prior to completion.

Contractor may contact City personnel to request if there is City-owned land in the vicinity of the project available for staging. The City may grant access to City-owned land for staging, but shall not be obligated to do so. Prior to use of City property for staging purposes, Contractor and City shall execute a License Agreement in a form acceptable to the City which shall include provisions for indemnification and required insurance coverages. Contractor is advised that execution of a License Agreement will require time. Contractor is encouraged to begin the process early to avoid delay. City's processing time for the License Agreement shall not be justification for an increase in contract time.

4.05 SUBSTANTIAL COMPLETION:

Substantial Completion is the stage in the progress of the project when the work is sufficiently complete in accordance with the Contract so that the intended purpose of the project has been achieved. Substantial Completion shall include all Work for the Project, except the following:

- Completion of minor punch list items that do not prohibit use of the completed facility for its intended use and purpose
- Delivery of Operations and Maintenance manuals
- Completion of As-built drawings

When the Contractor considers the project to be substantially complete, the Contractor shall submit a request for Engineer's concurrence in writing and shall attach a list of incomplete work that it considers is minor in nature and does not prohibit the use of the completed facility for its intended use and purpose. Upon receipt of the Contractor's request and list of items, the Engineer will inspect and determine whether the project is substantially complete within three (3) working days of the request. If the inspection yields that the project is not sufficiently complete, the Engineer will notify the Contractor of those items in need of completion or correction before the attainment of Substantial Completion. Upon completion of the remaining items, Contractor shall submit another request for inspection by the Engineer. When Engineer is satisfied that the work is substantially complete, a written notice of Substantial Completion shall be transmitted by Engineer to Contractor within 24 hours of the successful inspection and shall include a list of all items of work that must be completed by Contractor prior to attainment of Final Completion (final punch list). This final punch list is provided for Contractor's convenience only. Engineer reserves the right to identify and add to the final punch list as new items may be identified as outstanding and in need of the Contractor's attention.

WARRANTY

The Contractor shall guarantee the work in general for a period of one (1) year beginning on the date Substantial Completion is attained. The Contractor shall not be required to perform any further work thereon beyond the said one year, except upon such items noted otherwise in the project plans, Special Provisions, or Technical Specifications.

4.06 FINAL COMPLETION:

Final Completion is the stage in the progress of the project when all work is complete in accordance with the Contract. Contractor shall inform Engineer when, in the opinion of the Contractor, all work has been complete as per the requirements of the Contract. The Engineer shall promptly inspect the work and make a determination as to whether all work of the project has been completed. Should any items of work be incomplete, the Engineer shall provide a written list of outstanding items to the Contractor for completion. Contractor shall address any remaining items and then request a determination be made by the Engineer. When Engineer is satisfied that the work is complete, a written notice of Final Completion shall be transmitted by Engineer to Contractor and contract working days shall cease to be counted on the project.

SECTION 5 GENERAL

5.01 INTERNET BASED CONSTRUCTION MANAGEMENT SYSTEM:

The Engineer and Contractor shall utilize Virtual Project Manager (VPM; www.new.virtual-pm.com), for submission of all construction documents for the duration of the construction contract and shall utilize VPM for project correspondence to the maximum extent possible. VPM is an online electronic project management system used to create, share, and review construction management documentation. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, electronic notification of project activity, and overall management of contract documentation between City and Contractor. VPM shall be the primary means of project document submission and management.

VPM access is provided to the Contractor at no cost to the Contractor. The Contractor shall use computer hardware and software that meets the requirements of the VPM system. Upgrading of the Contractor's computer systems will not be justification for a cost or time modification to the Contract. The Contractor shall ensure its own connectivity to VPM by providing their own internet service and provide staff knowledgeable in the use of computers.

The Engineer will establish the Contractor's access to VPM by enabling access and assigning user profiles to Contractor's personnel. Contractor may request that access be granted to subcontractors, suppliers, or consultants, though access to these groups will be limited to read-only permissions. All communication to the Engineer shall be made directly through the Contractor. All authorized personnel shall have an individual user profile; no joint-use or shared user profiles will be allowed. Each user profile shall be assigned to a user group and have specific permission settings and privileges based on the user's need within VPM. The Contractor shall be responsible for the validity of the information entered by the Contractor into VPM.

Contractor will submit attachments within VPM in formats acceptable to the Engineer, such as PDF files, Microsoft Office files, and picture files (JPG, TIFF, BMP, JPEG, etc.). PDF documents shall be created through electronic conversion prior to uploading, rather than optically scanned, whenever possible.

Contractor shall upload relevant documents for review and approval under the corresponding module within VPM (submittal, RFI, etc.). Each document submittal shall have a unique title and description that references the item and the section number from the specifications.

Engineer shall provide training to the Contractor in the basic use of the VPM system, as requested by the Contractor.

The Contractor shall create a RFI upon recognition of any event or question of fact arising from the contract work. The Engineer will respond to a RFI submitted by the Contractor within seven (7) calendar days, not including legal holidays.

Inspector's daily logs shall be used by the City to document the activities of the work, any correspondence or direction given in the field, safety concerns and general comments about the project. The weekly statement of working days report (WSWD) will be generated by VPM and approved by the City. The WSWD shows the working days and non-working days charged for the reporting week, any time adjustments, a work completion date with the remaining working days left in the contract and the controlling activities for the week. The Contractor will be allowed 15 days to protest in writing the correctness of the statement.

5.02 BUSINESS LICENSE:

Contractor shall obtain a City of Turlock business license prior to issuance of the Notice to Proceed. The cost of the business license is an up-front fee of eighty-four dollars (\$84) plus fifty cents per thousand dollars in revenue received for work performed on the project, made payable on a semi-annual basis. Business Licenses are obtained through the Finance Division at Turlock City Hall, 156 S. Broadway, Suite 114. Additional information can be found on the City's website at <http://ci.turlock.ca.us/doingbusinessinturlock/businesslicenses/newbusinesslicense.asp>.

Full compensation for obtaining a business license as specified above shall be considered as included in the prices paid for the various contract bid items and no additional compensation will be allowed therefore.

5.03 PROGRESS SCHEDULE:

Contractor shall furnish City with Critical Path Method (CPM) format progress schedules. All schedules shall include separate activities, durations, and precedent and dependent activity relationships. Schedules shall be considered a submittal subject to review and acceptance by the Engineer in accordance with Section 5.06 "Submittals" of these Special Provisions. Schedules to be submitted include:

- Baseline Schedule
 - The baseline schedule shall be submitted and must be accepted prior to the start of field construction activities. Construction progress payments may be withheld until the baseline schedule is submitted and accepted by the Engineer.
- Schedule revisions
 - Submit revisions to the schedule when any of the following are true:
 - the schedule does not represent the actual progress of activities.
 - delay in completion of the project indicates an overrun of the current contract time.
 - completion of major portions of the work affect the critical path.
 - Schedule revisions shall include actual start and finish dates of activities that have been started and/or completed.

- Construction progress payments may be withheld if a required schedule revision is not submitted by contractor and accepted by Engineer
- 3 week look ahead schedules
 - Shall be submitted in advance of any scheduled project progress meeting

If the Contractor believes that the Engineer has impacted its work such that the project completion date will be delayed, the Contractor must submit proof demonstrating the delay to the critical path through the means of a time impact analysis of the current, accepted schedule.

Acceptance of schedules by the Engineer is for general conformance with the Contract Documents and for Engineer’s planning information, and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the contract completion dates. Omissions and errors in the accepted schedules shall not excuse performance less than that required by the Contract Documents. Acceptance by the Engineer in no way constitutes an evaluation or validation of the Contractor’s plan, sequence or means, methods, and techniques of construction.

Full compensation for Progress Schedules shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefor.

5.04 PUBLIC COMMUNICATIONS:

The Contractor shall notify adjacent property owners, residents, and/or tenants when the execution of work may affect their everyday activities.

Any time the Contractor is acting on behalf of the City to perform work, the communication material between the Contractor and the public shall adhere to these Special Provisions and is subject to review and approval by the City. All communication materials shall be in English and Spanish.

Work Notice

Provide notice to affected property owners in advance of work. Notice is required for any work within an easement, within the City’s right-of-way, outside of street, etc. Contractor shall notify the resident by door knocking and leaving a flier. Notices shall be received by the affected properties no less than two (2) and no more than seven (7) calendar days prior to starting the work.

Denial of Access

Provide notice for when it is necessary to temporarily deny access to public parking, residential property, or commercial property. Notify residents, businesses, and local agencies at least 24 hours before starting activities. The type of notification shall be a written communication prepared and distributed by the Contractor. The written communication shall contain, at a minimum, the following information:

- Describe the work to be performed
- Detail streets and limits of activities
- Indicate dates and work hours
- Be authorized by the City

Attention is directed to Section 12.02, “Traffic Management Plan,” of these Special Provisions.

Utility Service Interruption

Provide notice for when any City’s utility service connection must be interrupted. The type of notification shall be a written communication prepared and distributed by the Contractor. The written communication shall contain, at a minimum, the following information:

- The type of service (e.g. water or sewer) that will be interrupted
- The date and length of time service will be interrupted
- Contractor’s Name and Contact Information

Notices shall be received by the affected properties no less than two (2) and no more than seven (7) calendar days prior to the work.

5.05 PERMITS:

Contractor is required to obtain the following permits.

Permit:	Agency / Division:	Required for:	Fee	Notes
Erosion and Sediment Control Plan	City of Turlock	Any ground disturbing work	\$0	See Special Provisions section “EROSION CONTROL”
Encroachment Permit	City of Turlock	Any work within City limits, including traffic control	\$0	Issued by City Engineering Division after contract execution
Monthly Hydrant Use Permit	City of Turlock Municipal Services Department	Use of construction water from hydrants	\$0, though a deposit is required for meter	See Special Provisions section “USE OF HYDRANTS FOR CONSTRUCTION PURPOSES”

5.06 SUBMITTALS:

Special Note: These Special Provisions shall be supplemented by technical specification SECTION 01 33 00, “SUBMITTAL PROCEDURES.”

General

Before making submittals, Contractor shall ensure that products and materials will be available in the quantities and in the time required by the Contract and the approved outline of construction activity. Each submittal shall clearly identify, by highlighting, arrows or other defined and permanent mark, the products and materials proposed for use.

All Submittals shall be made to Engineer by Contractor, including those generated by subcontractors and suppliers. Contractor shall carefully review all subcontractor and supplier submittals before submitting to Engineer for review. Submittals received from sources other than Contractor’s office shall be returned without action. If a submittal contains extraneous

information, unmarked options or is incomplete, it will be returned to Contractor for correction and require re-submittal.

Submission

Submittals shall be made electronically in accordance with the Section 5.01 “Internet Based Construction Management System,” of these special provisions.

Each submittal shall contain, at a minimum, the following information:

1. Title page including the following information:

Capital Project No.

Name of Contractor

Name of subcontractor (if applicable)

Description of item

Item Number on Bid Schedule

Contractor’s initials and date indicating approval of item for submittal to Engineer

2. The brochure, product data sheet or catalog cut sheet. For all Product Data and Manufacturer’s Instructions, excise or cross out non-applicable information and clearly mark applicable information with citations to and terminology consistent with Contract Documents.

3. Submittals that involve engineering computations or original design work shall show the name, the California State registration number, seal, and signature of the Professional Engineer certifying that such computations or design work are correct and in conformance with applicable standards, codes and accepted engineering practices.

4. For product samples, Contractor shall submit two (2) representative samples, one of which may be retained for the duration of the project or indefinitely at the discretion of Engineer. Although a reasonable attempt will be made to maintain the samples in good condition, neither City nor its representative will be responsible for the condition of the samples if returned to Contractor.

5. For material samples, unless a specific quantity is called for in the contract documents, Contractor shall submit a representative sample of the material, which may be retained for the duration of the project or indefinitely at the discretion of Engineer.

6. Certificates of compliance shall be submitted by Contractor to Engineer for those materials and products for which no sample and test results are specified. Certificates of compliance shall include the following information:

- Statement that the product complies with the respective contract specifications.

- Producer's name and address, product trade name and catalog number (if applicable), place of product origin, quantity of product to be furnished, and related contract plans and specification section numbers.
- A certified copy of test results pertaining to the product from a certified independent testing laboratory. At the option of Engineer certified test results shall be signed and sealed by a Professional Engineer licensed to practice in the state of California.
- Material Safety Data Sheets (MSDS) for all materials used or stored on the site that possess a MSDS, including materials used by Contractor for maintenance of equipment.

Review

Submittals will be processed by Engineer within fourteen (14) calendar days after receipt, not including legal holidays. When a submittal cannot be returned within that period, the Engineer will, within a reasonable time after receipt of the submittal, give notice of the date by which that submittal will be returned. Submittal shall receive one of four review actions:

1. No Exceptions Taken – The submittal is approved without comments.
2. Supply as Noted / Make Corrections Noted – The submittal is approved, provided that the Contractor addresses the included comments.
3. Resubmit – The information provided with the submittal does not meet project requirements, however, Engineer has commented on some missing items that, if provided, may meet project requirements. Contractor shall resubmit the same product and provide additional information per the Engineer's comments.
4. Rejected – The submitted product cannot meet project requirements and is rejected. Contractor shall provide a separate product that meets project requirements as a resubmittal.

Engineer will review submittals for general conformance with the Contract Documents. The work shall be in accordance with approved submittals except that the Contractor shall not be relieved of the responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal as part of a cover letter to the submittal itself, and as a written communication separate from the submittal cover letter, and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer's approval thereof. The Engineer's review does not extend to accuracy of dimensions, quantities, or performance of equipment and systems designed by the Contractor, or means, methods, techniques, sequences, or procedures. Unless specifically authorized to do so by

Engineer, Contractor shall not procure, manufacture, or fabricate any part of the contract work until submittals related to said contract work have been favorably reviewed by Engineer.

“Or Equal” Items

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

1. "Or Equal" Items: If in the Engineer's discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may be accomplished. A proposed item of material or equipment will be considered functionally equal to a named item if:

- a. In the exercise of reasonable judgment Engineer determines that: (i) it is at least equal in quality, durability, appearance, strength, and design characteristics; (ii) it will reliably perform at least equally well the function of the named item, and;
- b. Contractor certifies that: (i) there is no increase in cost to the City; and (ii) it will conform substantially, even with deviations, to the detailed requirements of the item named in the Contract Documents.

5.07 CHANGE ORDER PROCEDURES:

The contract price and contract time may only be changed by an executed Contract Change Order. A Contract Change Order is a written instrument prepared by the Owner, authorized by the City, stating agreement of the following:

1. The change in the Work;
2. The amount of the adjustment, if any, in the Contract Price; and
3. The extent of the adjustment, if any, in the Contract Time.

When a change in the work is contemplated by the Engineer, a Construction Change Directive may be issued by the Engineer. A Construction Change Directive is a written order prepared by the Engineer directing a change in the Work prior to agreement on adjustment in the Contract Price or Contract Time, or both, in a Contract Change Order. The Engineer may, by Construction Change Directive and without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Price and Contract Time being adjusted accordingly thereafter according to the terms of the Agreement.

A Change Order Request is a document created by the Contractor which notifies the Engineer of changes in scope, changed conditions, errors, omissions, or inconsistencies in the contract documents which may or may not require an adjustment in the Contract Price and/or Contract Time.

Upon issuance of either a Construction Change Directive by the Engineer or a Change Order Request by the Contractor, the Contractor shall promptly prepare documentation proposing a contract cost and/or time adjustment for review by the Engineer for the purposes of arriving at a mutually agreeable lump sum. Contractor shall submit backup information for costs of labor, equipment, material, and agreeable markups. Backup information shall contain sufficient detail to allow a thorough review. The Engineer will review backup documentation and issue a response to the Contractor as to agreement or disagreement with proposed adjustments to contract price and/or time. Contractor shall not proceed with the change in the Work involved until the proposed cost and time adjustment is acceptable to the Engineer. If attempts to arrive at a mutually agreeable lump sum amount fail, the Engineer may direct that the work proceeds on the basis of force account in accordance with the terms of the Agreement.

When the Engineer and Contractor agree with the adjustments in the Contract Price and/or Contract Time, the Engineer will prepare the change order. The City Engineer or the Director of Municipal Services may approve change orders up to 50% of the approved contingency for the project. The City Manager may approve change orders up to 100% of the approved contingency for the project. Change orders exceeding the contingency balance must be approved by the City Council.

5.08 NOTICE OF POTENTIAL CLAIM:

Attention is directed to Section 5-1.43 "Potential Claims and Dispute Resolution," of the Caltrans Standard Specifications.

5.09 LABOR NONDISCRIMINATION:

Attention is directed to the following Notice that is required by Chapter 5 of Division 4 of Title 2, California Code of Regulations.

**NOTICE OF REQUIREMENT FOR NONDISCRIMINATION PROGRAM
(GOV. CODE, SECTION 12990)**

Your attention is called to the "Nondiscrimination Clause", set forth in Section 7 1.01A(4), "Labor Nondiscrimination," of the Caltrans Standard Specifications, which is applicable to all nonexempt state contracts and subcontracts, and to the "Standard California Nondiscrimination Construction Contract Specifications" set forth therein. The Specifications are applicable to all nonexempt state construction contracts and subcontracts of \$5,000 or more.

5.10 PREVAILING WAGE:

Attention is directed to Section 7-1.02K "Labor Code," of the Caltrans Standard Specifications, however certified payroll is not submitted to Caltrans for this project. Contractor shall submit certified payroll records both to the DIR and to the Engineer on a weekly basis. Contractor may submit certified payroll records to the Engineer via mail, email, or uploaded to VPM.

State Prevailing Wage Rates

Pursuant to Section 1773 of the Labor Code, the General Prevailing Wage Rates in the County Stanislaus in which the work is to be done have been determined by the Director of the California Department of Industrial Relations. These wages are set forth in the General Prevailing Wage Rates for this project, available at 156 S. Broadway St, Turlock, CA 95380 and available from the California Department of Industrial Relations' Internet web site at <http://www.dir.ca.gov/DLSR/PWD>. Changes, if any, to the general prevailing wage rates, will be available at the same location. Future effective General Prevailing Wage Rates, that have been predetermined and are on file with the California Department of Industrial Relations are referenced but not printed in the General Prevailing Wage Rates.

5.11 SUBCONTRACTING:

No subcontract releases the Contractor from the contract or relieves the Contractor of their responsibility for a subcontractor's work.

If the Contractor violates Pub Cont Code § 4100 et seq., the City may exercise the remedies provided under Pub Cont Code § 4110. The City may refer the violation to the Contractors State License Board as provided under Pub Cont Code § 4111.

Each subcontract must comply with the contract.

Each subcontractor must have an active and valid State Contractor's License with a classification appropriate for the work to be performed (Bus & Prof Code, § 7000 et seq.).

Do not use a debarred contractor; a current list of debarred contractors is available at the Department of Industrial Relations' Web site.

Upon request by the Engineer, immediately remove and not again use a subcontractor who fails to prosecute the work satisfactorily.

5.12 PAYMENTS:

Attention is directed to Section 8, "Compensation," of the Contract.

At the end of each month the Contractor shall submit a proposed progress invoice. The invoice shall delineate each bid item, the amount of work performed for the invoice period (previous month) and the total amount of work performed to date. A sample invoice with all of the required items will be given to the Contractor at the pre-construction meeting.

The Engineer will review the progress invoice and after any changes the Engineer makes, will issue an official invoice for the Contractor to sign. The Contractor shall sign the official invoice and return to the Engineer. After the Engineer receives the signed, official invoice, the progress payment will be processed.

Retention in the amount of 5% of the progress payment amount shall be held from all progress payments. Retention will be released 35 days after the Notice of Completion has been filed, insofar as no stop notices were filed.

5.13 GUARANTY:

Attention is directed to Section 9-4, "Guaranty," of the City of Turlock Standard Specifications.

5.14 PROMPT PROGRESS PAYMENT TO SUBCONTRACTORS:

A prime contractor or subcontractor shall pay any subcontractor not later than 10 days of receipt of each progress payment in accordance with the provision in Section 7108.5 of the California Business and Professions Code concerning prompt payment to subcontractors. The 10 days is applicable unless a longer period is agreed to in writing. Any delay or postponement of payment over 30 days may take place only for good cause and with the agency's prior written approval. Any violation of Section 7108.5 shall subject the violating contractor or subcontractor to the penalties, sanction and other remedies of that section. This requirement shall not be construed to limit or impair any contractual, administrative, or judicial remedies otherwise available to the contractor or subcontractor in the event of a dispute involving late payment or nonpayment by the prime contractor, deficient subcontract performance, or noncompliance by a subcontractor.

5.15 PROMPT PAYMENT OF FUNDS WITHHELD TO SUBCONTRACTORS:

The agency shall hold retainage from the prime contractor and shall make prompt and regular incremental acceptances of portions, as determined by the agency of the contract work and pay retainage to the prime contractor based on these acceptances. The prime contractor or subcontractor shall return all monies withheld in retention from all subcontractors within seven (7) days for construction contracts and fifteen (15) days for consultant contracts after receiving payment for work satisfactorily completed and accepted including incremental acceptances of portions of the contract work by the agency. Any delay or postponement of payment may take place only for good cause and with the agency's prior written approval. Any violation of these provisions shall subject the violating prime contractor or subcontractor to the penalties, sanctions, and other remedies specified in Section 7108.5 of the California Business and Professions Code and Section 10262 of the California Public Contract Code for construction contracts, and Section 3321 of the California Civil Code for consultant contracts. This requirement shall not be construed to limit or impair any contractual, administrative or judicial remedies otherwise available to the contractor or subcontractor in the event of a dispute involving late payment or nonpayment by the contractor; deficient subcontractor performance and/or noncompliance by a subcontractor. This clause applies to both DBE and non-DBE subcontractors.

5.16 PUBLIC SAFETY:

In addition to any other measures taken by Contractor pursuant to the provisions of the Standard Specifications and the General Conditions, Contractor shall install temporary precast concrete barrier rail between any lane carrying public traffic and any excavation, obstacle or storage area when the following conditions exist:

Excavations: Any excavation, the near edge of which is 12 feet or less from the edge of the lane, except;

- (a) Excavations covered with sheet steel or concrete covers of adequate thickness to prevent accidental entry by traffic or the public.
- (b) Excavations less than one foot deep.

- (c) Trenches less than one foot wide for irrigation pipe or electrical conduit or excavations less than one foot in diameter.
- (d) Excavations parallel to the lane for the purpose of pavement widening or reconstruction.
- (e) Excavations in side slopes where the slope is steeper than 4:1.
- (f) Excavations protected by existing barrier or railing.

At the end of each working day, if a difference of 0.50 feet exists between the elevation of the existing pavement and the elevation of any excavation within 2 feet of the traveled way, material shall be placed and compacted against the vertical cuts adjacent to the traveled way. During excavation operations, native material may be used for this purpose, however, once the placing of the structural section commences, structural material shall be used. The material shall be placed to the level of the elevation of the top of the existing pavement and tapered at a slope of 4:1 or flatter to the bottom of the excavation. Treated base shall not be used for the taper. Full compensation for placing the material on a 4:1 slope, regardless of the number of times it is required, and subsequent removing or reshaping of the material to the lines and grades shown on the plans shall be considered as included in the cost for other contract items of work and no additional compensation will be allowed therefore.

Personal vehicles of Contractor's employees shall not be parked on the traveled way or shoulders, including any section closed to public traffic. Whenever vehicles or equipment are parked on the shoulder within 6 feet of a traffic lane, the shoulder area shall be closed with traffic cones or portable delineators placed on a taper in advance of the parked vehicles or equipment and along the edge of the pavement at 25-foot intervals to a point not less than 25 feet past the last vehicle or piece of equipment.

A minimum of one paved traffic lane, not less than 12 feet wide, shall be open for use by public traffic in each direction of travel. The full width of the traveled way shall be open for use by public traffic on Saturdays, Sundays and designated legal holidays, after 4:00 p.m. on Fridays and the day preceding designated legal holidays and when construction operations are not actively in progress.

5.17 REMOVAL OF ASBESTOS AND HAZARDOUS SUBSTANCES:

The contractor shall promptly, and before the following conditions are disturbed, notify the local public entity, in writing, of any:

1. Material that the contractor believes may be material that is hazardous waste, as defined in Section 25117 of the Health and Safety Code, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing law.
2. Subsurface or latent physical conditions at the site differing from those indicated by information about the site made available to bidders prior to the deadline for submitting bids.
3. Unknown physical conditions at the site of any unusual nature, different materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract.

Upon notification of any of the above, the City shall promptly investigate the conditions, and if it finds that the conditions do materially so differ, or do involve hazardous waste, and cause a decrease or increase

in the contractor's cost of, or the time required for, performance of any part of the work, a change order shall be issued to modify the contract scope.

In the event that a dispute arises between the City and Contractor whether the conditions materially differ, or involve hazardous waste, or cause a decrease or increase in the contractor's cost of, or time required for, performance of any part of the work, the contractor shall not be excused from any scheduled completion date provided for by the contract, but shall proceed with all work to be performed under the contract. The contractor shall retain any and all rights provided either by contract or by law which pertain to the resolution of disputes and protests between the contracting parties.

When the presence of asbestos or hazardous substances are not shown on the plans or indicated in the specifications and the Contractor encounters materials which the Contractor reasonably believes to be asbestos or a hazardous substance as defined in Section 25914.1 of the Health and Safety Code, and the asbestos or hazardous substance has not been rendered harmless, the Contractor may continue work in unaffected areas reasonably believed to be safe. The Contractor shall immediately cease work in the affected area and report the condition to the Engineer in writing.

In conformance with Section 25914.1 of the Health and Safety Code, removal of asbestos or hazardous substances including exploratory work to identify and determine the extent of the asbestos or hazardous substance will be performed by separate contract.

If delay of work in the area delays the current controlling operation, the delay will be considered a right of way delay and the Contractor will be compensated for the delay in conformance with the provisions in Section 8 1.07, "Delays," of the Caltrans Standard Specifications.

5.18 WORKING HOURS:

Contractor's working hours shall be between 7:00 a.m. and 5:00 p.m., Monday through Friday, excluding legal holidays.

Contractor shall notify Engineer 48 hours prior to beginning work.

Contractor shall not work outside the above-mentioned working hours without prior written consent of Engineer.

Designated legal holidays are: January 1st, the third Monday in January, the third Monday in February, the last Monday in May, June 19th, July 4th, the first Monday in September, November 11th, Thanksgiving Day, the day after Thanksgiving, and December 25th. When a designated legal holiday falls on a Sunday, the following Monday shall be a designated legal holiday. When a designated legal holiday falls on a Saturday, the preceding Friday shall be a designated legal holiday.

Should the Contractor desire to work on a Saturday, Sunday or Legal Holiday, the Contractor shall request approval of the Engineer. The Engineer may reject the request with or without cause. Should approval be granted, the Contractor shall reimburse the City of Turlock the premium portion of cost of engineering, inspection, testing, superintendent, and/or other overhead expenses due to overtime which are directly chargeable to the contract. Should such work be undertaken at the request of the City, reimbursement will not be required.

5.19 SOUND CONTROL REQUIREMENTS:

Sound control shall be in accordance with Section 7 1.01I, "Sound Control Requirements," of the Caltrans Standard Specifications and these special provisions.

The noise level from Contractor's operations, between the hours of 9:00 p.m. and 6:00 a.m., shall not exceed 86 dba at a distance of 50 feet. This requirement in no way relieves Contractor from responsibility for complying with local ordinances regulating noise level.

Said noise level requirements shall apply to all equipment on the job or related to the job, including but not limited to trucks, transit mixers or transient equipment that may or may not be owned by Contractor. The use of loud sound signals shall be avoided in favor of light warnings except those required by safety law for the protection of personnel.

Full compensation for conforming to the requirements of this section shall be considered as included in the prices paid for the various contract items of work involved and no additional compensation will be allowed therefore.

5.20 UNDERGROUND SERVICE ALERT REQUIREMENTS:

Contractor shall contact Underground Service Alert of Northern California at least 48 hours in advance of any construction activity, will or could damage or affect any underground utility or subsurface improvement, and obtain an inquiry identification number. Contractor shall notify Underground Service Alert in the event of change in the project limits or change in original work previously shown on the plans or indicated in the specifications. Contractor shall not commence construction prior to City Inspector receiving City's notice from USA North regarding this construction activity.

5.21 SURVEYING:

Construction survey staking shall be provided by City. Contractor shall provide the initial staking request no less than 1 week prior to Contractor starting work. Contractor shall submit subsequent staking requests no less than 48 hours before the staking is required to continue construction. Contractor shall post all staking requests to Virtual Project Manager (VPM) under the Request for Information (RFI) tab. The Contractor shall provide unimpeded access to the site and allow the survey crew to perform their work.

Contractor shall protect all survey stakes and markers during construction. If survey stakes and/or markers are damaged or destroyed during the course of construction, by vandalism or by any other means, Contractor may submit a request to have the survey re-staked. If re-staking is required, Contractor may be back charged at the fully burdened hourly rate for the survey crew and shall fully reimburse City for all necessary materials and equipment as a deductive change order.

Prior to installation of formwork for concrete building structures, Contractor shall be required to notify the City a minimum of 48 hours in advance of scheduled formwork activities so that the City may complete a survey for the purposes of verifying horizontal and vertical placement. The Engineer shall review the survey results and determine if the preparation of the building pad area is in conformance with the project plans and specifications. Contractor shall not proceed with installing formwork until after it is determined that the building pad area is in conformance with the project plans and specifications. After formwork is

in place and prior to pouring any concrete, Contractor shall notify the City a minimum of 48 hours in advance for a survey of formwork. Upon completion of the survey, the Engineer may either approve or reject the formwork. Contractor shall not proceed with pouring concrete until after the Engineer has certified that the area is in compliance with the project plans and specifications. Contractor shall be required to correct this work in a manner acceptable to the Engineer if found to not be in conformance with the project plans and specifications at its own expense.

5.22 PRESERVATION OF PROPERTY:

The work performed in connection with various existing facilities shall be in accordance with Section 7-8, "Preservation of Property," of the City of Turlock Standard Specifications and these special provisions.

Due care shall be exercised to avoid injury or damage to existing improvements or facilities, utility facilities, adjacent property, and roadside trees, shrubs and other plants that are to remain in place.

Roadside trees, shrubs and other plants that are not to be removed and pole lines, fences, signs, markers and monuments, buildings and structures, conduits, pipelines under or above ground, sewer and water lines, sprinkler systems above or below ground, all roadway facilities, and any other improvements or facilities within or adjacent to the right-of-way shall be protected from injury or damage, and if ordered by Engineer, Contractor shall provide and install suitable safeguards, approved by Engineer, to protect such objects from injury or damage. If such objects are injured or damaged by reason of Contractor's operations they shall be replaced or restored at Contractor's expense. The facilities shall be replaced or restored to a condition as good or better as when Contractor entered upon the work, or as good as required by the specifications accompanying the contract, if any such objects are a part of the work being performed under the contract. Engineer may make or cause to be made such temporary repairs as necessary to restore to service any damaged facility. The cost of such repairs shall be borne by Contractor and may be deducted from any moneys due or to become due to Contractor under the contract.

The fact that any underground facility is not shown upon the plans shall not relieve Contractor of his responsibility under the Section "Existing Utilities and Facilities", of these provisions. It shall be Contractor's responsibility, pursuant thereto, to ascertain the location of such underground improvements or facilities that may be subject to damage by reason of construction operations.

Full compensation for furnishing all labor materials, tools, equipment, and incidentals, and for doing all the work involved in protecting or repairing property as specified above, shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefore.

5.23 PRESERVATION OF EXISTING MONUMENTS:

Contractor shall be responsible for protecting all survey monuments identified on the plans. Any monuments identified on the plans that are damaged or destroyed by Contractor that have not been tied off by City's surveyor shall be replaced at the Contractor's cost and deducted from the Contract Price by Change Order. Contractor shall notify City of all monuments that may or will be disturbed by necessary construction operations. City's surveyor will tie off said monuments and provide Contractor a notice to proceed prior to demolition of existing monuments.

Once Contractor is finished with its construction operations, the City's surveyor shall be responsible to set new survey monuments. New monument wells that conform to the City of Turlock Standard Specifications and Drawings will be required to be installed by the Contractor prior to setting new monuments. Contractor shall include the cost of new monument well(s) if shown on the project plans in its contract price. If no new monument wells are shown to be installed by Contractor on the project plans, installation of monument well(s) will be added to the project scope by Contract Change Order. Contractor shall confirm location of each monument well with City's surveyor prior to installation of the monument well. Once Contractor has installed monument well(s), City's surveyor will reset the monument(s).

Full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved with protecting existing monuments as specified above, shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefore.

5.24 DUST CONTROL:

Dust Control shall conform to the provisions in Section 10, "Dust Control", of the Standard Specifications and these special provisions.

Full compensation for Dust Control will be considered as included in the various contract items of work requiring Dust Control, as determined by Engineer, and no separate payment will be made therefor.

5.25 USE OF HYDRANTS FOR CONSTRUCTION PURPOSES:

City will permit the use of a hydrant for construction purposes provided that the following are abided by:

1. A spanner wrench shall be the only type of wrench used on fire hydrants.
2. Contractor shall be liable for the damages to or loss of all hydrants and associated water lines and equipment which result from the use of this equipment.
3. Water shall only be used within City limits.
4. The vehicle must be approved by Engineer for approved backflow device.
5. Contractor shall pay a deposit on a water meter provided by the City. After the project ended the Contractor shall return the meter to the City for the release of the deposit.

Contractor shall obtain a no-fee monthly hydrant use permit for use of construction water for this project from the City of Turlock Municipal Services Department located at 156 S. Broadway Suite 270, Turlock, California 95380, ph:209-668-5590.

Use of city hydrants does not exempt Contractor from providing a water truck where hydrants cannot be utilized due to unsafe working conditions as deemed by Engineer.

5.26 TEMPORARY CONSTRUCTION POWER:

If temporary construction power is determined to be needed by the Contractor to perform the work, Contractor shall arrange and pay for all temporary electric power. The cost of temporary power shall be considered as included in the various contract bid items and no additional compensation will be allowed therefore.

5.27 SALVAGE MATERIALS:

If Contractor is directed to salvage materials in the Contract Documents, Contractor shall arrange for delivery of said item(s) to the City of Turlock Corporation Yard located at 701 S. Walnut Road, unless noted otherwise. Contractor shall coordinate delivery of salvaged materials through the public works inspector.

5.28 TESTING:

Unless otherwise noted, City of Turlock will supply all acceptance testing. Coordination of said testing is the responsibility of Contractor through the project’s inspector. The Contractor shall provide at least 24 hours’ notice to the Engineer in advance of needing acceptance testing. If the Contractor request testing and the Contractor is not ready for the testing to occur, the Contractor shall be back charged the cover the cost of the testing firm.

At sites chosen by the project inspector, City’s testing laboratory will conduct all tests. Contractor shall supply any necessary equipment and or labor required to obtain all samples for the completion of the testing process.

City of Turlock shall compensate the testing laboratory for all initial tests. Secondary and all other follow-up tests required due to failure of initial testing shall be reimbursed to City of Turlock based on the following schedule:

Water sample test: \$300.00 Per Test

Compaction test: \$100.00 Per Test

5.29 AS-BUILTS:

When the job is complete, Contractor shall provide City with as-built drawings. These as-built drawings shall show any and all differences (revisions, additions, etc.) between the signed improvement plans and the installed improvements. The Contractor shall identify all utilities that are located in the field. The as-builts will consist of redlined signed improvement plans. The Notice of Completion will not be issued until acceptable as-builts have been received by the Engineer.

SECTION 6 WORK RESTRICTIONS (BLANK)

SECTION 7 (BLANK)

SECTION 8 MATERIALS (BLANK)

SECTION 9 DESCRIPTION OF WORK

The work consists, in general of: installing a sodium hypochlorite disinfection system skid, storage enclosure, eyewash station, related piping, electrical, and instrumentation improvements, and installation of a new concrete driveway and other associated work.

The work includes all necessary labor, materials, tools, equipment and any incidentals needed to perform the improvements as shown on the contract plans.

SECTION 10 CONSTRUCTION DETAILS

10.01 MOBILIZATION & DEMOBILIZATION

Mobilization is intended to compensate the Contractor for operations including, but not limited to, those necessary for the movement of personal, equipment, supplies and incidentals to / from the project site; for the payment of premium cost and insurance for the project; for any necessary costs of acquisition of equipment, including purchase and mobilization expense; and for any other work and operations which must be performed or costs that must be incurred incident to the initiation of meaningful work at the site and for which payment is not otherwise provided in the contract.

- (1) When 5 percent of the original contract amount is earned, 50 percent of the amount bid for mobilization, or 5 percent of the original contract amount, whichever is less, may be paid.
- (2) When 10 percent of the original contract amount is earned, 75 percent of the amount bid for mobilization or 7.5 percent of the original contract amount, whichever is less, may be paid.
- (3) When 20 percent of the original contract amount is earned, 95 percent of the amount bid for mobilization, or 9.5 percent of the original contract amount, whichever is less, may be paid.
- (4) When 50 percent of the original contract amount is earned, 100 percent of the amount bid for mobilization, or 10 percent of the original contract amount, whichever is less, may be paid.
- (5) Upon completion of all work on the project, payment of any amount bid for mobilization in excess of 10 percent of the original contract amount will be paid.

10.02 UTILITY COORDINATION:

All coordination with the utility companies shall be the Contractor's responsibility.

10.03 POTHOLE EXISTING UTILITIES:

Prior to the beginning or continuation of any trenching for the installation of utilities, the Contractor shall:

1. Pothole all utility crossings shown on the plans and identified by Underground Service Alert (USA) utility markings. Contractor shall exercise due diligence to utilize techniques and practices which will limit damage to located utilities, including vacuum truck and hand digging, or other means as required by the buried utility owner. Damage to buried utilities as a result of Contractor's failure to perform potholing work per these Special Provisions shall be repaired at the Contractor's expense.
2. Measure depth from top of pavement to top of all utilities and mark depths on the project plans and provide a copy to the Engineer (electronic PDF or hard copy is acceptable)
3. Notify the Engineer of potential conflicts with the proposed location of new utilities. See Section 2.02, "EXISTING UTILITIES, FACILITIES, AND SITE CONDITIONS,"
4. Backfill, compact, and patch or plate potholes prior to opening the paved surface up to traffic.

The project plans depict sizes, horizontal locations, and materials of existing utilities based on surface evidence and facility maps from utility companies. Attention is directed to the possibility of utility locators

marking utilities in locations other than what is shown on the plans or the possible existence of underground facilities not indicated on the plans or in the special provisions. Should additional pothole effort be needed to locate underground facilities beyond that which could be reasonably estimated at the time of bid, the change in contract price will be determined as per Section 4 “Contract Price” of the Agreement.

10.04 REMOVE EXISTING IMPROVEMENTS

Concrete, asphalt concrete and all other items designated on the plans to be removed or must be removed in order to install the improvements as shown on the plans, shall be removed and disposed of outside the highway right of way in accordance with the provisions in Section 7-10 of the Standard Specifications. Saw-cut all concrete and asphalt materials surfaces prior to removal.

10.05 EROSION CONTROL:

Contractor is required to provide an Erosion and Sediment Control Plan (ESCP) for review and approval by the City of Turlock Engineering Division. A blank ESCP worksheet is available to download from the City’s website at <https://ci.turlock.ca.us/buildinginturlock/landdevelopment/improvementplan.asp>. The plan must be approved prior to beginning of work on-site. Contractor shall implement Best Management Practices (BMPs) before construction occurs both in the area of work, as well as staging areas. Contractor shall maintain BMPs in good working condition at all times. Contractor shall provide drain inlet protection, at a minimum. The completed ESCP and required BMPs must be in place prior to soil disturbing construction activities.

The cost to create and implement an ESCP shall be considered as included in the various contract items, and no additional compensation shall be made.

10.06 FINAL CLEANUP:

Upon completion of the work, the Contractor shall remove all equipment, debris, and shall leave the site in a neat clean condition to the satisfaction of the Engineer. The Contractor shall clean the area of all construction related materials and sweep the entire project area including sidewalk and gutter thoroughly. All construction signs, cones, barricades, and conflicting markings shall be removed. At the request of the Contractor, a final punchlist will be provided. After all items of the punchlist have been completed to the satisfaction of the Engineer, the Engineer will issue substantial completion. The accrual of working days will cease after substantial completion has been issued.

SECTION 11 SIGNALS, LIGHTING, AND ELECTRICAL SYSTEM (BLANK)

SECTION 12 WORK ZONE MOBILITY

12.01 PEDESTRIAN MANAGEMENT PLAN:

Contractor shall develop and submit a pedestrian management plan for the Engineer’s review and approval. Contractor shall implement the pedestrian management plan upon approval of the Engineer. The pedestrian management plan shall mitigate impact to existing sidewalks and pedestrian crossings at intersections disturbed during construction. Acceptable pedestrian management plans will include sequenced construction activities to keep at least one existing crossing at each intersection accessible to

the public as well as temporary pedestrian access routes placed by contractor with accessibility features that meet or exceed the level of features provided on the disturbed route. The pedestrian management plan shall be approved by the Engineer prior to disturbing existing pedestrian routes.

Full compensation for Pedestrian Management Plan, including furnishing all labor, materials, tools, equipment and incidentals necessary to develop and implement the plan shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefor.

12.02 TRAFFIC MANAGEMENT PLAN:

Contractor shall comply with the City of Turlock Standard Specifications Section 11 "Traffic Safety." Contractor shall submit a completed Temporary Traffic Control Plan Checklist with submittal of the Temporary Traffic Control Plan. The checklist may be found online at the City's website at https://ci.turlock.ca.us/_pdf/trafficengineeringdoc.asp?id=4

If construction activities affect access to public parking, residential property, or commercial property, contractor shall post signs at 100-foot intervals on the affected streets at least 48 hours prior to starting construction. Signs must display No Parking – Tow Away, C.V.C. 22651(L). Signs must state the dates and hours parking or access will be restricted. Notify residents, businesses, and local agencies at least 24 hours before starting activities. The notice must:

1. Describe the work to be performed
2. Detail streets and limits of activities
3. Indicate dates and work hours
4. Be authorized

Compensation shall be made at the respective lump sum bid price included on the Bidder's Form. If no separate bid item is included, the cost shall be included in the various other bid items and no additional compensation will be made therefor.

SECTION 13 BLANK

APPENDIX A - TECHNICAL SPECIFICATIONS

CITY OF TURLOCK
CITY PROJECT NO. 23-046

TECHNICAL
SPECIFICATIONS
FOR THE
WELL 29 CHLORINATION
ISSUED FOR BIDDING PURPOSES
DECEMBER 2024

TECHNICAL SPECIFICATIONS

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DIVISION 31 - EARTHWORK

31 11 00	Clearing and Grubbing
31 22 19	Finish Grading
31 23 00	Earthwork
31 23 17	Trenching Backfilling and Compacting
31 23 19	Structure Excavation & Backfilling
31 23 21	Dewatering
31 23 31	Compacting Earth Materials
31 23 35	Disposal of Materials

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 11 23	Aggregate Base
32 12 13	Bituminous Prime & Tack Coat
32 12 16	Asphalt Concrete Paving
32 12 36	Seal Coat

DIVISION 33 - UTILITIES

33 05 26	Utility Line Markings
33 13 00	Disinfection of Water Distribution System

DIVISION 40 – PROCESS INTEGRATION

40 05 00	Pipe & Fittings
40 05 23	Valves & Appurtenances
40 05 75	Piping and Equipment Identification
40 20 10	Pipe Supports
40 20 90	PVC and CPVC Process and Chemical Piping
40 24 68	PVC Secondary Containment Piping
40 50 00	I&C General Provisions
40 50 01	I&C Testing
40 50 30	Water Quality Analyzers
40 51 50	Control Panels and Panel Mounted Equipment
40 64 01	Control Systems: Programmable Logic Controllers
40 66 70	Control Systems: Wireless Communications -Radio
40 67 01	Controls Systems: Panels, Enclosures and Panel Components
40 96 31	SCADA Control Loop Descriptions

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE

43 41 43	Polyethylene Chemical Storage Tank
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DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

46 33 43	Motor Operated Diaphragm Chemical Feed Pumps
46 33 85	Chemical Metering Skids and Accessories

SECTION 01 11 10
COORDINATION OF WORK

PART 1 GENERAL

1.1 RESPONSIBILITY OF CONTRACTOR

- A. If any part of the Work depends for proper execution or results upon the work of others, the Contractor shall inspect and promptly report to the Engineer any apparent discrepancies or defects in such work of others that render it unsuitable for such proper execution and results. Failure of the Contractor to so inspect and report shall constitute an acceptance of the work of others as fit and proper except as to defects which may develop in the work of others after execution of the Work by the Contractor.

1.2 WORK INVOLVED WITH EXISTING SYSTEM

- A. Existing materials and equipment removed not designated to be salvaged for Owner in the execution of the Work shall become the property of the Contractor and shall be removed from, and disposed of, off the site by the Contractor in an acceptable and lawful manner.

1.3 COORDINATION OF WORK

- A. The Contractor shall maintain overall coordination for the execution of the Work. Based on the Construction Schedule prepared in accordance with these Specifications, he shall obtain from each of his subcontractors a similar schedule and shall be responsible for all parties maintaining these schedules or for coordinating required modifications.

END SECTION

COORDINATION OF WORK
01 11 10-1

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SECTION 01 20 00
MEASUREMENT & PAYMENT

PART 1 GENERAL

1.1 MEASUREMENT

- A. Unless otherwise specified in the Contract Documents, quantities of work shall be determined from measurements or dimensions in a horizontal plane. All measurements shall be made in accordance with United States Standard Measures and shall be measured on the basis of "in-place" quantities.
- B. After the work has been completed, the Engineer will make field measurements of unit price items in order to determine the quantities of the various items as a basis for payment. On all unit price items, the contractor will be paid for the actual amount of the work performed in accordance with the contract documents, as computed from field measurements unless item is Lump Sum Bid Item.
- C. Work or quantities not listed in the description of bid items are considered incidental to other construction and will not be measured. Compensation for such incidental work is considered to be included in the various items of work bid.

1.2 INCREASED OR DECREASED QUANTITIES

- A. Increases or decreases in quantities shall be governed by the General Conditions.
- B. All written requests for adjustment shall be made no later than five working days after notification by the Engineer that the item of work is complete.

END SECTION

MEASUREMENT & PAYMENT
01 20 00-1

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SECTION 01 22 00 EXPLANATION OF BID ITEMS

PART 1 GENERAL

The Contract payment for the specified items of work as set forth in the Bid Schedule shall be full compensation for furnishing all labor, materials, methods or processes, implements, tools, equipment and incidentals and for doing all work involved as required by the provisions of the Contract Documents for a complete in place and operational system.

- A. Unless otherwise specified in the Specifications, quantities of work shall be determined per each, or from measurements or dimensions in a horizontal plane. All materials shall be measured on the basis of "in place" quantities and paid for using the units listed in the bid schedule.
- B. Except as noted, the Engineer will make field measurements of unit price items in order to determine the quantities of the various items as a basis for payment. On all unit price items, the contractor will be paid for the actual amount of the work performed in accordance with the contract documents, as computed from field measurements.
 - 1. Work or quantities not listed in the description of bid items are considered incidental to other construction and will not be separately measured or paid for. Compensation for such work and/or material shall be included in the prices paid for other items of work.

1.2 *BID ITEMS*

Bid Item 1 – Mobilization, Bonds and Insurance: Payment for this item shall include full compensation for all labor, materials, tools, equipment and incidentals making up the cost of mobilization, move-in, move-out, all necessary bonds, insurance, permits, licenses, and fees required during the performance of the work as specified. This item also includes demobilization, including the removal of all equipment, supplies, personnel and incidentals from the project at the end of construction.

Bid Item 2 – Traffic Control: Payment under this item shall be considered full compensation for all labor, materials, tools, equipment and incidentals required to maintain traffic control measures for the project limits in accordance with the Plans and specifications. This bid item will be paid for by Lump Sum, prorated, based on percentage of contract work completed.

Bid Item 3 – Site Piping: This bid item includes all site piping accessory piping and tubing, pipe supports, backflow preventers, flow meters, emergency eye wash / shower, valves, fittings, and appurtenances within the enclosed treatment site. This bid item includes trenching, bedding, and backfill and compaction. Completed item shall provide a complete and fully operational onsite yard piping system. This bid item will be paid for by Lump Sum on a prorated basis.

Bid Item 4 – Chemical Storage Building and Pad: This bid item includes furnishing and installing a chemical enclosure, including associated reinforced concrete foundation, structural steel, roofing, rafters, and all labor, equipment, materials, and incidentals necessary for proper completion of the enclosure. All wet utilities, dry utilities, chemical feed, and electrical are included in other bid items. Completed item shall provide a complete and fully operation chemical enclosure system. This bid item will be paid for by Lump Sum on a prorated basis.

Bid Item 5 – Chlorination Equipment (Pumps, Tank, and Analyzers): This bid item includes chemical tank and metering pump, chlorine residual analyzer, conduits and tubing, injection and sample taps, valves and accessories, NSF-60 certified sodium hypochlorite solution for start-up testing, and all appurtenances including electrical connections and wiring required to provide a complete system for injection of sodium hypochlorite solution and monitoring of chlorine residual levels as shown in the Plans and these Specifications. This bid item will be paid for by Lump Sum on a prorated basis.

Bid Item 6 – Electrical, Instrumentation and Controls: This bid item is a lump sum bid item for all work associated with all electrical equipment as well as instrumentation and controls integration required for the well site, including, but not limited to main electrical service, site lighting, site electrical, transformers, conduit and conductors for all work, all electrical connections, all SCADA infrastructure and integration with the existing SCADA system, testing and startup.

The bid item price shall include full compensation for furnishing all labor, tools, equipment and materials, along with all associated appurtenances required to complete electrical, controls and lighting in conformance with the Plans and Specifications and as directed by the Engineer. Completed item shall provide a complete and fully operation telemetry, integration, and lighting system. This bid item shall be paid at the lump sum price bid. This bid item will be paid for by Lump Sum on a prorated basis.

Bid Item 7 – Site Civil Improvements: This bid item includes all additional site civil work for driveway access and/or perimeter fence expansion. This bid item includes all demolition and clearing, site grading, fencing, gates, frontage improvements and drive access as shown on the plans. This bid item will be paid for by Lump Sum on a prorated basis.

Bid Item 8 – Startup and Testing: This bid item includes furnishing services associated with startup and testing of the chlorination site. This bid item will be paid for by Lump Sum on a prorated basis.

Bid Item 9 – Operation and Maintenance Manuals: This bid item includes preparing and furnishing an operations and maintenance manual for all equipment. Refer to the specific requirements for each process in the Technical Specifications. This bid item will be paid for by Lump Sum on a prorated basis.

Bid Item 10 – As-Built Drawings: This bid item includes preparing and furnishing a complete set of as-built drawings. Refer to the General Conditions for specific requirements. This bid item will be paid for by Lump Sum on a prorated basis.

END SECTION

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SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work described in this section includes general requirements and procedures related to the preparation and transmission of submittals to include Shop Drawings, Product Information, Calculations, Test Reports, Certificates, Samples, Manuals, and Record Drawings.

1.2 RELATED WORK

- A. City of Turlock Bidding and Contract Documents
- B. Individual equipment specifications

1.3 GENERAL

- A. Contractor shall have completed the following work tasks before a submittal:
 - 1. Reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - 2. Determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
 - 3. Determined and verified the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 - 4. Determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

1.4 TRANSMITTAL INFORMATION

- A. Each submittal document shall have a separate cover or transmittal. Transmittals shall include the following identification data, as applicable:
 - 1. Submittal number
 - 2. Contract number
 - 3. Project name and location

4. Product identification
5. Applicable contract drawing number, specification section, and paragraph number
6. Stamp Space: Blank space of approximately 2-1/2 inches high by 4 inches wide adjacent to the identification data to receive Engineer's status stamp.
7. Contractor's certification statement as described below:
 - a. "Certification Statement: By this submittal, we hereby represent that we have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and pertinent data and we have checked and coordinated each item with other applicable approved drawings and all Contract requirements."
- B. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review of each such variation.
- C. Furnish neat, legible, and sufficiently explicit detail to enable proper review for Contract compliance.
- D. Contractor assumes all risks of error and omission.
- E. Work performed before acceptance, or not conforming to accepted submittals, shall be at Contractor's risk.
- F. Submittal requirements contained in this specification are in addition to specific submittal requirements contained in individual equipment specification sections.

1.5 *LIMITATIONS OF ENGINEER'S REVIEW*

- A. Engineer's review is only for the purposes of determining if the items covered by the submittals will conform to the requirements in the Contract Documents.
- B. Engineer's review will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.
- C. Engineer's review of a separate item will not indicate acceptance of the assembly in which the item functions.
- D. Engineer's review of a Submittal shall not relieve Contractor from responsibility for any deviation from the requirements of the Contract Documents unless Contractor has given Engineer specific written notice of any deviation per the requirements of this Section. Engineer will document any such accepted variation from the requirements of the Contract Documents in a Field Order.

- E. Engineer's review of a Submittal, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.

1.6 SUBMITTAL PROCESS

- A. Submittals shall be sent to the Engineer electronically through email or a file transfer system agreed upon by the Owner, Engineer, and Contractor during the Preconstruction Conference.
- B. Engineer will provide timely review of Submittals in accordance with the Schedule of Submittals agreed upon by the Owner, Engineer, and Contractor during the Preconstruction Conference.
- C. Submittals will be returned, marked with one of the following classifications:
 - 1. NO EXCEPTION TAKEN: Requires no corrections, no marks.
 - 2. MAKE CORRETIONS NOTED: Requires minor corrections. Items may be fabricated as marked without further resubmission. Resubmit 2 corrected copies to the Engineer.
 - 3. REVISE AND RESUBMIT: Requires corrections. Resubmit entire submittal following original submission with corrections noted. Allow time for checking and Engineer's appropriate action.
 - 4. REJECTED: Submitted information does not comply with the Contract Documents. No items shall be fabricated. Resubmit entire submittal following original submission with corrections noted.
 - 5. INFORMATION ONLY: Items in the submittal are saved in the project file for information only but were not reviewed by the Engineer.

PART 2 SUBMITTAL DOCUMENTS

2.1 SHOP DRAWINGS

- A. When requested submit, submit two (2) sets of shop drawings.

2.2 SAMPLES

- A. When requested or required by individual specification sections, submit one (1) sample of each item.
- B. Samples shall be representative of the actual material proposed for use in the project and of sufficient size to demonstrate design, color, texture, and finish.
- C. Permanently attach to each sample
 - 1. The submittal number

2. The contract number
 3. Project name and location
 4. Product identification
 5. Applicable contract drawing and specification section number
 6. Subcontractor's, vendor's and/or manufacturer's name, address, and telephone number.
- D. Certain samples may be tested for specific requirements by the Owner and/or Engineer prior to acceptance. Failure of sample to pass tests will be sufficient cause for refusal to consider further samples of the same brand and make.
- E. Rejected samples will be returned upon request, and resubmittals shall consist of new samples.

2.3 AS-BUILT DRAWINGS

- A. Maintain 1 record copy of Contract Documents at site in good order and annotated to show revisions made during construction. Keep annotations current for possible inspection.
1. Make as-built drawings available to Engineer at all times during life of Contract.
 2. Drawings: Made part of as-built drawings and to include:
 - a. Contract Drawings: Annotate or redraft, as required, to show revisions, substitutions, variations, omissions, and discrepancies made or discovered during construction concerning location and depth of utilities, piping, ductbanks, conduits, manholes, pumps, valves, vaults, and other equipment. Make revisions and show on all drawing views with actual dimensions established to permanent points.
 - b. Working/Layout Drawings: When required as submittals, record actual layouts of conduit runs between various items of electrical equipment for power, control, and instrumentation; wire sizes, numbers, and functions; configuration of conduits; piping layouts; and duct layouts.
 3. Before preliminary inspection, furnish reproducible of as-built drawings. At completion of Contract and before final payment is made, furnish Engineer 1 set of reproducibles of finally accepted as-built drawings reflecting revisions herein described.

2.4 OPERATION AND MAINTENANCE MANUALS

- A. Furnish Operation and Maintenance Manuals for various types of equipment and systems, as required by Contract Documents. Operation and Maintenance Manuals shall be provided for all mechanical and electrical equipment. Unless otherwise indicated, furnish separate manual for each piece of equipment and system. If

manual contains other items or equipment, indicate where specified items are located in manual. Include in manual complete information necessary to operate, maintain, and repair specific equipment and system furnished under this Contract, and include the following specific requirements;

1. Contents.
 - a. Table of Contents and Index.
 - b. Brief description of equipment/system and principal components.
 - c. Starting and stopping procedures, both normal and emergency.
 - d. Installation, maintenance, and overhaul instructions including detailed assembly drawings with parts list and numbers, and recommended spare parts list with recommended quantity, manufacturer's price, supplier's address, and telephone number.
 - e. Recommended schedule for servicing, including technical data sheets that indicate weights and types of oil, grease, or other lubricants recommended for use and their application procedures.
 - f. One copy of each component wiring diagram and system wiring diagram showing wire size and identification.
 - g. One accepted copy of each submittal with changes made during construction properly noted, including test certificates, characteristic curves, factory and field test results.
 - h. For electrical systems, include dimensioned installation drawings, single line diagrams, control diagrams, wiring and connection diagrams, list of material for contactors, relays and controls, outline drawings showing relays, meters, controls and indication equipment mounted on equipment or inside cubicles, control and protective schematics, and recommended relay settings.
2. Material:
 - a. Preliminary
 - 1) Submit one (1) electronic copy of the preliminary O&M manuals in searchable PDF format.
 - b. Final
 - 1) Submit one (1) electronic copy of the final O&M manuals in searchable PDF format.
 - 2) Submit two (2) hard copies of the final O&M Manual as described below:
 - a) Covers: Oil, moisture, and wear resistant 9 inches by 11-1/2 inches size.

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- b) Pages: 60 pound paper 8-1/2 inches by 11 inches size with minimum of 2 punched holes 8-1/2 inches apart reinforced with plastic, cloth, or metal.
- c) Fasteners: Metal screw post or Acco metal strap type.
- d) Diagrams and Illustrations: Attach foldouts, as required.

PART 3 EXECUTION

NOT USED

END SECTION

SUBMITTAL PROCEDURES
01 33 00-6

SECTION 01 50 00

TEMPORARY FACILITIES

PART 1 GENERAL

1.1 GENERAL

- A. The Contractor shall provide all temporary facilities and utilities required for completion of the Work as well as safety precautions and programs. No attempt is made to set out in detail the Contractor's means or methods necessary to accomplish the tasks involved.

1.2 TEMPORARY UTILITIES

- A. Water

- 1. The Contractor may make arrangements with the Owner to use municipal water where appropriate during construction.
- 2. Water used for human consumption shall be kept free from contamination and shall conform to the requirements of the State and local authorities for potable water.

- B. Sanitary Facilities

- 1. The Contractor shall provide suitable and adequate sanitary conveniences for the use his staff at the site of the Work. Such conveniences shall include chemical toilets or water closets and shall be located at appropriate locations at the site of the Work. All sanitary conveniences shall conform to the regulations of the public authority having jurisdiction over such matters. At the completion of the Work, all such sanitary conveniences shall be removed, and the site left in a sanitary condition.
- 2. With respect to sanitation facilities, the Contractor shall cooperate with and follow directions of representatives of the Public Health Service and the State. State and County Public Health Service representatives shall have access to the Work, whether it is in preparation or progress, and the Contractor shall provide facilities for such access and inspection.

1.3 TEMPORARY CONSTRUCTION FACILITIES

- A. Construction hoists, shoring, and similar temporary facilities shall be of ample size and capacity to adequately support and move the loads to which they will be subjected. Railings, enclosures, safety devices, and controls required by law or for adequate protection of life and property shall be provided.
- B. Temporary supports shall be designed with an adequate safety factor to assure adequate load bearing capability. The Contractor shall submit design calculations prepared by a professional registered engineer for staging and shoring prior to application of loads.

- C. Barriers shall be placed at each end of all excavations and at such places as may be necessary along excavations to warn all pedestrian and vehicular traffic of such excavations from one hour before sunset each day to one hour after sunrise of the next day until such excavation is entirely refilled, compacted, and paved. All excavations shall be barricaded in such a manner as to prevent persons from falling, walking, or otherwise entering any excavation in any street, roadway, parking lot, treatment plant, or any other area, public or private.
- D. The Contractor shall adequately identify and guard all hazardous areas and conditions by visual warning devices and, where necessary, physical barriers. Such devices shall, as a minimum, conform to the requirements of Cal/OSHA.
- E. At such time or times any temporary construction facilities and utilities are no longer required for the work, the Contractor shall notify the Engineer of his intent and schedule for removal of the temporary facilities and utilities, and obtain the Engineer's approval before removing the same. As approved, the Contractor shall remove the temporary facilities and utilities from the site as his property and leave the site in such condition as specified, as directed by the Engineer, and/or as indicated on the Plans.

1.4 ACCESS ROADS AND STAGING AREA

- A. Adequate access shall be maintained to all storage areas and other areas to which frequent access is required. The Contractor shall limit the location of his storage of equipment and materials outside of the project site. The Contractor shall make his own arrangements for space that may be required and bear all associated costs. The Contractor shall provide any temporary storage required for the protection of equipment and materials as recommended by manufacturers of such materials.
- B. Storage and protection:
 - 1. Materials and equipment shall be stored in accordance with supplier's written instructions, with seals and labels intact and legible. Exposed metal surfaces of valves, fittings and similar materials shall be coated in accordance with manufacturer's recommendations to prevent corrosion.
 - 2. Storage shall be arranged to provide access for inspection. The Contractor shall periodically inspect to assure materials and equipment are undamaged and are maintained under required conditions.

END SECTION

TEMPORARY FACILITIES
01 50 00-2

SECTION 01 57 19

ENVIRONMENTAL PROTECTION MEASURES

PART 1 GENERAL

1.1 GENERAL

- A. The Contractor shall implement the environmental protection measures described in the following sections, excepting those measures specifically identified to be completed by the Owner.

1.2 NOISE

- A. The Project shall comply with the Turlock General Plan noise guidelines regarding construction

1.3 BIOLOGICAL RESOURCES

- A. Pre-construction Requirements/ Mitigation Requirements for Specific Species

1. Nesting Birds

- a. The Project's construction activities shall occur, if feasible, between September 16 and January 31 (outside of nesting bird season) in an effort to avoid impacts to nesting birds.
- b. If activities must occur within nesting bird season (February 1 to September 15), a qualified biologist shall conduct pre-construction surveys for active nests within 30 days prior to the start of construction. The survey shall include the proposed work area and surrounding lands within 0.5 mile. If no active nests are observed, no further mitigation is required. Raptor nests are considered "active" upon the nest-building stage.
- c. On discovery of any active nests near work areas, the biologist shall determine appropriate construction setback distances based on applicable CDFW and/or USFWS guidelines and/or the biology of the species in question. Construction buffers shall be identified with flagging, fencing, or other easily visible means, and shall be maintained until the biologist has determined that the nestlings have fledged.

1.4 CULTURAL RESOURCES

- A. Discovery of Archaeological and Human Remains:

- 1. In the event that archaeological resources are encountered at any time during development or ground-moving activities within the entire project area, all work in the vicinity of the find shall halt until a qualified archaeologist can

assess the discovery. The City shall implement all recommendations of the archaeologist necessary to avoid or reduce to a less than significant level potential impacts to cultural resource. Appropriate actions could include a Data Recovery Plan or preservation in place.

2. If human remains are uncovered, or in any other case when human remains are discovered during construction, the Stanislaus County Coroner is to be notified to arrange proper treatment and disposition. If the remains are identified—on the basis of archaeological context, age, cultural associations, or biological traits—as those of a Native American, California Health and Safety Code 7050.5 and Public Resource Code 5097.98 require that the coroner notify the NAHC within 24 hours of discovery. The NAHC would then identify the Most Likely Descendent who would determine the manner in which the remains are treated.

END SECTION

SECTION 02 01 20
PROTECTION OF UNDERGROUND
FACILITIES AND SURVEY MONUMENTS

PART 1 GENERAL

1.1 UNDERGROUND FACILITIES

- A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing underground facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such underground facilities, including Owner, or by others.
1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data; and
 2. The cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
 - a. Reviewing and checking all such information and data,
 - b. Locating all Underground Facilities shown or indicated in the Contract Documents,
 - c. Coordination of the Work with the owners of such underground facilities, including Owner, during construction, and
 - d. The safety and protection of all such underground facilities and repairing any damage thereto resulting from the Work.
- B. Not Shown or Indicated: If an underground facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated with reasonable accuracy in the Contract Documents, the following shall apply.
1. Contractor shall develop and execute a work-plan, subject to Engineer's approval to protect underground facilities.
 2. The Contractor shall expose, prior to staking and trenching, all existing utilities and existing facilities which may control proposed facility grades, and alignment. Two working days notice shall be given to the Engineer prior to commencing this work.
 3. Full compensation for all costs involved in locating, verifying, protecting, exposing, and otherwise providing for utilities shall be included in the amounts bid for the various items of work, and no separate payment shall be made therefore.

1.2 PROTECTION

- A. The Contractor shall not interrupt the service function or disturb the supporting base of any Utility by disrupting any facility identified in the Plans and Specifications without authority from the Owner or order from the Engineer. Where protection of such facilities is required to ensure support of utilities, the Contractor shall, unless otherwise provided, furnish and place the necessary protection at the Contractor's expense.
- B. The Contractor shall be prepared at all times with labor, equipment and materials to make repair on damaged mains or Utility facilities. The Contractor shall immediately notify the Engineer and the Utility owner if he disturbs, disconnects or damages any Utility. The Contractor shall bear the costs of repair or replacement of any Utility facility described with reasonable accuracy in the Plans and Specifications that is damaged by the Contractor. No extra compensation will be made for the repair of any services or mains damaged by the Contractor, nor for any damage incurred if the neglect or failure of providing protective barriers, lights and other devices or means required to protect such existing utilities or facilities described with reasonable accuracy in the Plans and Specifications.

1.3 SURVEY MARKERS AND PERMANENT REFERENCE POINTS

A. Surveying and Permanent Survey Markers

The Engineer will take measurements to assure the preservation of survey markers (monuments and bench marks). The Contractor shall not disturb permanent survey markers without the consent of Engineer and shall bear the expense of replacing any that may be disturbed without permission.

- 1. Replacement of survey markers shall be done only by the Engineer.
- 2. If disturbing of markers cannot be avoided, the Owner shall pay the cost of replacing said markers.

B. Lot Corner Monuments

The Contractor shall preserve property line and corner survey markers except where their destruction is unavoidable and the Contractor is proceeding in accordance with accepted practice. Markers that are lost or disturbed by his operations shall be replaced at the Contractor's expense by the Engineer.

END SECTION

SECTION 02 41 00

DEMOLITION

PART 1 GENERAL

1.1 DESCRIPTION

- A. The work of this section consists of demolition and removal of pavements, slabs, miscellaneous debris, signs, barriers, salvaged items, and portions of abandoned utilities.
- B. Definitions:
 - 1. Portland Cement Concrete: A mixture of Portland cement, fine aggregate, coarse aggregate, admixtures (if used) and water, proportioned and mixed. Also, included is rebar.
 - 2. Asphalt Concrete: A mixture of liquid asphalt and graded aggregate used as paving material for roadways and parking lots.

1.2 WORK INCLUDED

- A. Repair and restoration of areas damaged due to demolition work.
- B. Salvaging of equipment for Owner.
- C. Removal of demolished materials from site.
- D. Remove existing piping and other existing structures as shown on the Plans to be removed.
- E. Properly dispose of all removed materials.
- F. Dewatering as needed in order to complete the proposed demolition.
- G. Removal of trees and landscaping as required for construction.

1.3 RELATED WORK

- A. Section 17-2 – Clearing and Grubbing, State Standard Specifications
- B. Section 19 – Earthwork, State Standard Specifications

1.4 SEQUENCING

- A. Sequence work to minimize interference with water treatment facilities operation.

1.5 REGULATORY REQUIREMENTS

- A. All equipment that is demolished shall be reviewed by City staff for surplus prior to removal from site.
- B. Dispose of removed materials in an approved disposal or salvage facility.

1.6 REFERENCES

- A. Section 17-2 – Clearing and Grubbing, State Standard Specifications
- B. Section 19 – Earthwork, State Standard Specifications

1.7 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures
- B. Demolition plan including sequence of operations. The plan shall specifically address methods of demolition, schedule, sequence of demolition, and procedures for archeological monitoring. Demolition shall not proceed until the plan has been approved.

1.8 QUALITY ASSURANCE

- A. General: Take all necessary precautions with regard to safety in carrying out the demolition and site work. Erect suitable barriers around open excavations and fulfill all appropriate requirements of CAL/OSHA. Comply with safety requirements for demolition, ANSI A10.6-90.

1.9 PROJECT CONDITIONS

- A. Underground utilities exist at this site. Contractor shall take all necessary precautions to protect said utilities. Notify Engineer of any deviation in utility location from that which is shown on the drawings.
- B. Keep dust to a minimum at removal site and on haul roads. Use sprinklers or water trucks as necessary or as directed by the Engineer.
- C. Ensure safety of persons in demolition area. Provide temporary barricades as required.
- D. Excavations may encounter groundwater and require dewatering depending on the time of year and amount of seasonal run-off. Loose sands exposed in excavation sidewalls may be unstable and require shoring or lying back in accordance with OSHA requirements. Flowing sands may also be encountered in excavations below groundwater levels.

1.10 CLOSEOUT SUBMITTALS

- A. Show all capped and abandoned utility terminations and location of remaining facilities on project Record Drawings.

PART 2 PRODUCTS

2.1 REPAIR AND RESTORATION MATERIALS

- A. Concrete shall be as specified in Section 03 30 00 – Concrete Site Work.
- B. Backfill materials shall be as required by Section 19 – Earthwork, State Standard Specifications.
- C. Asphalt and concrete shall match existing materials and conditions.
- D. Asphalt and concrete shall be replaced in conformance with governing authority standards.

2.2 MATERIALS

- A. Salvaged Materials: Materials to be salvaged shall remain the property of the Owner and shall be stockpiled as directed by the Engineer. Contractor shall inventory all salvaged materials. Stockpiled materials shall be free of hazardous substances. Salvage materials include:
 - B. Items to be Salvaged and Relocated shall be salvaged and/or relocated as shown on the drawings, or as directed by the Engineer.
 - C. Materials and items demolished and not designated for reuse, salvage or transfer to the Owner, as well as all debris, rubbish and other materials resulting from the demolition operations, shall become the property of the Contractor and shall be removed from the site within 48 hours of demolition.
 - D. Storage or sale of the removed items will not be permitted at the site.

PART 3 EXECUTION

3.1 INSPECTION

- A. Prior to demolition, inspect the site conditions, verifying all governing dimensions, notes and specification. Notify the Engineer of any errors or omissions in the contract documents.
- B. Make such explorations and probes as are necessary to ascertain any required protection measures before proceeding with the demolition and removal work.

3.2 PREPARATION

- A. Protect existing, appurtenances, structures, which are not to be demolished.
- B. Prior to demolition work, all soil erosion control measures specified in Section 01 57 23 - Stormwater Pollution Prevention Plan (SWPPP) and inlet protection barriers shall be in place. Contractor shall provide appropriate measures to prohibit demolition debris and/or soil from entering any watercourse.

1. Protect all buildings, structures, utilities, and vegetation to remain.

3.3 DEMOLITION REQUIREMENTS

- A. Conduct demolition to protect and minimize damage to structures and existing improvements.
- B. Conduct salvaging to protect and minimize damage to salvaged equipment.
- C. Execute the work in a careful, orderly and safe manner, with the least possible disturbance to the public. Cease operations immediately if adjacent work appears to be endangered. Do not resume operations until corrective measures have been taken.
- D. Pavement and Slabs:
 1. Remove completely all Portland cement concrete slabs-on-grade including, but not limited to, equipment pads, sidewalks, etc. If approved by the Engineer, the Contractor may crush Portland concrete for use as aggregate base.
 2. Saw cut existing asphalt concrete pavements cleanly in straight continuous lines. Remove asphalt concrete pavement as shown on the drawings.
 3. Any material thus processed shall conform to the specifications for Section 32 11 23 – Aggregate Base.
 4. In areas that are demolished, but where no future roads or structures are shown, the exposed subgrade shall be scarified an additional 18 inches before placing backfill.
- E. Concrete and Masonry Structures: Remove structure to a minimum of 3 feet below grade. Break remaining portions to permit drainage. Remove completely if under proposed structures or roadways.
- F. Items to be Salvaged: Remove as directed by the Engineer. Remove carefully. All salvaged material remains the property of the Owner. Store where directed by the Engineer.
- G. Abandoned Utilities: Remove above ground utilities and terminate as approved by the utility company and the Engineer. Remove necessary portions of underground utilities to within 24 inches of excavation or final grade. Plug abandoned pipes and conduits with concrete plugs. Plugs shall be 6 inches or 2 times the pipe diameter in length, whichever is greater.
 1. Water lines shall be capped as close as possible to active mains.

3.4 *SALVAGE EQUIPMENT*

- A. Salvaged equipment shall be delivered to the Owner at a designated site within the project site. Salvaged equipment shall be placed on wood or concrete blocks so the equipment will be 4 inches minimum above ground elevation.
- B. Equipment to be salvaged at the treatment plant:
 - 1. All electrical panels, including breakers, contactors, disconnects, fuses, relays and switches.
 - 2. All threaded steel pipefittings 2 inch and larger.
 - 3. Gate and fencing materials that are to be reused and relocated.
- C. Electrical equipment items to be salvaged are covered in the electrical plans and specifications.

3.5 *ORDER OF WORK*

- A. Coordination will be required with the Owner for temporary shut-off of existing pipeline system for connection of new pipeline to existing pipelines and new chlorination connection. Contractor shall submit plans to Owner for approval for shut-off duration at least 10 days prior to shut-off.

3.6 *PRESERVATION*

- A. If indicated or required, preserve trees, plants, rock or other features designated to remain. Protect trees and plants from damage; fell trees in a manner which shall not injure standing trees, plants and improvements which are to be preserved.

3.7 *RESTORATION*

- A. All demolition areas, staging/stockpiling, and open excavations shall be filled in accordance with the Earthwork Sections. Fill all open excavations deeper than one foot to an elevation to match the surrounding topography.
 - 1. New Construction Areas: As shown on drawings.

3.8 *DISPOSAL*

- A. As specified in Section 01 50 00 – Temporary Facilities.

END SECTION

DEMOLITION
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SECTION 03 15 20
ANCHOR BOLTS AND POST-INSTALLED ANCHORS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work of this section consists of furnishing and installing all materials and equipment and providing all labor necessary to complete the work shown on the drawings and/or listed below and all other work and miscellaneous items not specifically mentioned but reasonably inferred for a complete installation, including all accessories and appurtenances required for a completed system.
- B. Cast-in-Place anchor bolts, anchor bolts and threaded rod anchors for epoxy grouting.
- C. Expansion anchors to be installed in hardened concrete.

1.2 RELATED WORK

- A. Section 03 30 00 – Cast-in-Place Concrete
- B. Section 05 50 00 – Fabricated Metal

1.3 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures.

1.4 GENERAL

- A. Unless otherwise specified or indicated on the drawings, all anchor bolts shall be cast-in-place bolts, shall have a diameter of at least 3/4 inch, and shall be headed and shall include a square washer a minimum of 1/4 inch thick and 2 inches square.
- B. Expansion anchors and threaded rod anchors indicated or accepted in lieu of cast-in-place anchor bolts for equipment or structural framing shall have a diameter of at least 3/4 inch and shall be ICC Evaluation Service Report listed.
 - 1. Unless otherwise specified or indicated on the drawings, or approved by the Engineer, all other expansion anchors shall have a diameter of at least 1/2 inch.

PART 2 MATERIALS

2.1 MATERIALS

- A. Nuts and washers for anchor bolts and expansion anchors shall be the same material as the bolts or anchors they are used with.

Application	Reference
A. Anchor Bolts and Nuts	
1. Carbon Steel	ASTM A307
2. Stainless Steel	IFI-104, Grade 304 or 316
3. Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.
B. Threaded Rod Anchors and Nuts	
1. Carbon Steel	ASTM F1554, Grade 55 with ASTM A563 nuts
2. Stainless Steel	ASTM 593 with ASTM F594 nuts
3. Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385
C. Flat Washers	ANSI B18.22.1; of the same material as anchor bolts and nuts.
D. Expansion Anchors	
1. For Concrete	Fed Spec FF-S-325; wedge type, Group II, Type 4, Class 1 or 2; self-drilling type, Group III, Type 1; or nondrilling type, Group VIII, Type 1 or 2; Hilti Kwik Bolt TZ2 ICC ESR-4622, Simpson Strong-Bolt 2 ICC ESR 3037, or ICC approved equivalent.
E. Adhesive Anchors	Hilti HIT RE-500 V3 ICC ESR 3814, ITW Red Head A7+ICC ESR 3903 or ICC approved equivalent.

- A. Anchor bolts, threaded rod anchors, expansion bolts and adhesive anchors for buried service, splash zones, and immersion service shall be stainless steel. Anchor bolts, threaded rods and adhesive anchors for exterior use shall be hot dipped galvanized. Zinc coated expansion anchors shall not be used for buried, splash zone, immersion or exterior service.

PART 3 EXECUTION

3.1 ANCHOR BOLTS

- A. Anchor bolts shall be delivered in time to permit setting before the structural concrete is placed. Anchor bolts which are cast in place in concrete shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or supporting template.
- B. Anchor bolts and threaded rod anchors which are to be epoxy grouted shall be clean and free of coatings that would weaken the bond with epoxy.
- C. Two nuts, a jam nut, and a washer shall be furnished for anchor bolts and threaded rod anchors indicated on the drawings to have locknuts; two nuts and a washer shall be furnished for all other anchor bolts.

- D. Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchor bolts and threaded rod anchors immediately before final installation and tightening of the nuts.

3.2 EXPANSION ANCHORS

- A. Expansion anchors shall be installed in conformity with the manufacturer's instructions and ICC Evaluation Service Report recommendations for maximum holding power, but in no case shall the depth of hold be less than four (4) bolt-hole diameters. The minimum distance between the center of any expansion anchor and an edge or exterior corner of concrete shall be at least four and one half (4-1/2) times the diameter of the hole in which the anchor is installed. Unless otherwise indicated on the Plans, the minimum distance between the centers of the expansion anchors shall be at least eight (8) times the diameter of the hole in which the anchors are installed.
- B. Anti-seize thread lubricant shall be liberally applied to threaded stainless steel components immediately before assembly.

3.3 ADHESIVE ANCHORS

- A. Adhesive anchors shall be installed in conformity with the manufacturer's instructions and ICC Evaluation Service Report recommendations. Anchors must be installed in holes drilled using carbide-tipped drill bits or diamond core drill bits. Should diamond core drill bits be used, the manufacturer's roughening tool must be used in conjunction with the bit.

END SECTION

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE (SITE WORK)

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Work required under this section consists of furnishing all materials, supplies, equipment, tools, transportation, and facilities, and performing all labor and services incidental to furnishing and installing concrete work as described in this section of the Specifications, shown on the accompanying Plans, or reasonably implied therefrom, except as hereinafter specifically excluded. The work shall include, but is not necessarily limited to:
1. All form work including special forms as required for any special construction and/or to accommodate the work of others and removal of forms.
 2. All concrete reinforcement, placement, bending and forming thereof.
 3. All concrete and cement finishing, all surface treatment and curing including non-slip finishes.
 4. Installation of all reglets, bolts, anchors, cans, sleeves, column bolts, etc., whether furnished under this section or by others.
 5. The furnishing of all items required to be or shown on the Plans as embedded in concrete, which are not specifically required under other sections.
 6. Setting headers and screens finishing, curing, and protecting concrete.
- B. Where prior inspection and test of materials are required, documentary evidence, in the form of test reports, shall be furnished prior to the time the material is incorporated into the work. All rejected material shall be promptly removed from the premises.

1.2 RELATED WORK

- A. Division 3 – Concrete
- B. Section 05 05 20 – Bolts, Washers, Anchors and Eyebolts
- C. Section 05 50 00 – Metal Fabrications
- D. Section 09 90 00 – Painting and Coating
- E. Division 10 – Specialties
- F. Division 31 – Earthwork
- G. Division 32 – Exterior Improvements

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H. Division 33 – Utilities

1.3 *REFERENCES*

- A. American Concrete Institute (ACI)
- B. American Society for Testing and Materials (ASTM)
- C. State Standard Specifications
- D. California Building Code (CBC)

1.4 *DEFECTIVE WORK*

- A. Work considered to be defective may be ordered, by the Engineer, to be replaced in which case the Contractor shall remove and replace the defective work at his expense. Work considered to be defective shall include, but not be limited to, the following:
 - 1. Concrete incorrectly formed, or not conforming to details and dimensions on the Plans or with the intent of these documents or concrete the surfaces of which are out of plumb or level.
 - 2. Concrete in which defective or inadequate reinforcing steel has been placed.
 - 3. Concrete containing wood, cloth, or other foreign matter, rock pockets, voids, honeycombs, cracks or cold joints not scheduled or indicated on the Plans.
 - 4. Concrete below specified strength.

1.5 *SUBMITTALS*

- A. Submittals shall be in accordance with Section 01 33 00 of these Specifications.
- B. Provide material certificates, mix designs including laboratory testing, shop fabrication and placement drawings, and schedule for all reinforcing steel, embedded items, form release and curing compounds.
- C. The Contractor shall provide a proposed concrete placement plan (to minimize the effects of cracking and differential settlement) to the Engineer, and gain approval of said plan, prior to ordering of reinforcing steel. As a minimum this plan shall contain the layout of horizontal and vertical construction joints, spaced no greater than 50 feet apart (unless specifically approved otherwise by the Engineer), and a pour schedule for the individual slab and wall pours.

PART 2 PRODUCTS

2.1 *CONCRETE*

- A. Concrete shall conform to Section 90 of the State Standard Specifications. Unless otherwise shown on the concrete note sheet or specified in other sections, all

CAST-IN-PLACE CONCRETE (SITE WORK)
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concrete shall conform to the following table of Portland cement mix requirements and minimum 28-day compressive strength. Portland cement shall be Type II.

Location	Mix Requirements
Paving, Exterior Slabs, and Sidewalks	3,000 PSI, F1, S0, W1, C1 (W/C Max 0.55)
Structural Footings and Interior Slabs	4,000 PSI, F0, S0, W1, C1
All Other Structural Concrete	4,000 PSI, F0, S0, W0, C0

1. Water/cement ratio shall not exceed 0.45 (by weight).
 2. Slump at placement shall be 4 inches +/- 1 inch.
- B. Concrete used for thrust blocks or for pipe encasement shall contain not less than 517 pounds of Type II Portland Cement per cubic yard of concrete (5 1/2 sack) with a slump of 4 inches +/- 1 inch.
- C. Slurry cement backfill used in lieu of compacted soil shall contain not less than 188-pounds of Type II Portland Cement per cubic yard of concrete (2 sack) and shall comply with Section 19-3.02E of the State Standard Specifications.

2.2 AGGREGATE

- A. Aggregate for normal weight concrete shall conform to Section 90-1.02C, "Aggregates" of the State Standard Specifications. Aggregates shall be free of dirt, clay balls, roots, bark and other deleterious substances and shall be thoroughly washed before use.
- B. The combined aggregates for concrete shall conform to the grading limits for the one-inch, maximum size specified in Section 90-1.02C(4)(d), "Aggregate Gradation" of the State Standard Specifications, Combined Aggregate Gradings.

2.3 WATER

- A. Water shall comply with Section 90-1.02D, "Water" of the State Standard Specifications, and shall be clean and free from injurious amounts of acids, alkalis, salts, oils, organic materials or other deleterious substances.

2.4 FLYASH

- A. Fly Ash: Shall comply with SSS Section 90-1.02B(3), "Supplementary Cementitious Materials", and shall comply with AASHTO M 295, Class F or N.
1. Type of fly ash shall be compatible with the type of cement and the intended use of the concrete.
- B. The combined weight of fly ash conforming to AASHTO M 295, Class F or N shall not exceed the amount provided for in Section 90-1.02B(3), "Supplementary Cementitious Materials" of the State Standard Specifications.

2.5 *ADMIXTURES*

- A. Admixtures shall comply with Section 90-1.02E, "Admixtures", of the State Standard Specifications
- B. Air Entraining: ASTM C260
- C. Water Reducing: ASTM C494, Type A, D or F
- D. Accelerating: ASTM C494, Type C or E
 - 1. No admixture containing any chloride ions is acceptable.
- E. Retarding: ASTM C494, Type B, D or G

2.6 *REINFORCING STEEL*

- A. Rebar shall be ASTM A615, Grade 60.
- B. Welded wire fabric shall conform to ASTM A1064.

2.7 *EXPOSED-TO-VIEW CONCRETE*

- A. For exposed-to-view concrete, where legs of metal supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class I).
- B. Metal bar supports in slab covers for sewage-containing structures shall also be provided with plastic coated legs.

2.8 *FORM MATERIALS*

- A. Exposed Concrete: Plywood complying with U.S. Plywood Standard PS-1 "BB (Concrete Form) Plywood" Class I, or better.
- B. Textured Finish Concrete: Units of face design, size arrangement and configuration to match control sample.
- C. Cylindrical Columns and Supports: Metal, fiberglass or waxed paper tubes of sufficient wall thickness to resist imposed loads without deformation.
- D. Form Release Agent shall leave behind a paintable concrete surface.
 - 1. Release #1, The Burke Co., or Engineer approved equivalent.

2.9 *CURING MATERIALS*

- A. Polyethylene film
- B. Reinforced waterproof paper
 - 1. Sisal Kraft, Orange Label, or approved equal.

- C. Liquid-membrane curing compound
 - 1. Curing compound shall comply with ASTM C309, Type 2.
 - a. White pigmented material
 - b. Clear pigment may be used for concrete that will be exposed to public view.

PART 3 EXECUTION

3.1 REINFORCING STEEL

- A. Comply with CRSI, "Placing Reinforcing Bars" and as specified herein.
- B. Place reinforcing steel and embedded items in accordance with approved shop drawings.
- C. Splicing of bars shall be by lapping. Lapped splices shall be 50 bar diameters for bar size through #6 and 62 bar diameters for larger bars, unless otherwise shown on the Plans.
- D. Splicing of the wire fabric shall be by lapping. Lapped splices shall be two full mesh, minimum.
- E. All rebar in vertical walls shall be supported by concrete block spacers or metal chairs.
- F. Prior to placement of the concrete, reinforcing steel shall be cleaned and free of all concrete, dirt, oil, mill scale, rust or other coatings that would reduce or destroy the bond.
- G. All reinforcing steel and embedded items shall be reviewed and approved by the Engineer prior to concrete placement.

3.2 FORMS

- A. All forms shall be cleaned and an approved agent applied each time they are used and shall be so constructed and set as to resist, without springing or settlement, the pressure of the concrete and the placing operations.
- B. In designing forms and falsework, the concrete shall be treated as a liquid weighing at least 150 lbs. per cubic foot for vertical loads and not less than 85 lbs. per cubic foot for horizontal pressure. The design of the forms and falsework system shall include allowances for temporary construction loads. The rate of placement of concrete shall be so regulated that the pressures caused by the wet concrete will not exceed the designed form pressure. The unsupported length of wooden columns and compression members shall not exceed 30 times the width of the least side.

- C. All forms shall be set and maintained in true alignment, grade and section until the concrete has sufficiently set. The interior surfaces of forms shall be adequately treated with an acceptable material to insure non-adhesion of mortar. All forms shall be mortar-tight. When forms appear to be unsatisfactory in any way, concrete placement shall be stopped until the defects have been corrected.
- D. All exposed outside corners, including the top edges of all walls, machinery bases and curbs shall have a 3/4-inch chamfer.
- E. Metal tie rods or anchorages within the forms shall be fitted with suitable cones or comparable devices. Metal tie rods or anchorages shall be removed to a depth of 1" from the surface without injury to the concrete. All fittings for metal ties shall be of such design that upon their removal, the cavities which are left will be of the smallest possible size, but of sufficient diameter to allow the cavity to be "dry packed" with cement mortar. The cavities shall be filled with cement mortar and the surface left sound, smooth and even.
- F. Form release agent shall be applied to the form so that no agent comes in contact with reinforcing steel.

3.3 PLACING

- A. All concrete shall be placed before it has taken its initial set and shall be placed in horizontal layers and in such a manner as to avoid segregation. The concrete adjacent to the forms and joints shall be thoroughly consolidated with a vibrator operating at not less than 4,500 vibrations per minute.
 - 1. Pumping equipment shall be of suitable type, without Y-sections, and with adequate pumping capacity.
 - 2. Loss of slump in pumping shall not exceed 1 1/2".
 - 3. Concrete shall not be placed through reinforcing that may cause separation of aggregates.
- B. The concrete shall be deposited as nearly as possible in its final position. Drop chutes and elephant trunks shall be used on drops greater than 5 feet. Concrete shall be placed at such a rate that all concrete in the same lift will be deposited on plastic concrete. The concrete comprising each unit of work shall be placed in a continuous lift.
- C. The Contractor shall notify the Engineer 24 hours (1 working day) prior to concrete placement.
 - 1. The form work and reinforcing steel placement shall be approved by the Engineer prior to ordering concrete.
- D. Form Removal. Minimum times for removal after concrete placement are as follows:

Beam sides but not shoring	3 days
Column forms and wall forms	2 days

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Forms for supported slabs but not shoring 14 days

E. Construction Joints

1. At ends of the first concrete pour, provide forms that positively locate any waterstop. Ensure the end forms of walls are removable without releasing the side forms. Provide seals around reinforcement and waterstop to prevent mortar leaks.
2. Overlap the hardened concrete of the first pour with forms for the second pour. Brace the ends of the forms against the hardened concrete to prevent joint offsets and mortar leakage. Align any exterior features required on the finished surface.

3.4 CONCRETE JOINTS

A. General

1. Provide joints:
 - a. As shown on the Drawings and as noted below in these Specifications.
 - b. As required for constructability
 - c. After favorable review of layout, sequence and concrete placement program.
2. Provide minimum curing times before the second placement:
 - a. 2 days after the first concrete placement at the joint.
 - b. 10 days after each adjacent concrete placement, for infill pours or checkerboard placement pattern.

B. Control Joints:

1. Space typical control joints in slabs on grade or suspended slabs not exceeding 10 feet, or as shown on the Drawings. Control joints shall not be provided in water containment structures.
2. If cast-in with the concrete, positively locate the preformed joint filler and hold rigidly in place during concreting.
3. If saw-cut, use a wheeled power saw as soon as the concrete surface is firm enough. Saw-cut control joints must be constructed within 8-hours after concrete placement. Fill the groove with sealant over a backer rod.

C. Construction Joints:

1. Produce quality concrete, with full continuity of reinforcing and water tightness across the joints.

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03 30 00-7

2. Space typical slab joints not exceeding 20 feet in the direction of the transverse or secondary reinforcing, typically the smaller reinforcing nearer to the center of the slab thickness. Space typical vertical wall joints no more than 30 feet apart.
 3. After the first concrete placement at the joint, do not walk on or disturb any reinforcing extending into the second placement area for at least 48 hours.
 4. Before depositing new concrete on or against concrete that has hardened, clean and roughen the entire surface of the joint exposing clean coarse aggregate solidly embedded in mortar matrix. Provide typically 1/4-inch roughness or amplitude of the concrete surface measured from the top of the exposed aggregate to the bottom of pockets between stones.
 5. Drench the prepared joint with clean water and remove prior to the concrete pour.
 6. Cover horizontal wall joints and wall-to-slab joints with a minimum thickness of 2 inches and a maximum of 6 inches of the modified concrete mix, consisting of the designated concrete mix with one-half of the coarse aggregate removed.
 7. Use special care in vibrating adjacent to construction joints to ensure thorough consolidation of the concrete against the hardened portion of the joint. Additional hand tamping may be required.
 8. For joints that are shown on architectural drawings as having a continuous reveal or recess, leave the wood form or pour strip used to create the reveal or recess in place or re-insert before roughening. Prevent the next concrete placement from filling the reveal or recess.
- D. Expansion Joints
1. Stop all steel reinforcing clear of the joint at each side.
 2. Prepare a smooth first concrete surface with all voids filled.
 3. Provide preformed joint filler, securely fastened to the existing concrete as directed by the Manufacturer.
 4. Install bond breaker and sealant after curing is completed and when directed.
- E. Bonding to Pre-existing Concrete: Mechanically roughen the old surface to a 1/4-inch amplitude, as defined in construction joint paragraph above. Apply epoxy bonding material prior to concreting, as recommended by the manufacturer.

3.5 CONCRETE CURING

- A. Exposed concrete surfaces shall be protected from premature drying by covering as soon as possible with canvas, plastic sheets with sealed joints, burlap, sand or other satisfactory materials and kept continuously moist; or, if the surfaces are not covered, they shall be kept continuously moist by flushing or sprinkling.

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1. Curing shall continue for a period of not less than 7 days after placing the concrete. If curing compound is used, two (2) applications will be made for even coverage. Curing methods must be approved by the Engineer.

3.6 FINISHING

- A. Defective and honeycombed surfaces shall be chipped back to such a depth to expose solid concrete. The surface shall be dampened and coated with a bonding agent and packed with mortar.
- B. Concrete Finishes for Vertical Wall Surfaces:
 1. Form facing material shall produce a smooth, hard, uniform texture.
 - a. Use forms specified for surfaces exposed to view in accordance with the Plans and other Specification Sections.
 2. At a minimum, repair the following surface defects:
 - a. Tie holes
 - b. Honeycombs deeper than $\frac{1}{4}$ "
 - c. Air pockets deeper than $\frac{1}{4}$ "
 - d. Rock holes deeper than $\frac{1}{4}$ "
 - e. Scabbing
 3. Chip or rub off fins exceeding $\frac{1}{8}$ " in height.
 4. Provide SF/ESF 3.0 finish and a smooth-rubbed finish for:
 - a. Walls being waterproofed, painted, coated with some other material.
 - b. Use at all exposed surfaces not specified to receive another finish.
- C. Related Uniform Surfaces (Except Slabs):
 1. Strike smooth tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
 2. Float surface to a texture consistent with that of formed surfaces.
 3. Continue treatment uniformly across unformed surfaces.
- D. Concrete Finishes for Horizontal Slab Surfaces:
 1. General: Tamp concrete to force coarse aggregate down from surface. Scream with straightedge, eliminate high and low places, bring surface to

required finish elevations; slope uniformly to drains. Dusting of surface with dry cement or sand during finishing processes not permitted.

2. Slab Finish shall be as follows:
 - a. Surfaces intended to receive damp proofing or water proofing membranes: Float finish.
 - b. Floors intended to receive floor coverings and MCC rooms: Trowel finish.
 - c. Sidewalks, garage floors, drive-throughs and ramps: Broom finish.
 - d. Exterior slabs, platforms, steps and landings, exterior and interior pedestrian ramps and interior stairs and all process equipment areas, not covered by other finish materials: Broom finish.
3. Deviation in finish surface shall not exceed $\frac{1}{4}$ " in 10 ft.
4. No tolerance will be allowed that will result in the maximum running, or cross, slope exceeding the requirements of the Americans with Disabilities Act.

3.7 TESTING

- A. Testing of concrete shall be as required by the Engineer and in accordance with ACI 301, Chapter 1.6.
 1. All costs of initial testing will be paid by the Owner unless otherwise noted.
 2. All costs involved, including those required by the Engineer, in retesting of concrete required because of a failure to meet these Specifications shall be at the expense of the Contractor.

3.8 WATERTIGHTNESS OF CONCRETE WORK

- A. It is the intent of this Specification to obtain concrete and grout with homogenous structure, which when hardened will have the required strength, is watertight, and resistance to weathering.

END SECTION

CAST-IN-PLACE CONCRETE (SITE WORK)
03 30 00-10

SECTION 03 33 15
CONCRETE WALKS, CURBS, GUTTERS AND DRIVEWAYS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work of this section consists of constructing on-site concrete flatwork, walks, drive approaches, curbs, and gutters.

1.2 RELATED WORK

- A. Section 03 30 10 - Concrete Site Work
- B. Section 31 23 00 –Earthwork

1.3 REFERENCES

- A. Section 40 – Concrete Pavement, State Standard Specifications
- B. Section 90 –Concrete, State Standard Specifications
- C. ASTM C172 – Sampling Fresh Concrete
- D. California Test 540 – Method for Making, Handling and Storage of Concrete

1.4 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures.

1.5 QUALITY ASSURANCE

- A. Concrete testing will be the responsibility of the Owner. All costs of initial testing will be paid by the Owner unless otherwise noted. All costs involved in retesting of concrete required because of a failure to meet these Specifications shall be at the expense of the Contractor, including those required by the Engineer.
- B. The Contractor shall cooperate by rerouting equipment or by temporarily closing the work area being tested.

1.6 PROJECT CONDITIONS:

- A. Place concrete only when temperatures are above 35 degrees F, unless it is protected from freezing and approved in advance by the Engineer.

PART 2 PRODUCTS

2.1 CONCRETE

- A. Materials: Materials, including cement, aggregates, water, and admixtures, shall meet the requirements of Section 90 of the State Standard Specifications.
 - 1. Cement: Type II.
 - 2. Coarse Aggregate: Maximum size, 1-inch for hand methods, 3/4-inch for slip-form construction, and 1/2-inch for extruded curbs. For machine placed concrete, Contractor may, with Owner's approval, modify the aggregate grading specified to meet the recommendations of the manufacturer of the machine.
- B. Slump:
 - 1. Concrete Walks: Maximum 4 inches.
 - 2. Curbs and Gutter:
 - a. Hand Vibrated: Maximum 3 inches.
 - b. Slip-Formed: Maximum 2 inches.
- C. Strength: 4,000 psi for concrete pavements and drive approaches and valley gutters and 3,000 psi for site flatwork, sidewalks, curbs and gutters at 28 days.
- D. Manufacture and Delivery: Measurement of materials, batching, mixing, transporting, and delivery shall be as specified in ASTM C94. Discharge concrete into forms within 1-1/2 hours after introduction of water to cement. When temperature of concrete is 85 degrees F or above, the time between introduction of water to cement and complete discharge of concrete into forms shall not exceed 45 minutes.
- E. Air Entraining Admixture: ASTM C260.
- F. Other admixtures complying with ASTM C494 or ASTM C618 may be used with approval of Engineer. No chlorides will be permitted.

2.2 EXPANSION JOINT FILLERS

- A. ASTM D994, preformed bituminous type, 1/2-inch thick.

2.3 SURFACE RETARDANT

- A. Rugasol S, manufactured by Sika Chemical Corporation, Lyndhurst, New Jersey, Top Stop by WR Meadows, or approved equal.

2.4 CURING COMPOUND

- A. In accordance with Section 90 of the State Standard Specifications.

CONCRETE WALKS, CURBS, AND GUTTERS
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2.5 CURING MATERIAL

- A. Waterproof paper, polyethylene sheet, clean burlap, cotton mats, or other approved material that will not cause stain or discoloration.
- B. Using curing compound or curing materials, thoroughly cure and protect concrete keeping the surface moist for 7 days. Cure slabs with integral color in accordance with instructions of the pigment manufacturer. On exposed aggregate slabs or slabs with integral color, do not use polyethylene or paper sheeting.

PART 3 EXECUTION

3.1 PREPARATION OF SUBGRADE

- A. Excavate to required depth. Remove soft, yielding material and replace with select fill. Scarify and compact subgrade soils to a density of not less than 95 percent of the maximum dry density.

3.2 MAINTENANCE OF SUBGRADE

- A. Maintain subgrade in a compacted condition until concrete is placed.

3.3 FORMS

- A. Metal or uniform warp-free lumber, coated with form release agent. Grade forms to give slabs positive drainage and stake securely. Obtain approval of alignment and grade before placing concrete.

3.4 PLACING

- A. Concrete slabs for walks shall be formed, placed, vibrated, and finished by hand using conventional methods. Concrete curbs or curbs and gutters may be constructed in the same manner, but Contractor has the option of machine placing curbs using the extrusion method or machine placing curb and gutter using the slip-form method.
- B. Place concrete on moistened subgrade monolithically between construction joints. Deposit to full depth in one operation. Consolidate immediately. After depositing concrete, screed and darby or bullfloat.

3.5 FORM REMOVAL

- A. Remove forms within 24 hours after concrete placement. Repair minor defects with mortar. Plastering will not be permitted on exposed faces.

3.6 SLAB FINISHING

- A. After darbying or bullfloating, stop finishing until bleeding has ceased and until concrete can support foot pressure with only about 1/4-inch indentation. Edge and joint, then float the slab. Use steel trowel to densify surface, then broom slab perpendicular to line of traffic.

3.7 EXPOSED AGGREGATE FINISHING

- A. Clean and thoroughly wet surface aggregate before use and drain to prevent free water from entering the concrete.
- B. Evenly distribute aggregate by hand, covering surface with a single layer.
- C. Embed the surface aggregate by patting with the flat side of a strike-off board or another tool.
- D. When surface is firm, lightly hand float with a float or darby.
- E. Spray retardant on the surface according to manufacturer's recommendations.
- F. When the concrete has set up sufficiently, expose aggregate by simultaneously brushing and flushing with water without overexposing or dislodging the aggregate. Expose aggregate to a depth of 1/8 to 1/4 inch.

3.8 JOINTS

- A. Construct joints true to line with faces perpendicular to surface.
 - 1. Isolation Joints: Separate walks from walls, stairways, and other structures, using expansion joint fillers.
 - 2. Contraction (Control) Joints: Space joints at intervals about equal to width of walk to a depth of one-fourth the slab thickness. Space curb and gutter joints not over 12 feet 6 inches on center and align them with sidewalk joints. Contraction joints may be either sawn or tooled.
 - a. Sawn: Cut with a power saw fitted with an abrasive or diamond blade within 4 to 12 hours after walk has been placed and finished. Use sawn joints on exposed aggregate.
 - b. Tooled: Form plane of weakness by inserting and later removing a metal divider, finish with an edger or a groover, or by saw cutting a previously tooled joint.

3.9 SIDEWALK RESTORATION

- A. Where sections of miscellaneous sidewalk work require removal and restoration the following shall apply:
 - 1. The surface of the sidewalk shall match the existing weakened plane joints, score joints and construction joint patterns with the adjoining sidewalks or City or County standards.
 - 2. Where short sections of sidewalk have been removed for replacement, a minimum distance of three (3) feet section of sidewalk shall be removed or as directed by the Engineer.

3. If curbs and gutters cannot be cut off square and neat, the entire curb and gutter shall be removed to the nearest weakened plane or expansion joint. No patching at joints will be permitted.

3.10 *FIELD QUALITY CONTROL*

- A. Surfaces shall not vary more than 5/16 inch when tested with a 10-foot straightedge, nor curb gutters and valley gutters shall not vary more than .03 feet from design grade.

END SECTION

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SECTION 04 22 00
CONCRETE BLOCK MASONRY

PART 1 GENERAL

1.1 WORK INCLUDED

- A. All concrete block masonry and related items necessary and required to complete the work as indicated in the Contract Documents.
- B. All labor, materials, equipment, and incidentals necessary and required for their completion.

1.2 RELATED WORK

- A. Division 3 Concrete

1.3 REFERENCES

- A. American Concrete Institute (ACI)
- B. American Society for Testing and Materials (ASTM)
- C. Section 58 – Sound Walls, State Standard Specifications
- D. California Building Code (CBC)

1.4 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures.

1.5 TESTS AND SAMPLES

- A. Tests of mortar and grout shall be made in accordance with the requirements of Section 1705.4, California Code of Regulations, Title 24, Part 2, by an independent laboratory selected by the Owner.
- B. QA shall be performed to a minimum of QA Level 2.
- C. Testing and sampling shall be coordinated by the Contractor, and copies of test reports shall be submitted to the Engineer.
- D. Cost of initial testing shall be borne by the Owner, any re-testing shall be charged to the Contractor, including time for the Engineer.

PART 2 PRODUCTS

2.1 CONCRETE BLOCK

- A. Concrete block shall be lightweight concrete masonry units as manufactured by Blocklite Company, or Engineer approved equivalent. Units shall be lightweight

CONCRETE BLOCK MASONRY
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conforming to ASTM C90 and shall have a maximum linear shrinkage of .06 percent from the saturated to the oven-dry condition.

1. Units shall be as indicated on the Plans.
 2. Concrete block colors to be a standard color as selected by Owner
- B. Bars for reinforcement shall be ASTM A706 Grade 60.

2.2 MORTAR

Mortar materials shall comply with Section 58-2.02C, "Mortar", of the State Standard Specifications as follows:

- A. Portland Cement: Cement shall conform to ASTM C150, Type II.
- B. Lime: Hydrated Lime shall be Type S or Type N, conforming to ASTM C207. Quicklime shall conform to ASTM C5. It shall be slaked in accordance with the manufacturer's directions.
- C. Lime Putty: Putty shall be a stiff mixture of lime and water. Keep putty moist until used. Putty made from quicklime shall be slaked and allowed to soak at least 24 hours before using. Putty made from Type S hydrated lime may be used immediately after mixing. All resulting lime putty shall weigh not less than 83 pounds per cubic foot.
- D. Sand & Pea Gravel: Sand for mortar shall conform to the "Standard Specifications for Aggregate for Masonry Mortar", ASTM C144", except that not less than 3 percent of the sand shall pass the number 100 sieve. Sand and pea gravel for grout shall conform to the requirements of the CBC, and be well graded.
- E. Cement Admixtures: Mortar containing admixtures shall comply with ASTM C270.
- F. Water: Used for mortar and grout shall be clean and free from deleterious amounts of acids, salts, alkalis, or organic materials.

2.3 GROUT

- A. Grout shall comply with Section 58-2.02D, "Grout", of the State Standard Specifications as follows:
- B. Cementitious material shall comply with Section 90-1.02B of the State Standard Specifications.
- C. Grout shall have a minimum of 550 pounds of cementitious material per cubic yard as well as a minimum 28 day compressive strength of 2,000 psi or masonry design strength whichever is greater.
- D. Water: Used for mortar and grout shall be clean and free from deleterious amounts of acids, salts, alkalis, or organic materials.

2.4 STORAGE OF MATERIALS

Store materials under cover in a dry place and in a manner to prevent damage or intrusion of foreign matter. During freezing weather protect all masonry units with tarpaulins or other suitable material. Store concrete masonry units under covers that will permit circulation of air and prevent excessive moisture absorption. Store cement, lime and air-setting mortars in water-tight sheds with elevated floors. Protect reinforcement from the elements; immediately before placing, reinforcement shall be free from loose rust, ice or other foreign coatings that will destroy or reduce the bond. Concrete masonry units shall be protected against wetting prior to use.

2.5 MORTAR AND GROUT MIXES

- A. Mortar shall be composed of one-fourth to one-half part hydrated lime, one part Portland Cement and the sand shall not be more than two and one-quarter to three times the sum of the separate volumes of cementitious material based on damp loose volumes.
 - 1. The minimum compressive strength at 28 days shall be at least 1,800 psi.
- B. Grout shall consist of one part portland cement to not more than three parts sand. Sufficient water shall be added to grout to cause it to flow into all joints of the masonry. Where practicable, pea gravel may be added to the grout in approved amounts to make a workable mix, but the combined mix shall not exceed 1:3:2.
 - 1. Grout shall attain a minimum compressive strength of 2,000 lbs. per square inch but not less than the minimum compressive strength of masonry at 28 days.

PART 3 EXECUTION

3.1 MIXING OF MORTAR AND GROUT

- A. Measurements: Materials for mortar and grout shall be accurately measured in suitable calibrated devices. Shovel measurements will not be acceptable. Ninety-four pounds of Portland Cement (one sack) shall be considered as one cubic foot.
- B. Mixing of Mortar or Grout: The sand, cement and water shall be placed in the mix in that order for each batch of mortar or grout and shall be mixed for a period of at least two minutes, the lime shall then be added and mixing continued as long as needed to secure a uniform mass, but in no case less than 10 minutes. Equipment for mixing and handling mortar and grout shall be acceptable to the Engineer.
 - 1. Mixers of at least one-sack capacity shall be used. Batches requiring fractional sacks will not be permitted unless the cement is weighed for each such batch. Retempering by dashing water over the mortar shall not be permitted. Any mortar or grout which is unused within one hour after the initial mixing shall be removed from the work. Mortar shall be mixed and maintained on the boards to a slump of 2-3/4", plus or minus one-quarter inch, using a truncated cone 4" x 2", 8" high.

3.2 PRECAUTIONS AND GENERAL REQUIREMENTS

- A. Do not lay masonry when the temperature of the outside air is below 40°F, unless suitable means as approved by the Engineer are provided to heat materials, protect work from cold and frost and insure that mortar will harden without freezing. No anti-freezing ingredient shall be used in the mortar.
- B. Protect facing material against staining, and keep tops of wall covered with non-staining waterproof coverings when work is not in progress. When work is resumed, top surface of work shall be cleaned of all loose mortar.
- C. Before closing up any pipe, duct or similar inaccessible spaces or shafts with masonry, remove all rubbish and sweep out the area to be enclosed.
- D. Provide level and solid bearing in masonry walls directly under poured concrete slabs, structural steel beams, trusses, and steel joists. Solid bearing shall be of sizes and thickness indicated.
- E. Where fresh masonry joins masonry that is partially set or totally set, clean the exposed surface of the set masonry so as to obtain the best possible bond with the new work. Remove all loose block and mortar. If it is necessary to "stop off" a horizontal run of masonry, this shall be done by racking back one-half block length in each course.
- F. Consult other trades and make provisions that will permit the installation of their work in a manner to avoid cutting and patching. Build in work specified under other sections, as necessary, and as the work progresses.

3.3 LAYING CONCRETE MASONRY UNITS

- A. Set units plumb and true to line. All units shall be laid with level horizontal joints. Except where specified or shown otherwise, units shall be laid in "running or stacked" or other bond as indicate on Drawings.
- B. Finish joints by tooling to dense, concave condition.
- C. Where electric conduits, outlet and switch boxes occur, grind and cut units before building-in services. Coordinate work with other trades. Cutting of all units exposed in finished work shall be done with an approved type of power saw.
- D. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Make joints uniform, approximately 3/8 inch thick unless indicated otherwise.
- E. All units shall be fully grouted.
- F. Make provision for all units as may be required to form all offsets and maintain a proper pattern throughout the length of the wall.
- G. Provision shall be made for the installation of bolts, anchors, wall plugs and frames, as required.

- H. Contractor shall coordinate the masonry work with other trades.

3.4 *GROUTING*

- A. The methods and procedures for grouting shall conform to the requirements Chapter 21 of the CBC (Current Edition).
- B. No grout shall be placed until the mortar has set and cured two days minimum.
- C. Under normal weather conditions with typical masonry units the individual lifts of grout shall be limited to four feet in height with a waiting period between lifts of thirty to sixty minutes.
- D. Succeeding lifts shall be poured and alternate cells vibrated twelve to eighteen inches into preceding lift.
- E. The top lift shall also be reconsolidated after the required waiting period and any space left by settlement shrinkage filled with grout.

3.5 *FOUNDATIONS*

- A. The contact surfaces of all foundations and floors that are to receive masonry work shall be cleaned and roughened before start of laying. It shall be protected during construction to insure a good bond between the grout fill and the concrete surface.

3.6 *CLEANOUTS*

- A. Cleanout openings shall be provided through block faces for all cells at the bottom of each pour. The openings shall be made by removing the face shell of the bottom block for the entire length and height of each block unit.
- B. One inch layer of clean sand, placed on top of preceding pour after course with cleanouts is laid, shall be used to prevent mortar droppings from adhering to bearing surface below.
- C. After the laying of masonry units is completed, the cells cleaned, the reinforcing positioned and inspection completed, the cleanouts shall be closed by inserting face shells of masonry units. Face shell plugs shall have a minimum curing time of two days and shall be adequately braced to resist the pressure of the fluid grout.

3.7 *REINFORCEMENT*

- A. All reinforcing steel shall be accurately placed in strict accordance with the approved Plans and Specifications. Both horizontal and vertical reinforcing shall be held in position by wire ties or spacing devices near ends and of intervals not exceeding 160 diameters of the reinforcement.
- B. The horizontal reinforcing shall be placed as the work progresses and the vertical reinforcing may be dropped into position after the completion of the laying if adequate positioning devices are provided to hold the reinforcement at proper intervals.

3.8 MASONRY UNITS

- A. Use of open-end concrete masonry is preferred wherever possible and is required for stacked bond. Bond beams shall be used at horizontal bars to provide a minimum opening at all cross webs one and one-half inches high for the width of the cell.

3.9 LAYING

- A. All head and bed joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Care shall be taken in placing the mortar to keep a minimum of droppings from falling into the block cells. Open-end units used in stacked bond shall be arranged so the closed ends are not abutting.

3.10 WALL TIES AND BRACING

- A. When stacked bond is used or when adequate cross webs between face shells are not provided, ties of heavy gauge wire embedded in the horizontal mortar joints shall be provided across continuous vertical joints or between face shells to prevent "blow-outs" due to the hydrostatics pressure of the fluid grout. External ties or braces may also be used for this purpose.
- B. During construction, the ungrouted walls shall be adequately braced against wind and other forces.

3.11 MORTAR DROPPINGS AND OVERHANGS

- A. All mortar droppings and overhangs shall be removed from the foundation or bearing surface, cell walls, and reinforcing.
- B. Acceptable methods are by hosing with a jet stream at least twice a day (at mid-day and quitting time) or by dislodging any hardened mortar from the cell walls and reinforcing with a pole or rod and removing the mortar debris from the bottom of the cells prior to grouting.

3.12 CONSTRUCTION JOINTS

- A. Intermediate horizontal construction joints are not permitted.
- B. The section of wall to be grouted in any one pour shall be limited to a length in which successive lifts can be placed within one hour of the preceding lift.

3.13 CURING

- A. The concrete block work and top grout pour should be kept damp to prevent too rapid drying during hot or drying weather, and drying winds.

3.14 POINTING AND CLEANING MASONRY

- A. Point all holes in exposed masonry. Cut out defective joints and repoint them with mortar.

- B. Acid solutions shall not be used for cleaning concrete masonry units. Metal cleaning tools and brushes, or abrasive powders shall not be used.
- C. Clean all loose mortar and remove all stains from the exposed surfaces of the concrete masonry units.

3.15 *CLEANUP*

- A. All rubbish and/or debris resulting from the operation of this trade shall be cleaned up and removed from the site as the work progresses, and disposed of in a legal manner.

END SECTION

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SECTION 05 05 20
BOLTS, WASHERS, ANCHORS AND EYEBOLTS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section describes materials and installation of anchor bolts, connecting bolts, washers, drilled anchors, epoxy anchors, screw anchors, eyebolts, and stainless steel fasteners.

1.2 DESIGN CRITERIA

- A. Structural Connections: AISC Specification for Structural Steel Buildings (June 22, 2010), except connection details are shown in the Drawings.

1.3 REFERENCES

- A. American Institute of Steel Construction (AISC)
- B. American Society for Testing and Materials (ASTM)
- C. Research Council on Structural Connections (RCSC)

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00 – Submittals.
- B. Submit manufacturer's catalog data and ICC Evaluation Service Reports for bolts, washers, and concrete anchors. Show dimensions and reference materials of construction by ASTM designation and grade.
- C. Submit anchor bolt layout drawings.

PART 2 PRODUCTS

2.1 GENERAL

- A. Anchor bolts, drilled anchors and epoxy anchors for buried service, immersion service and in splash zones shall be stainless steel. All other anchor bolts, drilled anchors and epoxy anchors shall be galvanized steel unless otherwise specified on the Plans.

2.2 ANCHOR BOLTS

- A. Steel anchor bolts shall conform to ASTM F1554, Grade 36, Class 1A or 2A unless otherwise indicated. Size, length and thread length shall be as shown on the Drawings.

- B. Bolts shall be provided with a head and two washers of a minimum of ¼ inch thick and 2 inches square. One washer shall be embedded in the concrete at the head of the bolt.
- C. Anchor bolts, nuts and washers shall be galvanized per ASTM F2329.

2.3 CONNECTION BOLTS

- A. Steel connection bolts shall conform to ASTM A325, Type 1 with the threads included in the shear plane.
- B. Provide galvanized bolts where shown in Drawings. Galvanizing of bolts, nuts, and washers shall be in accordance with ASTM F2329.

2.4 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall be ASTM A193, Grade B8 or ASTM F593, Type 316. Nuts shall be ASTM A194, Grade 316 or ASTM F594, Type 316. Use ASTM A194 nuts with ASTM A193 bolts; use ASTM F594 nuts with ASTM F593 bolts. Provide washer for each nut and bolthead. Washers shall be of the same material as the nuts.

2.5 LUBRICANT FOR STAINLESS STEEL BOLTS AND NUTS

- A. Lubricant shall be chloride free and shall be RAMCO TG-50, Anti-Seize by RAMCO, Huskey™ Lube-O-Seal by HUSK-ITT Corporation, or equal.

2.6 WASHERS

- A. Washers for bolts conforming to ASTM F1554 shall conform to ASTM F436, Type 1.
- B. Washers for bolts conforming to ASTM A307 shall conform to ASTM F844.
- C. Washers for bolts conforming to ASTM A325 shall be square or rectangular, tapered in thickness, smooth, hot-dipped galvanized, conforming to ASTM F436.
- D. Stainless steel washers shall be Type 316.

2.7 DRILLED ANCHORS

- A. Unless otherwise indicated in the Drawings, drilled anchors shall be 316 stainless steel wedge anchors as manufactured by ITW Red Head Trubolt+, Kwik Bolt TZ by Hilti, or equal. Anchors shall have ICC-approved testing.

2.8 EPOXY ANCHORS

- A. Epoxy anchors in concrete shall be 316 stainless steel threaded rod adhesive anchors. Adhesive shall be ITW Red Head Epcon S7, Hilti HIT RE 500-SD, or equal. Epoxy anchor assemblies shall be ICC approved.
- B. Epoxy anchors in grouted concrete masonry walls shall be 316 stainless threaded rods. Epoxy adhesive shall be Hilti HIT HY 70, Simpson ET-HP, or equal.

PART 3 EXECUTION

3.1 STORAGE OF MATERIALS

- A. Store material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.2 GALVANIZING

- A. Zinc coating for bolts, anchor bolts, and threaded parts shall be in accordance with ASTM F2329.

3.3 INSTALLING CONNECTION BOLTS

- A. Use steel bolts to connect structural steel members. Use stainless steel bolts to connect structural aluminum members.
- B. Install ASTM A325 bolts and washers per the RCSC "Specification for Structural Joints Using High Strength Bolts".
- C. Bolt holes in structural members shall be 1/16 inch in diameter larger than bolt size. Measure cast-in-place bolt locations in the field before drilling companion holes in structural steel beam or assembly.
- D. Slotted holes, if required in the Drawings, shall conform to AISC 360-10, Chapter J, Section J3, Table J3.3.
- E. Drive bolts accurately into the holes without damaging the thread. Protect boltheads from damage during driving. Boltheads and nuts or washers shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, provide beveled washers to give full bearing to the head or nut. Where self-locking nuts are not furnished, bolt threads shall be upset to prevent the nuts from backing off.
- F. Bolts shall be of the length that will extend entirely through but not more than 1/4 inch beyond the nuts. Draw boltheads and nuts tight against the work.

3.4 INSTALLATION OF STAINLESS STEEL BOLTS AND NUTS

- A. Prior to assembly, coat threaded portions of stainless steel bolts and nuts with lubricant.

3.5 INSTALLING ANCHOR BOLTS

- A. Anchor bolts shall be delivered in time to permit setting before the structural concrete is placed. Anchor bolts which are cast in place in concrete shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or supporting template.
- B. Preset bolts and anchors by the use of templates. Do not use concrete anchors set in holes drilled in the concrete after the concrete is placed for mechanical equipment.

BOLTS, WASHERS, ANCHORS AND EYEBOLTS
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Anchor bolts and threaded rod anchors which are to be epoxy grouted shall be clean and free of coatings that would weaken the bond with epoxy.

- C. Two nuts, a jam nut, and a washer shall be furnished for anchor bolts and threaded rod anchors indicated on the drawings to have locknuts; two nuts and a washer shall be furnished for all other anchor bolts.
- D. Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchor bolts and threaded rod anchors immediately before final installation and tightening of the nuts.
- E. For static items such as storage tanks, use preset anchor bolts or drilled anchors with ICC report data.
- F. After anchor bolts have been embedded, protect projecting threads by applying grease and having the nuts installed until the time of installation of the equipment or metalwork.

3.6 *INSTALLING DRILLED ANCHORS*

- A. Minimum depth of embedment of drilled mechanical anchors shall be as recommended by the manufacturer, but no less than that shown in the Drawings.
- B. Prepare holes for drilled anchors in accordance with the anchor manufacturer's recommendations prior to installation.

3.7 *INSTALLING EXPOXY ANCHORS*

- A. Epoxy anchors shall be clean and free of coatings that would weaken the bond with epoxy.
- B. Minimum depth of embedment of epoxy anchors shall be as recommended by the manufacturer, but no less than that shown in the Drawings.
- C. Prepare holes for epoxy anchors in accordance with the anchor manufacturer's recommendations prior to installation.

END SECTION

SECTION 05 50 00
FABRICATED METAL

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Provide metals work for fencing, bearing plates for pumps, and other miscellaneous metal works, complete as indicated, specified and required.
1. Steel channel and/or angle frames and thresholds with anchors
 2. Handrails, guardrail, stairs and platform
 3. Grating
 4. Pipe supports with saddles, hangers, bracing and attachments as detailed and required, except as provided by other trades.
 5. Guard post assemblies for removable and stationary types
 6. Miscellaneous iron and steel items indicated, specified, or required for completion of the Work, unless included under other Sections of the Specification
 7. Miscellaneous connections, anchors, bolts, clips, spacers, nuts, washers, shapes and inserts, as required.
 8. Galvanizing, shop primer finishes for work of this Section as specified or required, including field touchups.

1.2 RELATED WORK

- A. Section 03 15 20 – Anchor Bolts and Post-Installed Anchors
- B. Section 03 30 00 – Cast-In-Place Concrete
- C. Section 09 90 00 – Painting and Coating

1.3 REFERENCES

- A. Industry Codes and Standards

American Institute of Steel Construction (AISC)

Specification for the Design, Fabrication and Erection of Steel for Buildings

Code of Standard Practice for Steel Buildings and Bridges

American Society for Testing and Materials (ASTM)

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American Welding Society (AWS)

AWS D 1.1 Structural Welding Code Steel

B. Government Regulations

U.S. Department of Labor, Occupational Safety and Health Administration (OSHA)

Cal/OSHA Standards

1.4 *QUALITY ASSURANCE*

A. Unless otherwise specified all work specified herein and shown on the Drawings shall conform to the applicable requirements of the following specifications and codes:

1. Fabricate and erect miscellaneous metal work in accordance with the latest edition of the AISC "Specification for the Design, Fabrication and Erection of Steel for Buildings," and "Code of Standard Practice for Steel Buildings and Bridges."
2. Inspections. Perform all field welding and field high strength bolting of structural steel assemblies under the inspection of the Engineer. Notify the Engineer at least 48 hours in advance of needed inspections. Provide copies of testing and inspection reports to the Engineer.

1.5 *SUBMITTALS*

A. Furnish submittals, samples and material data in conformance with Section 01 33 00 – Submittal Procedures.

1. Shop Drawings and Erection Drawings. Show materials and specification list, construction and fabrication details, layout and erection diagrams and method of anchorage to adjacent construction. Give location, type, size and extent of welding and bolted connections and clearly distinguish between shop and field connections. Coordinate shop drawings with related trades to ensure proper mating of assemblies.
 - a. Catalog work sheets showing illustrated cuts of item to be furnished, scale details and dimensions may be submitted for standard manufactured items.
 - b. Where items must fit and coordinate with finished surfaces and/or constructed spaces, take measurements at site and not from Drawings. Where concrete, masonry or other materials must be set to exact locations to receive work, furnish assistance and direction necessary to permit other trades to properly locate their work. Where welded connectors, concrete, or masonry inserts are required to receive work, show on shop drawings exact locations required.
2. Shop Painting Data. Submit product list with product data sheets of intended shop coats. These products shall be compatible with the products and manufacturers with those systems Specified in Section 09 90 00 - Painting.

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PART 2 PRODUCTS

2.1 MATERIALS – GENERAL

A. Provide materials that are new, sound and conforming to the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast Iron	A48	Class 40B
Steel		
Galvanized sheet iron or steel	A653	Coating G90
Black steel, sheet or strip	A569 A570	--
Coil (plate)	A635	--
Structural plate, bars, rolled shapes, and miscellaneous items (except W and HSS shapes)	A36	--
Rolled W shapes	A992	Grade 50
HSS Shapes	A500	Grade B
Standard bolts, nuts and washers	A307	--
High strength bolts, nuts and hardened flat washers	A325 A490	--
Eyebolts	A489	Type 1
Tubing, cold-formed	A500	--
Tubing, hot-formed	A501	--
Steel pipe	A53	Grade B
Stainless steel		
Plate, sheet and strip	A240	Type 304* or 316**
Bars and shapes	A276	Type 304* or 316**

Aluminum		
Flashing sheet aluminum	B209	Alloy 5005-H-14, 0.032 inches minimum thickness
Structural sheet aluminum	B209	Alloy 6061-T6
Structural aluminum	B209 B308	Alloy 6061-T6
Extruded aluminum	B221	Alloy 6063-T52
*Use Type 304L if material will be welded		
**Use Type 316L if material will be welded		

1. Anchor bolts and Post-Installed Anchors
 - a. Anchor bolts and post-Installed anchors shall conform to Section 03 15 20.
2. Galvanizing.

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- a. Iron and Steel. ASTM A123, with average weight per square foot of 2.0 ounces and not less than 1.8 ounces per square foot.
 - b. Ferrous Metal Hardware Items. ASTM A153 with average coating weight of 1.3 ounces per sq. ft.
 - c. Touch-up Material for Galvanized Coatings. Repair galvanized coatings marred or damaged during erection or fabrication by use of DRYGALV as manufactured by the American Solder and Flux Company, Galvalloy, Galvion, Rust-Oleum 7085 Cold Galvanizing Compound, or Engineer approved equivalent.
3. Welding Electrodes. Use welding electrodes conforming to AWS D1.1.
 4. Shop Prime Paint. To assure compatibility with deferred field-applied paint or coating systems, for ferrous metals other than stainless steel, galvanized steel and cast iron, provide surface preparations and use shop prime paint product and manufacturer as painting or protective coating system intended for field application specified in Section 09 90 00 - Painting.
 - a. Do not shop prime portions of work immediately adjacent to intended field welds, or portions intended for embedment.

PART 3 EXECUTION

3.1 GENERAL FABRICATION AND INSTALLATION REQUIREMENTS

- A. Standards: Thoroughly clean ferrous metals of all loose scale and rust before being fabricated. Provide finished members free of twists, bends or open joints, and that present a neat workmanlike appearance when completed. Perform steel work conforming to the best practices set forth in the "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.
 1. Perform aluminum work conforming to the applicable requirements of "Specifications for Aluminum Structures, Aluminum Construction Manual" of the Aluminum Association.
- B. Welding: Perform all welding in accordance with the "Structural Welding Code-Steel," AWS D1.1.
 1. Use only welders qualified by tests in accordance with AWS B 3.0.
- C. General Fabrication and Installation
 1. Using new stock of sizes specified or detailed, fabricate in shop producing high grade metal work. Form and fabricate to meet required conditions. Include clips, straps, bolts, screws, and other fastenings necessary to secure the work. Accurately make and tightly fit joining and intersections in true planes with adequate secure fastenings. Erect all metal work plumb, true on line and in its designated location. Grind and finish smooth field welds on exposed surface. Bolt or weld connections as indicated on Drawings. After

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installation, leave all work in a neat and clean condition, ready for field painting or coating.

- a. The maximum misalignment tolerance for railing shall be 1/8 inch in 12 feet. Bent, deformed or otherwise damaged railings shall be replaced.
2. Coordinate work of this Section with related trades. Particular attention is required for items to be embedded in concrete work. Provide all punching and drillings indicated or required for attachment of other work to that of this Section.
3. Compliance with Safety Requirements: Dimensions required for the fabrication and installation of handrails, ladders, grating, plate, pipe hangers and etc. which are not shown on the Drawings, shall conform to the requirements of the Division of Occupational Health and Safety.

D. Protection

1. Provide protection and repair of adjacent surfaces and areas which may become damaged as a result of work of this Section. Protect work performed hereunder until completion and final acceptance of project by the Owner. Repair or replace all damaged or defective work to original specified condition, at no additional cost to the Owner.

E. Painting

1. Apply all products in strict conformance with manufacturer's printed instructions.
2. Provide one or more shop coats of paint on all ferrous metals, except cast-iron, ductile iron, stainless steel and galvanized metals. Before priming, thoroughly clean surfaces. Allow shop coats to dry before materials are loaded for delivery to the job site. After erection, paint all areas where the shop coats have been rubbed off or omitted.
 - a. See Section 09 90 00 – Painting and Coating of these specifications for surface preparation, prime coatings, finish painting and coatings.
3. Isolate aluminum members from contact with dissimilar metals, concrete and masonry to provide protection from electrolytic deterioration. Use non-absorptive tape or gaskets, heavy brush coat of approved zinc chromate primer made with a synthetic resin vehicle; or apply a heavy coat of approved alkali-resistant bituminous paint.

END SECTION

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SECTION 07 31 13
ASPHALT SHINGLES

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. Asphalt shingles.
 - 2. Underlayment.
- B. Related Sections:
 - 1. Division 06 Section "Plywood Sheathing" for roof sheathing.
 - 2. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal flashing and trim to be installed integral with shingle roofing.

1.3 DEFINITION

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of asphalt shingle indicated.
- C. Samples for Verification: Asphalt shingle, full size, to verify color selected.
- D. Qualification Data: For qualified Installer.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for asphalt shingles.
- F. Maintenance Data: For each type of asphalt shingle to include in maintenance manuals.
- G. Warranties: Sample of special warranties.

1.5 *QUALITY ASSURANCE*

- A. **Installer Qualifications:** Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. **Source Limitations:** Obtain ridge and hip cap shingles from a single source from a single manufacturer.
- C. **Fire-Resistance Characteristics:** Provide asphalt shingles and related roofing materials identical to those of assemblies tested for fire resistance per test method below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
 - 1. **Exterior Fire-Test Exposure:** Class A; ASTM E 108, for application and roof slopes indicated.

1.6 *DELIVERY, STORAGE, AND HANDLING*

- A. Store roofing materials in a dry, well-ventilated, weathertight location according to asphalt shingle manufacturer's written instructions. Store underlayment rolls on end on pallets or other raised surfaces. Do not double stack rolls.
 - 1. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
- B. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

1.7 *PROJECT CONDITIONS*

- A. Proceed with work only when existing and forecasted weather conditions will permit work to be performed in accordance with manufacturer's written recommendations.
- B. Do not install products on wet substrates.

1.8 *WARRANTY*

- A. **Special Warranty:** Standard form in which manufacturer agrees to repair or replace asphalt shingles that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Manufacturing defects.
 - b. Structural failures including failure of asphalt shingles to self-seal after a reasonable time.
 - 2. **Material Warranty Period:** 40 years from date of Substantial Completion, prorated, with first five years non-prorated.

3. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds up to 70 mph for 10 years from date of Substantial Completion.
 4. Workmanship Warranty Period: 10 years from date of Substantial Completion.
- B. Special Project Warranty: Roofing Installer's Warranty, or warranty form at end of this Section, signed by roofing Installer, covering the Work of this Section, in which roofing Installer agrees to repair or replace components of asphalt shingle roofing that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.
- C. Existing Warranties: Work of this section shall not void or affect existing roofing warranties.

PART 2 - PRODUCTS

2.1 GLASS-FIBER-REINFORCED ASPHALT SHINGLES

- A. Laminated-Strip Asphalt Shingles: Laminated, two-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, self-sealing, and complying with ASTM D3462, D3161, and D3018 Type I.
1. Basis of Design Products: Drawings and specifications are based on the following:
 - a. Elk Premium Building Products, Inc.; an ElkCorp company.
 - b. GAF Materials Corporation.
 2. Physical Properties:
 - a. Weight: 265 lbs. per square.
 - b. Exposure: 5-5/8 inch.
 - c. Granule Adhesion: Maximum 1.0 gram loss.
 - d. Butt Edge: Straight.
 - e. Strip Size: 13-1/4 x 38-3/4 inches.
 - f. Algae Resistance: Granules treated to resist algae discoloration.
 - g. Fire Resistance Classification: Class A, ASTM E108.
 - h. Color and Blends: As selected by Architect from manufacturer's full range.
 3. Hip and Ridge Shingles: Manufacturer's standard units to match shingles.
- B. Laminated-Strip, SBS-Modified Asphalt Shingles: ASTM D 3462, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
1. Basis-of-Design Product: Drawings and specifications are based on the following:
 - a. Atlas Roofing Corporation.
 - b. Malarkey Roofing Products.

2. Physical Properties:
 - a. Exposure: 5-5/8 inch.
 - b. Granule Adhesion: Maximum 1.0 gram loss.
 - c. Butt Edge: Straight.
 - d. Strip Size: 13-1/4 x 38-3/4 inches.
 - e. Algae Resistance: Granules treated to resist algae discoloration.
 - f. Fire Resistance Classification: Class A, ASTM E108.
 - g. Color and Blends: As selected by Architect from manufacturer's full range.
3. Hip and Ridge Shingles: Manufacturer's standard units to match shingles.

2.2 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226 or ASTM D 4869, Type II, SBS-modified asphalt-saturated organic felts, nonperforated.

2.3 ACCESSORIES

- A. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
- B. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch diameter, barbed shank, sharp-pointed, with a minimum 3/8-inch diameter flat head and of sufficient length to penetrate 3/4 inch into solid wood decking or extend at least 1/8 inch through OSB or plywood sheathing.
 1. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
- C. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch minimum diameter.

2.4 METAL FLASHING AND TRIM

- A. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
- B. Sheet Metal: 24 gauge hot-dip galvanized steel sheet, complying with ASTM A 653/A 653M, G90/Z275.
- C. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item.
 1. Step Flashings: Fabricate with a headlap of 2 inches and a minimum extension of 4 inches over the underlying asphalt shingle and up the vertical surface.
 2. Drip Edges: Fabricate in lengths not exceeding 10 feet with 2-inch roof-deck flange and 1-1/2-inch fascia flange with 3/8-inch drip at lower edge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips, that installation is within flatness tolerances, and that fasteners are flush with the sheathing.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored; and that provision has been made for flashings and penetrations through asphalt shingles.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove existing roofing to the extent required to accommodate interfacing with new roofing.

3.3 UNDERLAYMENT INSTALLATION

- A. General: Comply with shingle and underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
- B. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches in shingle fashion. Lap ends a minimum of 6 inches. Stagger end laps between succeeding courses at least 72 inches. Fasten with felt underlayment nails.

3.4 METAL FLASHING INSTALLATION

- A. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" and manufacturer's printed installation instructions.
 - 1. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."

- B. Eave Drip Edges: Install eave drip edge flashings below underlayment and fasten to roof sheathing.
- C. Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

3.5 ASPHALT SHINGLE INSTALLATION

- A. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
- B. Install starter strip along lowest roof edge, consisting of an asphalt shingle strip at least 7 inches wide with self-sealing strip face up at roof edge.
 - 1. Extend asphalt shingles 1/2 inch over fascia at eaves and rakes.
 - 2. Install starter strip along rake edge.
- C. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- D. Install asphalt shingles by single-strip column or racking method, maintaining uniform exposure. Install full-length first course followed by cut second course, repeating alternating pattern in succeeding courses.
- E. Fasten asphalt shingle strips according to manufacturer's written instructions and in compliance with CBC Table 15-B-1.
- F. Ridge and Hip Cap Shingles: Maintain same exposure of cap shingles as roofing shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds. Fasten with roofing nails of sufficient length to penetrate sheathing.

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SHEET METAL FLASHING AND TRIM

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. Formed sheet metal fabrications:
 - a. Flashing and trim.
 - b. Gutters and downspouts.
- B. Related Sections include the following:
 - 1. Division 07 Section "Asphalt Shingle Roofing."

1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: For fabricated sheet metal items. Show fabrication and installation layouts including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop and field-assembled work. Include the following:
 - 1. Identification of material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.

3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
4. Details of termination points and assemblies, including fixed points.
5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
7. Details of special conditions.
8. Details of connections to adjoining work.
9. Detail formed flashing and trim at a scale of not less than 3 inches per 12 inches.

C. Sample Warranty: For special warranty.

1.5 *QUALITY ASSURANCE*

- A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.6 *DELIVERY, STORAGE, AND HANDLING*

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

PART 2 - PRODUCTS

2.1 *PERFORMANCE REQUIREMENTS*

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The Roofing and Waterproofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements as applicable for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Sheet metal flashing and trim shall allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints,

hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
 - a. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil
- C. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40.
 1. Surface: Smooth, flat

2.3 UNDERLAYMENT MATERIALS

- A. Polyethylene Sheet: 6-mil thick polyethylene sheet complying with ASTM D 4397.
- B. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. Self-drilling screws, gasketed, with hex-washer head.
 2. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

4. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
- C. Solder for Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane, polysulfide, or silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 *FABRICATION, GENERAL*

- A. General: Custom fabricate sheet metal flashing and trim as indicated on Drawings and to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

- C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored and of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- F. Seams: Fabricate nonmoving seams with flat-lock seams and as follows:
 - 1. Seams for Pre-Finished Metal: Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
 - 2. Seams for Unfinished Sheet Steel: Tin edges to be seamed, form seams, and solder.
 - 3. Seams for Unfinished Aluminum: Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.
- G. Do not use graphite pencils to mark metal surfaces.
- H. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

2.6 *ROOF DRAINAGE SHEET METAL FABRICATIONS*

- A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
 - 1. Expansion Joints: Butt type with cover plate. Space expansion joints not more than 40 feet on center.
 - 2. Accessories: Wire ball downspout strainer.
 - 3. Gutters: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- B. Downspouts: Fabricate downspouts of size and profile indicated on Drawings complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors. Fabricate from same material and thickness as gutters.

2.7 *STEEP-SLOPE ROOF SHEET METAL FABRICATIONS*

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.

- B. Drip Edges: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- C. Eave, Rake Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- D. Base Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.
- E. Roof-Penetration Flashing: Fabricate from 0.028 inch (24 gage) thick galvanized steel.

2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Miscellaneous Sheet Metal Fabrications: Fabricate from 0.028 inch (24 gage) thick galvanized steel unless otherwise indicated.

2.9 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.

- B. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

3.3 *INSTALLATION, GENERAL*

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 - 5. Install sealant tape where indicated.
 - 6. Torch cutting of sheet metal flashing and trim is not permitted.
 - 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
 - 1. Coat back side of uncoated aluminum sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. 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 corners or intersections. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
- D. Fastener Sizes:
 - 1. Wood Framing, Blocking, and Sheathing: Use fasteners of sizes that will penetrate [wood sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- E. Seal joints as shown and as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
- F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Do not solder coil-coated steel and aluminum sheet.
 2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
- G. Rivets: Rivet joints in uncoated aluminum where indicated and where necessary for strength.

3.4 ROOF DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
- B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with elastomeric sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets or straps spaced not more than 36 inches apart. Provide end closures and seal watertight with sealant.
1. Fasten gutter spacers to front and back of gutter.
 2. Loosely lock straps to front gutter bead and anchor to roof deck.
 3. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
 4. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
 5. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion joint caps.
- C. Downspouts: Join sections with 1-1/2-inch 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 on center in between.
1. Provide elbows at base of downspout to direct water away from building.
 2. Connect downspouts to underground drainage system where indicated.

3.5 *ROOF FLASHING INSTALLATION*

- A. General: Install sheet metal flashing and trim to comply with performance requirements, SMACNA's "Architectural Sheet Metal Manual," and NRCA's Roofing and Waterproofing Manuals as applicable to project conditions Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to referenced requirements and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 16 inch centers.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 *MISCELLANEOUS FLASHING INSTALLATION*

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.7 *ERECTION TOLERANCES*

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.8 *CLEANING AND PROTECTION*

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Field painting including surface preparation, surface protection, clean up, and/or other appurtenant work as indicated in the Contract Documents.
- B. All labor, materials, tools and equipment, and incidentals necessary and required for their completion.
- C. All pipe, fittings, equipment, and structures are to be field coated except for those specific exceptions contained in this specification or identified on the drawings. The painting schedule included at the end of this specification summarizes the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the drawings are used to show exceptions to the schedules, to extend the limits of coating systems, or to clarify or show details for application of the coating systems.
- D. All coatings for potable water service shall be ANSI-NSF Standard 61 certified.

1.2 SUBMITTALS

- A. Shop Drawings, Product Data, and Samples: as specific in Section 01 33 00 – Submittals.
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Performance criteria as required by the Engineer to determine quality.
 - c. Manufacturer's installation instructions and environmental parameters.
 - d. Material Safety Data Sheets.
 - e. Color samples.

1.3 AIR QUALITY REGULATORY COMPLIANCE

- A. All paint shall conform to the applicable air quality regulations at the point of application. Any paint material which cannot be guaranteed by the manufacturer to comply, whether specified by product designation or not, shall not be used.
- B. The volatile organic compound (VOC) of coatings materials limits set forth in Rule 460.1 of the San Joaquin Valley Unified Air Pollution Control District shall apply to this project. The manufacturers' products listed in paragraphs 3.01 and 3.02 of this

section have been selected on the basis of their apparent compliance with Rule 460.1; however, it shall remain the Contractor's responsibility to ensure that all coatings materials furnished are in compliance with all regulatory agencies.

- C. The product listed may meet the VOC requirement in the unthinned (as shipped) condition, but may exceed the VOC requirement if thinned to the manufacturer's allowable recommendations. In this situation, the product is not to be thinned beyond the limit indicated in Rule 460.1, and if the product cannot be suitably thinned for the intended application method or temperature requirements, it will be necessary to use another manufacturer's product subject to acceptance by the Engineer.
- D. It shall be the responsibility of the Contractor to ensure the compatibility of the field painting products which will be in contact with each other or which will be applied over shop painted or previously painted surfaces. Paint used in successive field coats shall be produced by the same manufacturer. Paint used in the first field coat over shop or field primed surfaces, or previously painted surfaces shall cause no wrinkling, lifting, or other damage to underlying paint.
- E. All paint used for intermediate and finish coats shall be guaranteed by the paint manufacturer to be fume-proof. Paint shall be lead-free and mercury-free.

1.4 *QUALITY OF WORK*

- A. All finishes shall be applied by skilled workmen in accordance with the best practices and standards of the painting trade. Brushes, rollers, all equipment, and the techniques used in applying finishes shall be of sufficient quality to assure the specified results. Work not conforming to this Specification shall be corrected by touching up or refinishing as directed by the Engineer.
- B. It is the purpose and intent of this Specification to cover the complete paint finishing of all exterior and interior surfaces as scheduled or specified and all surfaces which normally require a paint finish for corrosion resistance, weather protection, finished appearance or utility. Finished surfaces shall be of the type of finish, color sheen film thickness and quality specified.

1.5 *DELIVERY AND STORAGE*

- A. Painting materials shall be delivered to site in manufacturer's original containers with labels intact and seals unbroken. Painting materials and equipment shall be stored and protected against freezing and mixed in rooms assigned for that purpose. No chemicals, unauthorized thinners, or other materials, not included in the paint formulation shall be added to the paint for any purpose. All necessary precautions shall be taken to prevent fire. Rags or waste soiled with paint shall be removed from premises at end of each day's work, or shall be stored in covered metal containers.

1.6 *EQUIVALENT PRODUCTS*

- A. Whenever a coating is specified using the name of a proprietary product or the name of a particular manufacturer or vendor, the specified coating shall be understood as establishing the type and quality of coating desired.

- B. Other manufacturers' products will be accepted provided sufficient information is submitted to allow the Engineer to determine that the coatings proposed are equivalent to those named. Proposed coatings shall be submitted for review in accordance with the Section 01 30 00 – Submittals.
- C. Requests for review of equivalency will not be accepted from anyone except the Contractor, and such requests will not be considered until after the contract has been awarded.
- D. Specific products for various applications shall be as specified in Part 2. In addition to the products named in Part 2, equivalent products of the following manufacturers will also generally be acceptable:

Ameron
Carboline
Devoe
PPG (Pittsburgh)
Sherwin Williams Co.
Sinclair
Tnemec
Valspar

- E. Contractor shall provide verification that equivalent products are acceptable for the desired application.

1.7 REFERENCE STANDARDS

- A. SSPC – Society of Protective Coatings, Pittsburgh, PA
- B. ASTM – American Society For Testing And Materials, West Conshohocken, PA

PART 2 PRODUCTS

2.1 GENERAL

- A. All paint shall be the product of a recognized manufacturer exclusively engaged in the manufacture of painting material. All paints for wood and metal surfaces shall be well-ground and shall not skin, liver, curdle, or body excessively in the containers.
- B. The paint shall not show laps or unevenness of color or texture. When applied to vertical surfaces, it shall not sag.
- C. All exposed surfaces, including sides and edges, shall be painted. Hangers, brackets, fastenings and other miscellaneous items shall be painted with the same system as the adjacent material. Paint systems shall be in addition to shop primers.
- D. Paint shall be stored inside and shall be protected against freezing. No adulterant, unauthorized thinner, or other material not included in the paint formation shall be added to the paint for any purpose.

- E. Paint used in successive field coats shall be produced by the same manufacturer. Paint used in the first field coat over shop painted or previously painted surfaces shall cause no wrinkling, lifting, or other damage to underlying paint. Any paint system shall be the product of a single manufacturer.
- F. All paint used for intermediate and finish coats shall be guaranteed by the paint manufacturer to be lead-free, mercury-free, and fume-proof. Where paint materials are referenced to Federal or military specifications, the reference shall define general type and quality required but is not intended to limit acceptable materials to an exact formulation.
- G. For each paint, the Contractor shall follow the paint manufacturer's specific application instructions. Upon the Engineer's request, the Contractor shall furnish the following application instructions.
 - 1. Surface preparation recommendations.
 - 2. Type of primer to be used.
 - 3. Maximum dry and wet mil thickness per coat.
 - 4. Minimum and maximum curing times between coats.
 - 5. Thinner to be used with each paint.
 - 6. Ventilation requirements.
 - 7. Atmospheric conditions during which the paint shall not be applied.
 - 8. Allowable methods of application.
 - 9. Maximum allowable moisture content and minimum age of plaster, concrete and wood surfaces at time of paint application.
 - 10. Curing time before submergence in water.
- H. The minimum number of coats and minimum total dry mil thickness of the system for each surface shall be as specified in the paint schedule.

2.2 PAINTING SCHEDULE

- A. A schedule is appended to this section listing the surface preparation, primer, finish and dry mil thickness to be used on each surface to be coated.

2.3 PRIMERS AND PRETREATMENT

- A. P-1 Epoxy Primer – Minimum dry thickness 4 mils. Devoe "Bar Rust 235H", Sherwin Williams "Macropoxy 646 FC Epoxy B58-600", or Tnemec 69-1211 "Hi-Build Expoxoline."

- B. P-2 Rust Inhibitive, non-submerged – Minimum dry thickness 3 mils. Devoe "Devran 203 Waterborne Epoxy Primer", Sherwin Williams "Macropoxy 646 FC Epoxy B58-600" or Tnemec 135 "Chem Build."
- C. P-3 Rust inhibitive, submerged – Minimum dry thickness 4.0 mils. Devoe "Bar Rust 235H", Sherwin Williams "Macropoxy 646 FC Epoxy B58-600" or Tnemec 136 "Chem Build."
- D. P-4 Primer for Wood – Maximum of 400 sq. ft/gal. Devoe 2010-1200 "Ultra- Hide Durus Exterior Acrylic Primecoat", Sherwin Williams "A-100 Wood Primer B42W41" or Tnemec 151 "Elaso-Grip."
- E. P-5 Wallboard Primer – Maximum of 400 sq. ft/gal. Devoe 1060-1200 "Ultra- Hide Latex Primer- Sealer", Sherwin Williams "Preprite 200 Interior Latex Primer B28W200", or Tnemec 51-792 "PVA Sealer."
- F. P-6 High Build Acrylic – Maximum of 100 sq. ft/gal., Tnemec 180 WB Tneme-Crete, Sherwin Williams "Heavy Duty Block Filler B42W46".

2.4 INTERMEDIATE AND FINISH PAINTS

- A. F-1 Epoxy Resin - Minimum dry thickness 5 mils. Devoe "Bar Rust 235H", Sherwin Williams "Macropoxy 646 FC Epoxy B58-600", or Tnemec 69 "Hi-Build" epoxy.
- B. F-2 Gloss Acrylic Emulsion - Minimum dry thickness 2.0 mils Devoe " Devflex 4208 Waterbone Acrylic Enamel", Sherwin Williams "Shercryn Hi Performance Acrylic Gloss B66-300", or Tnemec 1028.
- C. F-3 Semi-gloss Acrylic Emulsion - Minimum dry thickness 2.5 mils Devoe "Devflex 4216 HP Waterborne", Sherwin Williams "Shercryn Hi Performance Acrylic Semi-Gloss B66-350", or Tnemec 1029 "Tuf Cryn".
- D. F-4 High Build Epoxy (Substitute for Coal Tar) - Minimum dry thickness 6 mils. Devoe "Devtar 5A HS", Sherwin Williams "Targuard Coal Tar Epoxy B69B60", or Tnemec "V69F Black"
- E. F-5 Polyurethane O - Minimum dry thickness 2 mils. Devoe "Devthane 379H Aliphatic Urethane Gloss Enamel", Sherwin Williams "Hi Solids Polyurethane CA B65j-300", or Tnemec 1075 "Endurasheild."
- F. F-6 Acrylic Epoxy – Minimum dry film thickness 4 mils. Tnemec 113 Tneme-Tufcoat, Sherwin Williams " Waterbased Tile Clad Epoxy B73-100".
- G. F-7 High Build Acrylic – Maximum of 100 sq. ft./gal. Tnemec 180 WB Tneme-Crete, Sherwin Williams "Heavy Duty Block Filler B42W46".

2.5 FUSION BONDED EPOXY LINING AND COATING

- A. Fusion bonded epoxy linings and coatings shall be per Specification Section 09 97 61.

2.6 ALUMINUM SURFACES

- A. All aluminum in contact with steel or concrete: Sherwin Williams "Macropoxy 646 FC Epoxy B58-600 series or approved equivalent.

2.7 SHOP COATINGS

- A. Shop coatings shall be applied as indicated in the individual equipment and component specifications.
- B. Electric motors, speed reducers, starters, and other self contained or enclosed components shall be shop primed or finished with a high grade, oil resistant enamel suitable for top coating in the field with an alkyd enamel.
- C. All shop coatings shall be compatible with the pain system specified in the Painting Schedule contained at the end of this specification.

2.8 SURFACES NOT TO BE PAINTED

- A. Except as otherwise required or directed, the following surfaces are to be left unpainted:
 - 1. Exposed surfaces of aluminum.
 - 2. Polished or finished stainless steel. Unfinished stainless steel shall be painted.
 - 3. Nickel or chromium.
 - 4. Galvanized surfaces, except piping, conduit, electrical conduit, pipe supports, fasteners, hangers, bracing, brackets, and accessories.
 - 5. Rubber and plastics, including fiberglass reinforced plastics.
 - 6. Precast concrete.

2.9 SYSTEM IDENTIFICATION

- A. Above Grade Piping: Provide markers on piping which is either exposed or concealed in accessible spaces. For piping systems, other than drain and vent lines, indicate the fluid conveyed or its abbreviation, either by preprinted marker or stenciled marking, and include arrows to show the direction of flow. Comply with ANSI A13.1 for colors. Locate markers at ends of lines, near major branches and other interruptions including equipment in the line, where lines pass through floor, walls or ceilings or otherwise pass into inaccessible spaces, and at 50' maximum intervals along exposed portion of lines. Marking of short branches and repetitive branches for equipment connections is not required.

- B. Equipment: All equipment shall be identified with a plastic laminated, engraved nameplate which bears the unit mark number as indicated on the drawings (e.g. AC-4). Provide ½-inch high lettering, white on black background. Nameplates shall be permanently secured to the unit.
- C. Valves: Provide valve tags on all valves of each piping system, excluding check valves, valves within equipment, faucets, stops and shut-off valves at fixtures and other repetitive terminal units. Provide brass tags or plastic laminate tags. Prepare and submit a tagged valve schedule, listing each valve by tag number, location and piping service. Mount in glazed frame where directed.

2.10 COLORS

- A. All colors and shades of colors shall be as specifically indicated in the specifications or plans, or, where not specifically indicated, selected from the manufacturer's standard color samples by the Owner.
- B. Electrical conduit shall be painted to match adjacent ceiling or wall surfaces as directed by the Engineer.

PART 3 EXECUTION

3.1 PRELIMINARY EXAMINATION

- A. Notify the Engineer in writing of any uncorrected defects in surfaces to be painted. Do not proceed with the finishing of surfaces in question until any discrepancies are corrected. No work on any surface shall be started, unless the surface has been inspected and approved for painting by the Engineer.

3.2 SURFACE PREPARATION

- A. The Contractor shall prepare the surfaces to be coated as specified under the paint schedule. Any surfaces to be coated which are not listed under the paint schedule shall be prepared in accordance with the manufacturer's instructions for the material to be applied.
- B. All grease, oil, dirt, and other contaminants which may affect the bond between the coating and the surface shall be removed by a cleaning agent which will leave the surface clean and dry.
- C. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces.
- D. Surfaces shall be free of cracks, pits, projections, or other imperfections which would prevent the formation of smooth, unbroken paint film, except for concrete block construction where a rough surface is an inherent characteristic.
- E. When applying touch-up paint, or repairing previously painted surfaces, the surfaces to be painted shall be cleaned and sanded or wire brushed in such a manner that the edges of adjacent paint are feathered or otherwise smoothed so that they will

not be noticeable when painted. All paint made brittle or otherwise damaged by heat or welding shall be completely removed.

- F. Hardware items such as bolts, screws, washers, springs, and grease fittings need not be cleaned prior to painting if there is no evidence of dirt, corrosion, or foreign material.
- G. All galvanized surfaces shall have a metal conditioner applied prior to the first prime coat.
- H. All surfaces to be finished shall be clean and dry before any materials are applied. Use a moisture meter to determine moisture content as follows. The moisture content shall be less than 18% for wood; 8% for concrete or plaster.
 - 1. Metal Surfaces – Where noted, the surface preparation for steel and other metals refer to the specifications for surface preparation by the latest revision of the Steel Structures Painting Council. All metal work shall be cleaned of grease, oil and dirt by solvent cleaning (SSPC-SP1). Do not use hydrocarbon based solvents for cleaning prior to use of acrylic materials.
 - a. Method SP-2: Surface shall be wire brushed where required to remove loose rust and dirt, etc. (SSPC-SP2)
 - b. Method SP-3: Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by power wire brushing, power impact tools or power sanders. (SSPC-SP3)
 - c. Method SP-6: Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues. (SSPC-SP6)
 - d. Method SP-10: Sandblast to near white condition. This method shall remove all rust and scale, but streaks and shadows in the metal will be acceptable. (SSPC-SP10)
 - 2. Wood Surfaces
 - a. Method W-1: All unprimed millwork delivered to the jobsite shall be given the specified first coat on all surfaces immediately upon arrival. Give all unprimed woodwork the specified first coat as soon as possible following installation. Prime any wood surface that is to be in contact with concrete, or a caulking material, with the specified first coat material before installation. Unless specified otherwise, all casings and trim, and all woodwork shall be free of oil, dirt, loose fibers, etc., sealed with a sanding sealer recommended by the coating manufacturer, and sanded smooth and dusted thoroughly before application of the priming coat. Give all knots, pitch pockets and sappy areas a preliminary coat of Dutch Boy Knot Sealer, or approved equivalent, prior to application of the prime coat.
 - 3. Galvanized Surfaces

- a. Method G-1: All galvanized surfaces shall be prepared for painting in strict conformity with the instructions of the manufacturer. All galvanized shall be cleaned per SSPC-SP7.

4. PVC Pipe

- a. Method V-1: All wax and oil shall be removed from PVC plastic surfaces by wiping with a solvent of the type used for the specified primer.

3.3 PAINT APPLICATION

- A. Apply all finishes evenly, free from sags, runs, crawls, brush marks, skips or other defects. Apply products at the proper consistency and do not thin or otherwise alter them except in accordance with the manufacturer's printed directions. All coats shall be applied in such manner as to produce an even film of uniform thickness completely coating all corners and crevices. All painting shall be done by thoroughly experienced workmen.
- B. Care shall be exercised during spraying to hold the nozzle sufficiently close to the surfaces being painted to avoid excessive evaporation of the volatile constituents and loss of material into the air, or the bridging over of crevices and corners. Spray equipment shall be equipped with mechanical agitators, pressure gauges, and pressure regulators. Nozzles shall be of proper size. Floors, roofs, and other adjacent areas and installations shall be satisfactorily protected by drop cloths or other precautionary measures. All over-spray shall be removed by approved methods or the affected surface repainted. Care shall be exercised to avoid lapping of paint on hardware of other unscheduled surfaces.
- C. Each coat of material shall be thoroughly dry before the application of a succeeding coat. In no case shall paint be applied at a rate of coverage per gallon which is greater than the maximum rate recommended by the manufacturer. Paint films showing sags, checks, blisters, teardrops, or fat edges will not be accepted. Paint containing any of these defects shall be entirely removed and the surface repainted.
- D. Sandpaper enamels and varnishes lightly between coats and dust thoroughly before the application of a succeeding coat.
- E. If the finish coat is to be colored, the prime coat and the intermediate coat shall be tinted to have a slight variation in color from each other and from the finish coat.

3.4 PRIMING

- A. Edges, corners, crevices, welds, and bolts shall be given a brush coat of primer before the specified spot or touch-up painting of metal surfaces. Special attention shall be given to filling all crevices with paint.
- B. Abraded and otherwise damaged portions of shop applied paint shall be repainted. Welded seams and other uncoated surfaces, heads and nuts of field installed bolts, and surfaces where paint has been damaged by heat, shall be given a coat of the

specified primer. This patch, spot, or touch-up painting shall be completed, and shall be dry and hard, before additional paint is applied.

3.5 *LATEX PAINT*

- A. Latex paint shall be applied by brushing or rolling; spraying is not permitted. Latex paint shall not be thinned excessively.

3.6 *MIXING AND THINNING*

- A. Paint shall be thoroughly mixed each time any is withdrawn from the container. Paint containers shall be kept tightly closed except while paint is being withdrawn.
- B. Unless otherwise authorized, all paint shall be factory mixed to proper consistency and viscosity for hot weather application without thinning. Thinning will be permitted only as necessary to obtain recommended coverage at lower application temperatures. In no case shall the wet film thickness of applied paint be reduced, by addition of paint thinner or otherwise, below that represented by the recommended coverage rate.

3.7 *FILM THICKNESS FOR FERROUS METALS*

- A. It is intended that the dry film thickness and the continuity of painted ferrous metal surfaces be subject to continual field check by the Engineer. Dry film thickness shall be measured by the Contractor, using an approved Thickness Gauge, at locations selected by Engineer. Testing equipment provided shall be provided by Contractor and kept on site.
- B. Measurement of dry coating thickness shall conform with paint application Standard SSPC-PA2
- C. Thickness and Holiday Checking: Thickness of coatings and paint shall be checked with a non-destructive, magnetic type thickness gauge.
- D. Holiday Checking of all interior coated surfaces shall be tested with an approved holiday detection device. Non-destructive holiday detectors shall not exceed 100 volts nor shall destructive holiday detectors exceed the voltage recommended by the manufacturer of the coating system. For thicknesses between 10 and 20 mils (0.25mm and 0.50mm) a non-sudsing type wetting agent such as Kodak Photo-Flo, shall be added to the water prior to wetting the detector sponge. All pinholes shall be marked, repaired in accordance with the manufacturer's printed recommendations and re-tested. No pinholes or other irregularities will be permitted in the final coating. Holiday detection devices shall be operated in the presence of the Engineer.
- E. Continuity shall be tested by a low voltage-wet sponge per RPO 188. Contractor shall perform continuity tests as required by the Engineer on surfaces that will be submerged.

3.8 ATMOSPHERIC CONDITIONS

- A. Apply all material to dry and properly prepared surfaces when weather conditions are favorable for painting. No materials shall be applied when the temperature of the materials is below 50° F, or when the temperature of the air, surface to be painted or substrate, is below (or likely to fall below) 50° F. Final ruling on the favorability of weather conditions shall be in accordance with the recommendations of the manufacturer and/or the Engineer.
- B. No coating or paint shall be applied to wet or damp surfaces, in rain, snow, fog, or mist, when the steel temperature or surrounding air temperature is less than five degrees above the dew point, nor in conditions not recommended by the manufacturer.

3.9 REPAIRING DAMAGED PAINT ON EQUIPMENT

- A. Painted surfaces on equipment, which have become damaged prior to acceptance by the Owner, shall be repainted with the same or equivalent paint used in the original application.

3.10 PROTECTION OF SURFACES

- A. Throughout the work the Contractor shall use drop cloths, masking tapes, and other suitable measures to protect all surfaces from accidental spraying, splattering, or spilling of paint. Contractor shall be liable for and shall correct and repair any damaged condition resulting from its operations or from the operations of all those who are responsible to the Contractor during the time its work is in progress and until the work is accepted. In case bituminous paints are spilled or dropped on any material except metals, the spots shall, after surface cleaning, be spot painted with aluminum paint prior to applying the specified paint. Any exposed concrete or masonry not specified to be painted which is damaged by paint shall be either removed and rebuilt or, where so authorized by the Owner, painted with two coats of masonry paint.

3.11 CLEANUP

- A. All cloths and cotton waste which might constitute a fire hazard shall be placed in metal containers or destroyed at the end of each work day. Upon completion of the work all staging, scaffolding and containers shall be removed from the site or destroyed in a manner approved by the Engineer.

3.12 PAINTING SCHEDULE

<u>SYSTEM</u>	<u>SURFACE</u>	<u>FINISH</u>			
		<u>SURF. PREP.</u>	<u>PRIME COAT</u>	<u>2ND COAT</u>	<u>3RD COAT</u>
1.	New ferrous metal in submerged or damp environment including all	SP-10	P-1	F-1	F-1

	submerged mechanical components.				
2.	All exterior exposed new structural and miscellaneous steel. All exterior exposed surfaces of new piping, pumps, motors, electrical equipment and other unsubmerged mechanical and structural items.	SP-2 or 3	P-2	F-2	F-2
3.	All surfaces of new structural and miscellaneous steel pipe, pumps, motors and electrical equipment panels exposed inside building.	SP-6	P-2	F-3	F-3
4.	All interior exposed new galvanized metalwork including electrical conduit inside buildings, including fittings, boxes, supports and accessories.	G-1	P-3	F-3	F-3
5.	All exterior exposed new galvanized metalwork including roof flashings and other architectural items.	G-1	P-3	F-2	F-2
6.	Exposed new PVC piping	V-1	F-5	F-5	

<u>SYSTEM</u>	<u>SURFACE</u>	<u>FINISH</u>			
		<u>SURF. PREP.</u>	<u>PRIME COAT</u>	<u>2ND COAT</u>	<u>3RD COAT</u>
7.	All new buried valves and flanged joints and other buried miscellaneous ferrous piping and metal surfaces (excluding cast iron pipe). All exterior surfaces of new cast iron and steel piping exposed in manholes, wet wells and similar locations, including valves, fittings, flanges, bolts, supports, and accessories. Miscellaneous new castings, including manhole rings and covers and manhole steps. (One coat, if not foundry dipped.)	SP-10	F-4	F-4	
8.	Interior wood	P-4	F-2	F-2	
9.	Exterior wood	P-4	F-3	F-3	
10.	Interior dry wall	P-5	F-6		
11.	Exterior concrete block	P-6	F-7		
12.	Concrete	P-6	F-7		

3.13 CONFLICTS

- A. When conflicting painting specifications or requirements are encountered in the contract documents, the more restrictive specifications or requirements shall be required.

END SECTION

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SECTION 09 97 61
FUSION-BONDED EPOXY LININGS AND COATINGS

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section includes materials, application, and testing of one-part, fusion-bonded, heat-cured, thermosetting, 100 percent solids epoxy linings and coatings on steel, cast-iron, and ductile-iron equipment, such as valves, flexible pipe couplings, and steel pipe.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 09 90 00 – Painting and Coating
- B. Section 40 05 00 – Pipe and Fittings

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00 – Submittals.
- B. Submit manufacturer's catalog literature and product data sheets, describing the physical and chemical properties of the epoxy coating. Describe application and curing procedure.
- C. Submit coating application test records for measuring coating thickness and holiday detection for each item or pipe section and fitting. Describe repair procedures used.

PART 2 MATERIALS

2.1 PIPING AND EQUIPMENT SURFACES

- A. The Contractor shall require the equipment suppliers to provide equipment that is free of salts, oil, and grease to the coating applicator.
- B. The Contractor shall require pipe suppliers to provide bare pipe that is free of salts, oil, and grease to the coating applicator.

2.2 SHOP-APPLIED EPOXY LINING AND COATING

- A. Lining and coating shall be 100 percent solids, thermosetting, fusion-bonded, dry powder epoxy resin: Scotchkote 134 or 206N, Valspar "Pipeclad 1500 Red," or equal. Epoxy lining and coating shall meet or exceed the following requirements:

Hardness (minimum)	Barcol 17 (ASTM D2583) Rockwell 50 ("M" scale)
Abrasion resistance (maximum value)	1,000 cycles: 0.05 gram removed
	5,000 cycles: 0.115 gram removed
	ASTM D1044, Tabor CS 17 wheel, 1,000-gram weight
Adhesion (minimum)	3,000 psi (Elcometer)
Tensile strength	7,300 psi (ASTM D2370)
Penetration	0 mil (ASTM G17)
Adhesion overlap shear, 1/8-inch steel panel, 0.010 glue line	4,300 psi, ASTM D1002
Impact (minimum value)	100 inch-pounds (Gardner 5/8-inch diameter tup)

2.3 FIELD-APPLIED EPOXY COATING FOR PATCHING

- A. Use a minimum 80 percent solids liquid epoxy resin, such as Scotchkote 306 or 323.

2.4 PAINTING AND COATING OF GROOVED-END AND FLEXIBLE PIPE COUPLINGS

- A. Line and coat couplings the same as the pipe. Color shall match the color of the pipe fusion epoxy coating.

PART 3 EXECUTION

3.1 SHOP APPLICATION OF FUSION-BONDED EPOXY LINING AND COATING - GENERAL

- A. Grind surface irregularities, welds, and weld spatter smooth before applying the epoxy. The allowable grind area shall not exceed 0.25 square foot per location, and the maximum total grind area shall not exceed 1 square foot per item or piece of equipment. Do not use any item, pipe, or piece of equipment in which these requirements cannot be met.
- B. Remove surface imperfections, such as slivers, scales, burrs, weld spatter, and gouges. Grind outside sharp corners, such as the outside edges of flanges, to a minimum radius of 1/4 inch.
- C. Uniformly preheat the pipe, item, or piece of equipment prior to blast cleaning to remove moisture from the surface. The preheat shall be sufficient to ensure that the surface temperature is at least 5 degree Fahrenheit above the dew point temperature during blast cleaning and inspection.
- D. Sandblast surfaces per SSPC SP-5. Protect beveled pipe ends from the abrasive blast cleaning.

- E. Apply lining and coating by the electrostatic spray or fluidized bed process. Minimum thickness of lining or coating shall be 15 mils. Heat and cure per the epoxy manufacturer's recommendations. The heat source shall not leave a residue or contaminant on the metal surface. Do not allow oxidation of surfaces to occur prior to coating. Do not permit surfaces to flash rust before coating.

**3.2 SHOP APPLICATION OF FUSION-BONDED EPOXY LINING AND COATING TO PIPE-
ADDITIONAL REQUIREMENTS**

- A. Apply lining and coating per AWWA C213 except as modified herein.
- B. Grind 0.020 inch (minimum) off the weld caps on the pipe weld seams before beginning the surface preparation and heating of the pipe.

**3.3 SHOP APPLICATION OF FUSION-BONDED EPOXY LINING AND COATING TO JOINT
AREAS OF DUCTILE -IRON AND CAST-IRON FITTINGS - ADDITIONAL
REQUIREMENTS**

- A. Limit the protective coating thickness in the joints of ductile-iron and cast-iron fittings to maintain a leak-proof joint. However, the coating thickness in the joint area shall not be less than 4 mils.

3.4 QUALITY OF LINING AND COATING APPLICATIONS

- A. The cured lining or coating shall be smooth and glossy, with no graininess or roughness. The lining or coating shall have no blisters, cracks, bubbles, underfilm voids, mechanical damage, discontinuities, or holidays.

3.5 FACTORY TESTING OF COATING - GENERAL

- A. Test linings and coatings with a low-voltage wet sponge holiday detector. Test pipe linings and coatings per AWWA C213, Section 5.3.3. If the number of holidays or pinholes is fewer than one per 20 square feet of coating surface, repair the holidays and pinholes by applying the coating manufacturer's recommended patching compound to each holiday or pinhole and retest. If the number of pinholes and holidays exceeds one per 20 square feet of coating surface, remove the entire lining or coating and recoat the item or pipe.
- B. Measure the coating thickness at three locations on each item or piece of equipment or pipe section using a coating thickness gauge calibrated at least once per eight-hour shift. Record each measured thickness value. Where individual measured thickness values are less than the specified minimum thickness, measure the coating thickness at three additional points around the defective area. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than 2 mils below or 3 mils above the specified minimum value. If a section of the pipe, item, or piece of equipment does not meet these criteria, remove the entire lining or coating and recoat the entire item or piece of equipment.

3.6 *FACTORY INSPECTION OF LINING AND COATING OF PIPE-ADDITIONAL REQUIREMENTS*

- A. Check for coating defects on the weld seam centerlines. There shall be no porous blisters, craters, or pimples lying along the peak of the weld crown.

3.7 *SHIPPING, STORAGE, AND HANDLING*

- A. When loading piping, fittings, couplings, or other coated items for shipment to the project site, use spacers and other protective devices to separate pipes or other coated items to prevent damaging the coated surfaces during transit and unloading. If wood spacers are used, remove wood splinters and particles from the coated surfaces after separation. Use padded chains or ribbon binders to secure the loaded pipe or other coated items and minimize damage.
- B. Do not load or unload pipe, fittings, couplings, or other coated items by inserting forklift tines or lifting chains inside the pipe or item. Use nonmetallic slings, padded chains, or padded forklift tines to lift pipe or other coated items.
- C. Cover piping or other coated items 100 percent with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.
- D. Provide stulls, braces, and supports for piping during shipping and storage such that out-of-roundness or deflection does not exceed 0.5 percent of the pipe diameter.
- E. Handle piping and other coated items with care during the unloading, installation, and erection operations to minimize damage. Do not place or store pipe or other coated items on the ground or on top of other work unless ground or work is covered with a protective covering or tarpaulin. Place pipe or other coated items above the ground upon platforms, skids, or other supports.
- F. Store piping or other coated items at the site on pallets to prevent direct contact with ground or floor. Cover pipe or coated items during storage with protective coverings or tarpaulins to prevent deposition of rainwater, salt air, dirt, dust, and other contaminants.
- G. Do not allow piping or other coated items to contact metal, concrete, or other surfaces during storage, handling, or installation and erection at the site that could damage or scratch the coating.

3.8 *FIELD REPAIRS*

- A. Patch scratches and damaged areas incurred while installing fusion-bonded epoxy coated items with a two-component, 80 percent solids (minimum), liquid epoxy resin. Wire brush or sandblast the damaged areas per SSPC SP-10. Lightly abrade or sandblast the coating or lining on the sides of the damaged area before applying the liquid epoxy coating. Apply an epoxy coating to defective linings and coatings to areas smaller than 20 square inches. Patched areas shall overlap the parent or base coating a minimum of 0.5 inch. If a defective area exceeds 20 square inches, remove

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the entire lining and coating and recoat the entire item or piece of equipment. Apply the liquid epoxy coating to a minimum dry-film thickness of 15 mils.

END SECTION

FUSION-BONDED EPOXY LININGS AND COATINGS
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SECTION 11 00 00
GENERAL EQUIPMENT STIPULATIONS

PART 1 GENERAL

1.1 SCOPE

- A. All equipment furnished and installed under this Contract shall conform to the general stipulations set forth in this section except as otherwise specified in other sections.

1.2 RELATED WORK

- A. Section 09 90 00 – Painting and Coating

1.3 COORDINATION

- A. Contractor shall coordinate all details of the equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

1.4 MANUFACTURER'S EXPERIENCE

- A. Unless specifically named in the Specifications, a manufacturer furnishing equipment of the type and size specified shall have been in successful operation for not less than the past five years.

1.5 WORKMANSHIP AND MATERIALS

- A. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
- B. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
- C. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.

1.6 LUBRICATION

- A. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start up or shutdown and shall not waste lubricants.
- B. Lubricants, of the type recommended by the equipment manufacturer, shall be provided in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner.
- C. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

PART 2 PRODUCTS

2.1 DRIVE UNITS

- A. The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24-hour continuous service.
 - 1. Gear motors. Unless otherwise specified, the use of gear motors will not be acceptable.
 - 2. Gear Reducers. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout.
 - 3. Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class II. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall bear an AGMA nameplate.
 - 4. The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100° F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°.
 - 5. Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic re-greasing of the bearing by means of a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent over-greasing of the bearing. The use of permanently sealed, grease lubricated bearings will not be acceptable. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings. A dipstick or sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.

6. Gear reducers which require the removal of parts or periodic disassembly of the unit for cleaning and manual re-greasing of bearings will not be acceptable.
7. Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.
 - a. Variable Speed Drives. Each mechanical variable speed drive shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor. A spare belt shall be provided with each variable speed drive unit employing a belt for speed change. Unless specifically permitted by the detailed equipment specifications, bracket type mounting will not be acceptable for variable speed drives.
 - b. V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower of the drive motor.

2.2 SAFETY GUARDS

- A. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage or heavier galvanized or aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.3 ANCHOR BOLTS

- A. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall comply with the anchor bolts and expansion anchors section and, unless otherwise specified, shall have a minimum diameter of 3/4 inch.
- B. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on base plates shall be long enough to permit 1-1/2 inches of grout beneath the base plate and to provide adequate anchorage into structural concrete.

2.4 EQUIPMENT BASES

- A. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least six inches high. Cast iron or welded steel base plates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single base plate of neat design. Base plates shall

have pads for anchoring all components and adequate grout holes. Base plates for pumps shall have a means for collecting leakage and a threaded drain connection. Base plates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in the grout section.

2.5 SPECIAL TOOLS AND ACCESSORIES

- A. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.6 SHOP PAINTING

- A. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with a high-grade, oil-resistant enamel suitable for top coating in the field with an alkyd enamel. Coatings shall be suitable for the environment where the equipment is installed.
- B. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.
 - 1. All shop primers shall be compatible with the paint system specified in Section 09 90 00, Painting and Coating, for the particular item.
- C. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust preventive compound, such as Houghton "Rust Veto", Rust-Oleum "R-9" or Engineer approved equivalent.

PART 3 EXECUTION

3.1 PREPARATION FOR SHIPMENT

- A. All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.
- B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.
- C. Grease and lubricating oil shall be applied to all bearings and similar items.

- D. Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

3.2 STORAGE

- A. Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work.
- B. Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60° F. Equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.
- C. Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

3.3 INSTALLATION AND OPERATION

- A. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results. When so specified, or when employees of Contractor or his Subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.
- B. Qualified field representatives shall be provided by the equipment manufacturers as required to perform all manufacturer's field services called for in the Specifications. Manufacturer's field representatives shall observe, instruct, guide, and direct Contractor's erection or installation procedures, or perform an installation check, as required. The field representative shall revisit the site as often as necessary to attain installation satisfactory to Engineer.
- C. All equipment installed under this Contract shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.
- D. Acceptance of Work in connection with the installation of equipment furnished by others will be subject to approval of the field representative. Contractor shall be responsible for planning, supervising, and executing the installation of Work, and the approval or acceptance of Engineer or the field representative will not relieve Contractor of responsibility for defective Work.

3.4 OBSERVATION OF PERFORMANCE TESTS

- A. Where the Specifications require the presence of Engineer, initial tests shall be observed or witnessed by Engineer. Owner shall be reimbursed by Contractor for all costs of subsequent visits by Engineer to witness or observe incomplete tests, retesting, or subsequent tests.

3.5 *WARRANTY*

- A. A written manufacturer's warranty shall be provided for equipment supplied under this contract. The warranty shall be for a minimum of one (1) year or as specified in accordance with other Sections of the contract documents, after the date the equipment is accepted for use by the Owner by filing of the notice of completion, unless otherwise agreed in writing by Owner. The warranty shall cover all defects or failures of materials, design, or workmanship that occur as the result of normal operation and service.

END SECTION

SECTION 13 07 00
SEISMIC REQUIREMENTS FOR CONTRACTOR
FURNISHED AND/OR INSTALLED ITEMS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

- A. Comply with the CBC Chapter 16, Section 16 13 - Earthquake Loads plus clarifications and additions specified in this Section.
- B. Provide vertical support, lateral bracing, anchorage and adequate space for movement of the following items:
 - 1. Equipment. Examples include tanks (excluding self-supporting tanks), vessels, electrical and mechanical machinery.
 - 2. Non-Structural Components. Examples include suspended ceilings, raised floors, partitions, storage racks and architectural features.
 - 3. Systems. Examples include conduit, piping, cable trays, raceways and ducts.
 - 4. Non-building structures. Examples include elevated tanks, horizontally support tanks, flat-bottom tanks, telecommunication towers and signs.
- C. Take full responsibility for the equipment anchorage design, which may be performed by the manufacturer or supplier.
- D. Furnish and install all integral parts of the anchoring system as well as any anchorages or restraints that are independent of the equipment but required by the manufacturer or supplier.
- E. Install anchorages with direct connections to structural elements shown on the drawings.
- F. Notify the Engineer if, in the opinion of the manufacturer, supplier or the Contractor, the anchorage conditions are so special that the available structural elements will not resist the anchorage forces. The Engineer will then provide instructions for procedures to be followed.
- G. Submit certification for all equipment specified in Divisions 02 through 46 inclusive. State that the equipment or component anchorage, and where required, the equipment itself, complies with the requirements of this Section. Include in the Certification the following:
 - 1. Description, sketch and seismic load capacity of the anchorage.
 - 2. Where required by the technical specifications or is listed as a deferred submittal, equipment anchorage calculations by an engineer registered in the State in which the project is being built.

SEISMIC REQUIREMENTS FOR CONTRACTOR-FURNISHED AND/OR INSTALLED ITEMS
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3. Where required by Sections 1.2 M.1 or 2 below, a statement that the equipment assembly is designed to resist seismic forces required by this Section.
- H. Coordinate the layout and detailing of each system so that adequate space is provided between different items for seismic motions. Provide additional supports and restraints between items of different systems when necessary to prevent seismic impacts or interaction.
- I. The Engineer's Review of items within a Specification Division cannot be completed until all items have been coordinated and submitted for review.

1.2 SPECIFIC REQUIREMENTS

- A. The project is located at 37.508 latitude and -120.847 longitude.
- B. The Risk Category is III:
 1. Apply the Importance Factors appropriate for the Risk Category above.
- C. The Seismic Design Category is D.
- D. The mapped spectral acceleration for short periods, $S_S=0.665$
- E. The mapped spectral acceleration for 1-second period, $S_1=0.264$
- F. The design spectral acceleration for short periods, $S_{DS}=0.562$.
- G. The design spectral acceleration for 1-second period, $S_{D1}=0.365$.
- H. The project area is Site Class D (Default).
- I. Equipment, Non-Structural Components and Systems Design:
 1. Seismic design of equipment, non-structural components and systems shall be in conformance with ASCE 7 Chapter 13.
 2. Provide support details for piping, conduit, duct or other systems to resist minimum loadings specified above, if not shown on the Drawings. Support systems required for fluid carrying piping greater than 5 inches diameter are shown on the Drawings.
- J. Non-Building Structures Design
 1. Seismic design of non-building structures shall be in conformance with ASCE 7 Chapter 15.
- K. Comply with more detailed requirements in Division 2 through 46 inclusive and the requirements of the relevant nationally recognized Society or Association:

1. For ductwork, mechanical piping, process piping and electrical conduits, follow Guidelines for Seismic Restraints of Mechanical Systems by SMACNA modified in Section 01 61 10.
2. For fire protection systems, follow NFPA 13 modified as in paragraph 1.b above. Ensure that no seismic interaction occurs with items of other systems.

1.3 SPECIFIC REQUIREMENTS FOR SPECIAL HYDRAULIC STRUCTURES

- A. To allow for water sloshing, design rigid items such as piping or equipment supports for twice the lateral force, computed as if the item were above water.

END SECTION

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SECTION 22 40 10
PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work required under this section consists of related items necessary and required to complete the work. The Contractor shall provide all items, and operations, including all labor, materials, equipment, and incidentals necessary for completion of work.
- B. Section Includes
 - 1. Floor Drains
 - 2. Cleanouts
 - 3. Backflow Preventers
 - 4. Trap Primer

1.2 RELATED WORK

1.3 REFERENCES

- A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
- B. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- C. ANSI A112.21.1 - Floor Drains.
- D. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

1.4 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures
- B. The information shall include but shall not be limited to the following:
 - 1. Complete assembly, foundations, and installation drawings, together with detailed specifications and data covering materials used and accessories forming part of the equipment furnished.
 - 2. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
 - 3. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

4. Manufacturer's Installation Instructions: Indicate assembly and support requirements.
5. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, trap primers.
6. Operation and Maintenance Data: Indicate frequency of treatment required for interceptors. Include spare parts lists, exploded assembly views.

1.5 MATERIALS

- A. All materials in contact with potable water shall be certified to ANSI/NSF Standard 61.
- B. All backflow prevention devices installed in potable water applications shall conform to California AB 1953 no-lead regulations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.1 FLOOR DRAINS

- A. Manufacturers:
 1. J.R. Smith
 2. Josam
 3. Zurn
 4. Wade

2.2 CLEANOUTS

- A. Manufacturers:
 1. Zurn, Model 1400
 2. Smith, Model 4020
 3. Josam, Model 58010
- B. Cleanout to Grade: Round cast nickel bronze access frame and non-skid cover.
- C. Floor Cleanout: Galvanized cast iron, two piece body with double drainage flange, weep holes, and scoriated cover in areas with quarry tile floor square with depressed cover to accept floor finish.

2.3 *BACKFLOW PREVENTERS*

- A. Manufacturers
 - 1. Febco
 - 2. Watts
 - 3. Wilkins

- B. Reduced Pressure (RPP) Backflow Preventers: ANSI/ASSE 1013; bronze body with bronze and plastic internal parts and stainless steel springs; two independently-operating, spring loaded check valves; diaphragm-type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.
 - 1. RPP Backflow preventer shall be Febco Model LF825Y, or Engineer-approved equivalent.

2.4 *TRAP PRIMERS*

- A. Manufacturers:
 - 1. Precision Plumbing Products
 - 2. Zurn
 - 3. Watts

- B. Provide a wall access panel to allow access to all trap primer valves.

PART 3 EXECUTION

3.1 *PREPARATION*

- A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.2 *INSTALLATION - GENERAL*

- A. Install in accordance with manufacturer's instructions.

- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

- C. Encase exterior cleanouts in concrete flush with grade.

3.3 *INSTALLATION - BACKFLOW PREVENTERS*

- A. Install backflow and back-siphoning prevention devices to protect the water supply as required by CCR Title 24, Part 5, California Plumbing Code.
- B. Vacuum Breakers:
 - 1. Mount at least 6 inches above the highest point of discharge.
 - 2. Locate after the last valve; there shall be no downstream valves.
- C. Pressure Vacuum Breakers:
 - 1. Mount at least 12 inches above the highest point of discharge.
 - 2. Pressure vacuum breakers may have downstream valves, but must not be subjected to backpressure.
- D. Reduced-Pressure-Principle Backflow Prevention Devices:
 - 1. Mount at least 12 inches above grade.

3.4 *FIELD QUALITY CONTROL - TESTING AND INSPECTION*

- A. Testing of backflow protection and anti-siphon devices prior to activation of the water supply line shall be performed by a Certified Tester.
- B. Devices shall conform to the requirements of applicable codes, or the following requirements, whichever are the more stringent.
- C. Atmospheric Vacuum Breaker:
 - 1. Perform visual inspection.
 - a. Verify there are no downstream valves.
 - b. Verify there are no leaks or mineral stains indicating leaks from the vent.
- D. Pressure Vacuum Breaker:
 - 1. Test opening pressure differential of the air inlet valve.
 - 2. Air inlet valve shall open when the pressure in the body is no less than 1.0 psi above the atmospheric pressure; the air opening valve shall be fully open when the water drains from the body.
 - 3. Test check valve for tightness in the direction of flow. The check valve shall be drip-tight in the normal direction of flow when the inlet pressure is 1.0 psi and the outlet pressure is atmospheric.
- E. Reduced-Pressure-Principle Devices:

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1. Test operation of the pressure differential relief valve.
2. The zone between the two check valves shall be at least 2.0 psi less than the supply pressure.
3. Test Check Valve Number 2 for tightness against reverse flow. Valve shall be tight against reverse flow under all pressure differentials.
4. Determine static pressure drop across Check Valve Number 1. Pressure drop shall be at least 3.0 psi greater than the pressure differential between the line pressure and the pressure in the zone required to open the pressure differential relief valve.

3.5 ADJUSTING

- A. Repair or replace items not conforming to specified requirements at no additional cost to Owner.

END SECTION

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SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes

1. Provide all labor, materials and equipment necessary to complete the installation required for the items specified under Division 26.

B. Related work under this section

1. Labor and materials required to furnish and install the electrical systems in a complete and operational fashion.
2. Carpentry, masonry, steel and concrete materials and labor required for construction of proper stands, bases and supports for electrical materials and equipment.
3. Cutting and patching of holes required by installation including flashing and counter-flashing of roof and exterior wall penetrations.
4. Excavating, pumping and backfilling required for installation.
5. Repair of damage to the premises resulting from construction activities under this Section to Owner's satisfaction.
6. Removal of work debris from construction activities to Owner's satisfaction.
7. Testing and cleaning of equipment installed.

C. Work not under this section

1. Furnishing of motors, pumps, fans, compressors, water heaters, thermostats and motor starters included under Divisions 23 and 40, or as noted otherwise.
2. Finish painting of exposed metal surfaces included under Division 9, or as otherwise noted.
3. Electrical Contractor shall provide connections to mechanical equipment where voltage exceeds 50 V and all necessary raceways for low voltage controls.

D. Related sections

1. Where items specified in other Division 26 sections conflict with the requirements of this Section, the most stringent requirement shall govern.
2. The requirements of this Section apply to all Division 26 work, as applicable.

1.02 REFERENCES

A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:

1. CCR –California Code of Regulations
 - a. Title 8 –Industrial Relations; Section 1 –Department of Industrial Relations

- 1) Chapter 3.2 -California Occupational Safety and Health Regulations (CAL/OSHA)
- 2) Chapter 4 –Section of Industrial Safety
 - a) Subchapter 4 -Construction Safety Orders (CSO)
 - b) Subchapter 5 -Electrical Safety Orders (ESO)
- b. Title 24 –California Building Standards
 - 1) Part 1 -Building Standards Administrative Code
 - 2) Part 2 -California Building Code (CBC); International Building Code (IBC) with California amendments
 - 3) Part 3 -California Electrical Code (CEC); NFPA 70 National Electrical Code (NEC) with California amendments
 - 4) Part 4 -California Mechanical Code (MEC); IAPMO Uniform Mechanical Code (UMC) with California amendments
 - 5) Part 5 -California Plumbing Code; IAPMO Uniform Plumbing Code (UPC) with California amendments
 - 6) Part 6 -California Energy Code
 - 7) Part 7 -California Elevator Safety Construction Code
 - 8) Part 9 -California Fire Code; International Fire Code (IFC) with California amendments
 - 9) Part 12 -California Reference Standards Code
2. CPUC –California Public Utilities Commission
 - a. GO-95; Rules for Overhead Electric Line Construction
 - b. GO-128; Rules for Construction of Underground Electric Supply and Communication Systems
3. IEEE –Institute of Electrical and Electronic Engineers
 - a. C2; National Electrical Safety Code (NESC)
4. NECA –National Electrical Contractors Association
 - a. 1; Standard Practices for Good Workmanship in Electrical Contracting
 - b. 4090; Manual of Labor Units
5. All applicable local municipal codes and ordinances.
6. Applicable rules and regulations of local utility companies.

1.03 SUBMITTALS

A. Product Data

1. Refer to Section 01 33 00 “Submittals.”

B. Closeout Submittal

1. Furnish three complete sets of maintenance and operating instructions bound in a binder and indexed to Owner. Start compiling data upon approval of materials

and equipment. Final inspection will not be made until Engineer approves binders. Refer also to Division 1 for additional requirements.

2. Provide one of each manufacturer proprietary tool required for proper equipment operation and maintenance provided under this Division. All tools shall be delivered to the Owner at project completion.
3. Provide two keys to Owner for each lock furnished under Division 26.
4. As-Built Drawings

1.04 *SUBSTITUTIONS*

1. Refer to Division 0.

1.05 *CHANGE ORDER PROPOSALS*

- A. Refer to Division 0.
- B. All change order proposals and requests, both additive and deductive, shall be accompanied by a detailed materials and labor breakdown for each specific task and/or item.

1.06 *QUALITY ASSURANCE*

- A. References to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to bid submittal. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.
- B. Work and materials shall be in full accordance with the latest rules and regulations of applicable state or local laws or regulations and standards of following:
 1. National Fire Protection Association (NFPA)
 2. California Electrical Code (CEC)
 3. California Occupational Safety Health Act (Cal-OSHA)
 4. California State Fire Marshall (CSFM)
 5. California Code of Regulations (CCR)
 6. Electrical Safety Orders, CAC Title 8 (ESO)
 7. California Public Utilities Commissions, General Order 95 (GO-95)
 8. Applicable rules and regulations of local utility companies.
 9. NECA 1-2006, Standard Practices for Good Workmanship in Electrical Contracting
- C. All electrical equipment and material furnished under Division 16 shall conform to all CEC requirements and bear the Underwriters' Laboratories (UL) label where applicable.
- D. Nothing in the Construction Documents shall be construed to permit work not conforming to these Codes. Whenever the indicated material, workmanship, arrangement or construction is of high quality or capacity than that required by the

above rules and regulations, the Construction Documents shall take precedence. Should there be any direct conflict between the rules and regulations and Construction Documents, the rules shall govern.

- E. All electrical equipment and material furnished under this Division shall conform to NEMA and ASTM standards, CEC and bear the Underwriters' Laboratories (UL) label where such label is applicable.
- F. All electrical work shall conform to manufacturer's written instruction, and the NECA Standard Practices for Good Workmanship in Electrical Contracting and all published recommended practices at the time of project. The Contractor shall use the requirements within the Specifications whenever they exceed NECA guidelines.
- G. Follow manufacturer's direction where these direction cover points not included with the Construction Documents.

1.07 *DELIVERY, STORAGE AND HANDLING*

- A. Packing, shipping, handling and unloading
 - 1. Damage to the equipment delivered to the site or in transit to the job shall be the responsibility of the Electrical Contractor.
 - 2. Equipment and material delivery of shall be scheduled as required for timely, expeditious progress of work.
- B. Storage and protection of job equipment is the responsibility Contractor.
- C. Comply with Division 1 requirements with regards to waste management and disposal.

1.08 *PROJECT CONDITIONS*

- A. Discrepancies
 - 1. In the event of discrepancies with the Contract Documents, Engineer shall be notified with sufficient time as stated within Division 1 to allow the issuing of an addendum prior to the bid opening.
 - 2. If, in the event that time does not permit notification of clarification of discrepancies prior to the bid opening, the following shall apply:
 - a. The drawings govern in matters of quantity and specifications govern in matters of quality.
 - b. In the event of conflict within the drawings and specifications involving quantities or quality, the greater quantity or higher quality shall apply. Such discrepancies shall be noted and clarified within the contractor's bid. No additional allowances will be made because of errors, ambiguities or omissions which reasonably should have been discovered during the bid preparation.
- B. Verify all power and communication utilities' requirements prior to commencement of any utility work. Make proper adjustments to the construction to satisfy the serving utility.
- C. Information shown relative to services is based upon available records and data, but shall be regarded as approximate only. Make minor deviations found necessary to

conform to actual locations and conditions without extra cost. Verify locations and elevations of utilities prior to commencement of excavation for new underground installation.

- D. Exercise extreme care in excavating near existing utilities to avoid any damage thereto; be responsible for any damage caused by such operations. Contact all utility companies to obtain exact locations prior to commencement of construction.
- E. The electrical plans indicate the general layout and arrangement; the field conditions shall determine exact locations. Field verify all conditions and modify as required to satisfy design intent. Maintain all required working clearances.
- F. Fees, permits and utility services
 - 1. Obtain and pay for all permits and service charges required for the installation of this work. Arrange for required inspections and secure approvals from authorities having jurisdiction. Arrange for all utility connections and pay charges incurred including excess service charges if any.
 - 2. Extra charges imposed by the electrical and communication utility companies shall be included in the bid, if available. Unless otherwise stated, these charges will be assumed to include in the bid.
- G. Provide and maintain temporary construction power. The General Contractor will pay for electric energy charges. Should the Electrical Contractor be the prime contractor, the Electrical Contractor shall pay for energy charges unless negotiated with Owner.

1.09 SEQUENCING

- A. Coordinate work within phasing plans as provided by the Owner.

1.10 WARRANTY

- 1. Refer to City Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials mentioned herein or on Drawings require that the items be provided and of quality noted or an approved equal. All materials shall be new, full weight, standard in all respects and in first-class condition. Insofar as possible, all materials used shall be of the same brand or manufacturer throughout for each class of material or equipment.
- B. Trade names or catalog numbers stated herein indicates grade or quality of material desired. Materials, where applicable, shall be UL labeled and in accordance with NEMA standards.
- C. Dimensions, sizes and capacities shown are a minimum. Do not make changes without written permission of Engineer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Construction Documents and Site; be familiar with types of construction where electrical installation is involved. Note carefully other sections of Specifications with their individual cross-references, standard details, etc.
- B. Any electrical work or materials shown either in Construction Documents, but not mentioned herein, or vice versa, shall be executed the same as if mentioned herein, in a workmanlike manner in accordance with all published NECA Standards of Installation.
- C. Coordinate work with other crafts to avoid conflicts and check all outlet locations with drawings and specifications. Make minor adjustments without additional cost to Owner.
- D. Engineer will make clarifications and rulings concerning any obvious discrepancies or omissions in work prior and after bidding. Perform all work involved in correcting obvious errors or omissions after award of contract as directed by Engineer at Contractor's expense.
- E. Examine site dimensions and locations against Drawings and become informed of all conditions under which work is to be done before submitting proposals. No allowance will be made for extra expense due to error.
- F. Layouts of equipment, accessories and wiring systems are diagrammatic (not pictorial) but shall be followed as closely as possible. Construction Documents are for assistance and guidance, and exact locations, distance, levels, etc., will be governed by construction; accept same with this understanding.
- G. Horsepower of motors or wattage of equipment indicated in Construction Documents is estimated horsepower or wattage requirement of equipment furnished under other sections of Specifications. Size all feeders (conduit and wiring), motor starters, overload protection and circuit breakers to suit horsepower of motors or wattage of equipment actually furnished under various sections of specifications. However, in no case shall feeders and branch circuits (conduit and wiring) and circuit breakers be of smaller capacities or sizes than those indicated on Drawings or specified, unless approved in writing by Engineer.

3.02 PREPARATION

- A. Seal all exterior wall penetrations in an approved watertight manner and to the satisfaction of Engineer and Owner.
- B. Channels, joiners, hangers, caps, nuts and bolts and associated parts shall be plated electrolytically with zinc followed immediately thereafter by treating freshly deposited zinc surfaces with chromic acid to obtain a surface which will not form a white deposit on surface for an average of 120 hours when subjected to a standard salt spray cabinet test, or shall be hot dipped galvanized

3.03 INSTALLATION

- A. Equipment identification

1. Properly identify panelboards, remote control switches, push buttons, terminal boxes, etc. with a descriptive nameplate. Make nameplate with 3/32" laminated plastic with black background and white letters. Machine engraved letters 1/8" high for equipment in device box(es) and 1/4" high for panelboards, terminal cabinets or larger items. Punched strip type nameplates and cardholders in any form are not acceptable. Fasten nameplates with oval head machine screws, tapped into front cover/panel.

B. Working spaces

1. Provide adequate working space around electrical equipment in compliance with Article 4 of Electrical Safety Orders and CEC 110.26. In general, provide 78" of headroom and 30" wide minimum clear workspace in front of panelboards and controls. In addition to the above, provide the following minimum working clearances:
 - a. 0V – 150V (line-to-ground) provide 36" minimum clear distance.
 - b. 151V – 600V (line-to-ground) provide 42" minimum clear distance.

C. Equipment supports

1. Anchor all electrical equipment to structure. Support systems shall be adequate to withstand seismic forces per CBC.

D. Excavating and backfilling

1. Excavate and backfill as required for installation of Work. Restore all surfaces, roadways, walks, curbs, walls existing underground installations, etc., cut by installations to original condition in an acceptable manner. Maintain all warning signs, barricades, flares and lanterns as required by ESO and local ordinances.
2. Dig trenches straight and true to line and grade, with bottom clear of any rock points. Support conduit for entire length on undisturbed original earth. Minimum conduit depth of pipe crown shall be 24" below finished or natural grade, unless otherwise noted.

E. Forming, cutting and patching

1. In new construction, General Contractor shall provide any special forming, recesses, chased, etc., and provide wood blocking, backing and grounds as necessary for the proper installation of electrical work. Be responsible for notifying General Contractor that such provision is necessary; layout work and check to see that it suits his requirements.
 - a. Provide metal backing plates, anchor plates and such that are required for anchorage of electrical work under Division 26; securely weld or bolt to metal framing. Wood blocking or backing will not be permitted in combination with metal framing.
2. Be responsible for proper placement of pipe sleeves, hangers, inserts and supports for this Work.

F. Concrete work

1. Provide concrete work related solely to electrical work. Concrete work, including forming and reinforcing steel installed for all electrical work, shall comply with all applicable requirements of Division 03 30 10, or in accordance with the State of

California Standard Specifications issued by the Department of Transportation (CALTRANS).

3.04 REPAIR/RESTORATION

- A. Cutting, patching and repairing of existing construction to permit installation of work under Division 26 is the responsibility of Contractor. Repair or replace all damage to existing work in kind to Owner's satisfaction.
- B. Obtain Engineer's approval prior to performing any cutting or patching of concrete, masonry, wood or steel structure within building.

3.05 FIELD QUALITY CONTROL

- A. Inspection of work
 - 1. Working parts shall be readily accessible for inspection, repair and renewal. The right is reserved to make reasonable changes in equipment location shown on Drawings prior to rough in without additional costs to the Owner.
 - 2. During construction all work will be subject to observation by the Engineer and his representatives. Assist in ascertaining any information that maybe required.
 - 3. Do not allow or cause any work installed hereunder to be covered up or enclosed before it has been inspected and approved. Should any work be enclosed or covered prior to approval, uncover work, and after it has been inspected and approved, restore work of all others to the condition in which it was found at the time of cutting, all without additional costs to Owner.
- B. Furnish all testing equipment as maybe required.
- C. Test all wiring and connections for continuity and grounds; where such tests indicate faulty insulation or other defects, locate, repair and re-test.
- D. Check rotation of all motors and correct if necessary.

3.06 CLEANING

- A. Repair or replace all broken, damaged or otherwise defective parts without additional cost to Owner and leave entire work in a condition satisfactory to Engineer. At completion, carefully clean and adjust all equipment, fixtures and trim installed as part of this work; leave systems and equipment in satisfactory operating condition.
- B. Clean out and remove from the site all surplus materials and debris resulting from this work; this includes surplus excavated materials.

3.07 DEMONSTRATION

- A. At project completion, Contractor shall allot a period of not less than 8 hours per well site for instruction of operating and maintenance personnel in the use of all systems installed under this Division. This time is in addition to any instruction time stated in the Specifications of other sections for other equipment (i.e., fire alarm, security, intercom, etc.). All personnel shall be instructed at one time, the Contractor shall make all necessary arrangements with manufacturer's representatives as may be required. Contractor, if any, for the above services shall pay all costs.

3.08 PROTECTION

- A. In performance of work, protect work of other trades as well as work under this Division from damage.
- B. Protect electrical equipment, stored and installed, from dust, water or other damage.

END OF SECTION

SECTION 26 05 19 CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes

1. Provide all labor, materials and equipment necessary for the installation of all conductors and cables under this Section related to lighting, power, mechanical, control and signal systems.

B. Related sections

1. Where items specified in other Division 26 sections conflict with the requirements of this Section, the most stringent requirement shall govern.
2. The requirements of this Section apply to all Division 26 work, as applicable.
3. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:

1. ASTM -American Society for Testing and Materials
 - a. B3; Standard Specification for Soft or Annealed Copper Wire
 - b. B8; Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - c. B787/B787M; Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation
 - d. D1000; Standard Test Method for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
2. CCR –California Code of Regulations, Title 24
 - a. Part 3 -California Electrical Code (CEC); NFPA 70 National Electrical Code (NEC) with California amendments
3. UL -Underwriters Laboratories, Inc.
 - a. UL 83; Thermoplastic-Insulated Wire and Cables
 - b. UL 486A 486B; Wire Connectors
 - c. UL 486C; Splicing Wire Connectors
 - d. UL 486D; Standard for Insulated Wire Connector Systems For Underground Use Or In Damp Or Wet Locations
 - e. UL 486E; Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

- f. UL 493; Thermoplastic-Insulated Underground Feeders and Branch Circuit Cables
- g. UL 510; Standard for Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
- h. UL 854; Service-Entrance Cables
- 4. NEMA –National Electrical Manufacturer’s Association
 - a. WC 70-1999; Nonshielded Power Cables Rated 2000 Volts or less for the Distribution of Electrical Energy
- 5. IEEE –Institute of Electrical and Electronic Engineers
 - a. 82; Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors

1.03 DELIVERY

- A. Wire shall be in original unbroken package. Obtain approval of Inspector or Engineer before installation of wires.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

- A. Conductor material
 - 1. Provide annealed copper for all wire, conductor and cable of not less than 98% conductivity.
 - 2. Wire #8 AWG and larger shall be stranded.
 - 3. Wire #10 AWG and smaller may be stranded as long as the device being connected is listed from use with stranded wire. Under no circumstance will crimped terminals be allowed to make the installed Code compliant.
- B. Insulation material
 - 1. All insulated wire, conductor and cable shall be 600 Vac rated.
 - 2. Feeder and branch circuits larger than #6 AWG shall be type THW, XHHW or THHN/THWN.
 - 3. Feeder and branch circuits #6 AWG and smaller shall be type TW, THW, XHHW or THHN/THWN.
 - 4. Control circuits shall be type THW or THHN/THWN.
 - 5. Wires shall bear the UL label marked with gauge, type and manufacturer’s name on 24” centers.
 - 6. Insulation color shall match identification stated within these Specifications. The application of phase taping for conductors will not be permitted.

2.02 FLEXIBLE CORDS AND CABLES

- A. Provide flexible cords and cables of size, type and arrangement as indicated on Drawings.

- B. Type S flexible cords and cable shall be manufactured in accordance with CEC Article 400 and composed of two or more conductors and a full sized green insulated grounding conductor with an outer rubber or neoprene jacket.
- C. Flexible cords and cables shall be fitted with wire mesh strain relief grips either as a integral connector component or an independently supported unit.
- D. Suspended flexible cords and cables shall incorporate safety spring(s).

2.03 WIRE CONNECTIONS AND TERMINATIONS

- A. Electrical spring wire connectors
 - 1. Provide multi-part construction incorporating a non-restricted, zinc coated square cross-sectional steel spring enclosed in a steel sheet with an outer jacket of plastic and insulating skirt.
 - 2. Self-striping pigtail and tap U-contact connectors are not acceptable.
- B. Compression type terminating lugs
 - 1. Provide tin-plated copper high compression type lugs for installation with hand or hydraulic crimping tools as directed by manufacturer. Notch or single point type crimps are not acceptable.
 - 2. Two-hole, long barrel lugs shall be provided for size #4/O AWG and larger wire where terminated to bus bars. Use minimum of three crimps per lug where possible.
- C. Splicing and insulating tape
 - 1. Provide black, UV resistant, self extinguishing, 7 mil thick vinyl general purpose electrical tape per UL 510 and ASTM D1000. 3M Scotch 33 or equal.
- D. Insulating putty
 - 1. Provide pads or rolls of non-corrosive, self-fusing, 125 mil thick rubber putty with PVC backing sheet per UL 510 and ASTM D1000. 3M Scotchfil or equal.
- E. Insulating resin
 - 1. Provide two-part liquid epoxy resin with resin and catalyst in pre-measured, sealed mixing pouch. 3M Scotchcast 4 or equal.
 - 2. Use resin with thermal and dielectric properties equal to the cable's insulating properties.
- F. Terminal strips
 - 1. Provide box type terminal strips in the required quantities plus 25% spare. Install in continuous rows.
 - 2. Use the box type terminal strips with barrier open backs and with ampere ratings as required.
 - 3. Identify all terminal strips and circuits.
- G. Crimp type connectors
 - 1. Provide insulated fork or ring crimp terminals with tinned electrolytic copper-brazed barrel with funnel wire entry and insulation support.

2. Fasten crimp type connectors or terminals using a crimping tool recommended by the manufacturer.
 3. Provide insulated overlap splices with tinned seamless electrolytic copper-brazed barrel with funnel wire entry and insulation support.
 4. Provide insulated butt splices with tinned seamless electrolytic copper-brazed barrel with center stop, funnel wire entry and insulation support.
- H. Cable ties
1. Provide harnessing and point-to-point wire bundling with nylon cable ties. Install using tool supplied by manufacturer as required.
- I. Wire lubricating compound
1. UL listed for the wire insulation and conduit type, and shall not harden or become adhesive.
 2. Shall not be used on wire for isolated type electrical power systems.
- J. Bolt termination hardware
1. Bolts shall be plated, medium carbon steel heat-treated, quenched and tempered equal to ASTM A-325 or SAE Grade 5; or silicon bronze alloy ASTM B-9954 Type B.
 2. Nuts shall be heavy semi-finished hexagon, conforming to ANSI B18.2.2, threads to be unified coarse series (UNC), class 2B steel or silicon bronze alloy.
 3. Flat washers shall be steel or silicon bronze, Type A plain standard wide series, conforming to ANSI B27.2. SAE or narrow series shall be used.
 4. Belleville conical spring washers shall be hardened steel, cadmium plated or silicon bronze.
 5. Each bolt connecting lug(s) to a terminal or bus shall not carry current exceeding the following values:
 - a. 1/4" bolt – 125 A
 - b. 5/16" bolt – 175 A
 - c. 3/8" bolt – 225 A
 - d. 1/2" bolt – 300 A
 - e. 5/8" bolt – 375 A
 - f. 3/4" bolt – 450 A

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Thoroughly examine site conditions for acceptance of wire and cable installation to verify conformance with manufacturer and specification tolerances. Do not commence with work until all conditions are made satisfactory.

3.02 *INSTALLATION*

- A. All wire, conductor, and cable with their respective connectors, fittings and supports shall be UL listed for the installed application and ambient conditions.
- B. Feeders and branch circuits in wet locations shall be rated 75°C minimum.
- C. Feeders and branch circuits in dry locations shall be rated 90°C minimum.
- D. Minimum conductor size
 - 1. #12 AWG copper for all power and lighting branch circuits.
 - 2. #14 AWG copper for all line voltage signal and control wiring, unless otherwise indicated.
- E. Remove and replace conductors under the following conditions at no additional costs to the Owner:
 - 1. Installed within wrong specified conduit or raceway.
 - 2. Damaged during installation.
 - 3. Of insufficient length to facilitate proper splice of conductors

3.03 *WIRING METHODS*

- A. Install wires and cable in accordance with manufacturer's written instructions, as shown on Drawings and as specified herein.
- B. Install all single conductors within raceway system, unless otherwise indicated.
- C. Parallel circuit conductors and terminations shall be equal in length and identical in all aspects.
- D. Provide adequate length of conductors within electrical enclosures and neatly train to termination points with no excess. Terminate such that there is no bare conductor at the terminal.
- E. Splice cables and wires only in junction boxes, outlet boxes, pull boxes, manholes or handholes.
- F. Group and bundle with tie wrap each neutral with its associated phase conductors where more than one neutral conductor is present within a conduit.
- G. Install cable supports for all vertical feeders in accordance with CEC Article 300. Provide split wedge type fittings, which firmly clamp each individual cable and tighten due to cable weight.
- H. Seal cable where exiting a conduit from an exterior underground raceway with a non-hardening compound (i.e., duct seal or equal).
- I. Provide UL listed factory fabricated, solder-less metal connectors of size, ampacity rating, material, type and class for applications and for services indicated. Use connectors with temperature ratings equal or greater than the conductor or cable being terminated.
- J. Stranded wire shall be terminated using fittings, lugs or devices listed for the application. Under no circumstances shall stranded wire be terminated solely by wrapping it around a screw or bolt.

- K. Flexible cords and cables supplied as part of a pre-manufactured assembly shall be installed according to manufacturer's published instructions.

3.04 *WIRING INSTALLATION IN RACEWAYS*

- A. Install wire in raceway after interior of building has been physically protected from weather, and all mechanical work likely to injure conductors has been completed.
- B. Pull all conductors into raceway at the same time.
- C. Use UL listed, non-petroleum base and insulating type pulling compound as needed.
- D. Completely mandrel all underground or concrete encased conduits prior to installation.
- E. Completely and thoroughly swab raceway system prior to installation
- F. Do not use block and tackle, power driven winch or other mechanical means for pulling conductors smaller than #1 AWG.
- G. Wire pulling
 - 1. Provide installation equipment that will prevent cutting or abrasion of insulation during installation.
 - 2. Maximum pull tension shall not exceed manufacturer's recommended value during installation for cable being measured with tension dynameter.
 - 3. Use rope made of non-metallic material for pulling.
 - 4. Attach pulling lines by means of either woven basket grips or pulling eyes attached directly to the conductors.
 - 5. Pull multiple conductors simultaneously within same conduit.

3.05 *WIRE SPLICES, JOINTS AND TERMINATIONS*

- A. Join and terminate wire, conductors and cables in accordance with UL 486, CEC and manufacturer's instructions.
- B. Thoroughly clean wires before installing lugs and connectors.
- C. Make splices, taps and terminations to carry full conductor ampacity without perceptible temperature rise, and shall be made mechanically and electrically secure.
- D. Terminate wires in terminal cabinets using terminal strips, unless otherwise indicated.
- E. Insulate spare conductors with electrical tape and leave sufficient length to terminate anywhere within panel or cabinet.
- F. Encapsulate splices in wet locations using specified insulating resin kits.
- G. Make up all splices and taps in accessible junction or outlet boxes with connectors as specified herein. Pigtails and taps shall be the same color as feed conductor with at least 6 inches of tail, all neatly packed within box.
- H. Where conductors are to be connected to metallic surfaces, coated surfaces shall be cleaned to base metal surface before installing connector. Remove lacquer coating of conduits where ground clamps are to be installed.

- I. Branch circuits (#10 AWG and smaller) connectors shall comply with 2.03.A and 2.03.B above.
- J. Branch circuits (#8 AWG and larger)
 - 1. Join or tap conductors using insulated mechanical compression taps with pre-molded, snap-on insulating boots or specified conformable insulating pad and over-wrapped with two half-lapped layers of vinyl insulating tape starting and ending at the middle of joint.
 - 2. Terminate conductors using mechanical compression lugs in accordance with manufacturer's recommendation or as specified elsewhere.
 - 3. Field installed compression connectors for 250 MCM and larger shall have not less than two clamping elements or compression indents per wire.
 - 4. Insulate splices and joints with materials approved for the particular use, location, voltage and temperature.
- K. Termination hardware assemblies
 - 1. Al/Cu lugs connected to aluminum plated or copper bus shall be secured with steel bolt, flat washer (two per bolt), Belleville washer and nut.
 - 2. Copper lugs connected to copper buss shall be secured using silicon bronze alloy bolt, flat washer (two per bolt), Belleville washer and nut.
 - 3. The crown of Belleville washers shall be under the nut.
 - 4. Bolt assemblies shall be torque to manufacturer's recommendations. Where manufacturer recommendation is not obtainable, the following shall be used:
 - a. 1/4" -20 bolt at 80 inch-pound torque
 - b. 5/16" -18 bolt at 180 inch-pound torque
 - c. 3/8" -20 bolt at 20 inch-pound torque
 - d. 1/2" -20 bolt at 40 inch-pound torque
 - e. 5/8" -20 bolt at 55 inch-pound torque
 - f. 3/4" -20 bolt at 158 inch-pound torque

3.06 IDENTIFICATION

- A. Securely tag all branch circuits. Mark conductors with specified vinyl wrap-around markers. Where more than two conductors run through a single outlet, mark each conductor with the corresponding circuit number.
- B. Provide all terminal strips with each individual terminal identified using specified vinyl markers.
- C. In manholes, pullboxes and handholes provide tags of embossed brass type with cable type and voltage rating. Attach tags to cable with slip-free plastic cable lacing units.
- D. Color coding
 - 1. For 120/208 Volt (or 120/240 Volt), 1 phase, 3 wire systems:
 - a. Phase A – Black

- b. Phase B – Red
 - c. Neutral – White
 - d. Ground – Green
2. For 120/208 Volt, 3 phase, 4 wire systems:
 - a. Phase A – Black
 - b. Phase B – Red
 - c. Phase C – Blue
 - d. Neutral – White
 - e. Ground – Green
 3. For 277/480 Volt, 3 phase, 4 wire systems:
 - a. Phase A – Brown
 - b. Phase B – Orange
 - c. Phase C – Yellow
 - d. Neutral – Gray
 - e. Ground – Green
 4. Switch leg individually installed shall be the same color as the branch circuit to which they originate, unless otherwise indicated.
 5. Travelers for 3-way and 4-way switches shall be a distinct color and pulled with the circuit switch leg or neutral.

3.07 *FIELD QUALITY CONTROL*

- A. Supply labor, materials and test equipment required to perform continuity and ground tests.
- B. Electrical testing
 1. Perform feeder and branch circuit insulation test after installation and prior to connection to device.
 2. Tests shall be performed by 600 Vdc megger for a continuous 10 seconds from phase-to-phase and phase-to-ground.
 3. Torque test conductor connections and terminations for conformance to Specifications.
 4. If any failure is detected, locate failure, determine cause and replace or repair cable to Engineer's satisfaction at no additional costs.
 5. Furnish test results in type written report form for review by Engineer.

END OF SECTION

SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes

1. Provide all labor, materials and equipment necessary to complete the installation required for the item specified under this Section, including but not limited to power system grounding

B. Related sections

1. Where items specified in other Division 26 sections conflict with the requirements of this Section, the most stringent requirement shall govern.
2. The requirements of this Section apply to all Division 26 work, as applicable.
3. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:

1. CCR –California Code of Regulations, Title 24
 - a. Part 3 -California Electrical Code (CEC); NFPA 70 National Electrical Code (NEC) with California amendments
2. IEEE –Institute of Electrical and Electronic Engineers
 - a. 142; Recommend Practices for Grounding of Industrial and Commercial Power Systems
3. NFPA –National Fire Protection Association
 - a. 780; Lightning Protection Code
4. UL –Underwriters Laboratories, Inc.
 - a. 467; Grounding and Bonding Equipment

1.03 SYSTEM DESCRIPTION

- A. This Section provides for the grounding and bonding of all electrical and communication apparatus, machinery, appliances, components, fittings and accessories where required to provide a permanent, continuous, low impedance, grounded electrical system.**
- B. Ground the electrical service system neutral at service entrance equipment as shown on the Drawings.**

- C. Ground each separately derived system, as defined in CEC 250.5 (D) and on the Drawings, unless specifically noted otherwise.
- D. Except as otherwise indicated, the complete electrical installation including the neutral conductor, equipment and metallic raceways, boxes and cabinets shall be completely and effectively grounded in accordance with all CEC requirements, whether or not such connections are specifically shown or specified.

1.04 SUBMITTALS

- A. Submit manufacturer's data for equipment and materials specified within this Section in accordance to Section 26 05 00.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the materials specified herein shall be new and unused, bearing UL labels where applicable.

PART 2 - PRODUCTS

2.01 CONCRETE ENCASED GROUNDING ELECTRODE (UFER GROUND)

- A. #3/O AWG minimum bare stranded copper conductor.

2.02 DRIVEN (GROUND) RODS

- A. Copper clad steel, minimum 3/4" diameter by 10'-0" length, sectional type with copper alloy couplings and carbon steel driving stud; Weaver, Cadweld or equal.

2.03 INSULATED GROUNDING BUSHINGS

- A. Plated malleable iron body with 150°C molded plastic insulated throat and lay-in ground lug; OZ/Gedney BLG, Thomas & Betts #TIGB series or equal.

2.04 CONNECTION TO PIPE

- A. Cable to pipe connections; OZ/Gedney G-100B series, Thomas & Betts #290X series or equal.

2.05 CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS OR SPICES

- A. Where required by the Drawings, grounding conductors shall be spliced together, connected to ground rods or connected to structural steel using exothermic welds, Cadweld or equal, or high-pressure compression type connectors, Cadweld, Thomas & Betts or equal.

2.06 BONDING JUMPERS

- A. OZ/Gedney Type BJ, Thomas & Betts #3840 series or equal.

2.07 GROUND CONDUCTOR

- A. Ground conductor shall be code size UL labeled, Type THWN insulated copper wire, green in color.

2.08 MAIN BUILDING REFERENCE GROUND BUS (BGB)

- A. Provide 1 24"x4"x1/4" TK copper bus bar mounted on wall with insulating stand-offs at +18" AFF. Furnish complete with cast copper alloy body Thomas Betts Series 310 or equal lugs for connecting grounding conductors. Attach lugs to bus with appropriate size bronze bolt, flat washer and Belleville washer. All connections shall be torque, and all holes shall be drilled and tapped for single hole lugs. Provide 4 spare lugs with respective spaces.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Grounding electrodes

1. Concrete encased grounding electrode (Ufer ground)

- a. Provide a #3/O AWG minimum bare copper conductor encased along the bottom of concrete foundation, footing or trench which is in direct contact with the earth and where there is no impervious waterproofing membrane between the footing and soil. The electrode shall extend through a horizontal length of 30' minimum and shall be encased in not less than 2" or more than 5" of concrete separating it from surrounding soil. The electrode shall emerge from the concrete slab through a protective non-metallic sleeve and shall be extended to BGB or as shown on Drawings.

2. Supplementary grounding electrode (ground ring, grid and driven rod)

- a. Provide as shown driven ground rod(s). Interconnect ground rod with structural steel and adjacent rods with code size bare copper conductor. Ground rods shall be space no less than 6'-0" on centers from any other electrode or electrodes of another electrical system.

3. Separately derived electrical system grounding electrode

- a. Ground each separately derived system per CEC 250-26 or as shown on Drawings, whichever is greater.

4. Metal underground water pipe

- a. Contractor shall install an accessible grounding electrode conductor from the main incoming cold-water line to BGB. The electrode conductor shall be sized per CEC Table 250-94 or as shown on Drawings, whichever is greater.

B. Grounding electrode conductor

- 1. Provide grounding electrode conductors per CEC Table 250-94 or as shown on Drawings, whichever is greater.

C. Power system grounding

- 1. Connect the following items using code size copper grounding conductors to BGB or as shown on Drawings:

- a. Concrete encased electrode (Ufer ground)
- b. Ground rod(s)
- c. Incoming cold and fire water pipes
- d. Gas pipe
- e. Structural steel
- f. Distribution transformer secondary

D. Equipment Bonding/Grounding

1. Provide a code sized copper ground conductor, whether indicated or noted on the drawings, in each of the following:
 - a. All power distribution conduits and ducts
 - b. Distribution feeders
 - c. Motor and equipment branch circuits
 - d. Device branch circuits
2. Provide a separate grounding bus at distribution panelboards, loadcenters, switchboards and motor control centers. Connect all metallic enclosed equipment so that with maximum fault current flowing, shall be maintained at not more than 35V above ground.
3. Metallic conduits terminating in concentric, eccentric or oversized knockouts at panelboards, cabinets, gutters, etc. shall have grounding bushings and bonding jumpers installed interconnecting all such conduits.
4. Provide bonding jumpers across expansion and deflection coupling in conduit runs, pipe connections to water meters and metallic cold-water dielectric couplings.
5. Provide ground wire in flexible conduit connected at each end via grounding bushing.
6. Provide bonding jumpers across all cable tray joints.
7. Bond each end of metallic conduit longer than 36" in length to grounding conductor using a #6 AWG pigtail.

3.02 *FIELD QUALITY CONTROL*

- A. Contractor using test equipment expressly designed for that purpose shall perform all ground resistance tests in conformance with IEEE guidelines. Contractor shall submit typewritten records of measured resistance values to Engineer for review and approval prior to energizing the system.
- B. Obtain and record ground resistance measurements both from electrical equipment ground bus to the ground electrode and from the ground electrode to earth. Furnish and install additional bonding and add grounding electrodes as required to comply with the following resistance limits:
 1. Resistance from ground bus to ground electrode and to earth shall not exceed 5 ohms unless otherwise noted.

2. Resistance from the farthest panelboard, loadcenter, switchboard or motor control center ground bus to the ground electrode and to earth shall not exceed 20 ohms maximum.
- C. Inspection
1. The Engineer or Inspector prior to encasement, burial or concealment thereto shall review the grounding electrode and connections.

END OF SECTION

SECTION 26 05 33 RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes

1. Provide all labor, materials and equipment necessary to complete the installation required for the items specified under this Section, including but not limited to electrical conduits; outlet, junction and pull boxes; and related supports.

B. Related sections

1. Where items specified in other Division 26 sections conflict with the requirements of this Section, the most stringent requirement shall govern.
 - a. 26 05 26 – Grounding and Bonding for Electrical Systems
2. The requirements of this Section apply to all Division 26 work, as applicable.
3. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:

1. ANSI –American National Standards Institute
 - a. C33.91; Specification for Rigid PVC Conduit
 - b. C80.1; Specification Rigid Steel Conduit, Zinc-Coated
 - c. C80.3; Specification for Electrical Metallic Tubing, Zinc-Coated
 - d. C80.6; Intermediate Metal Conduit (IMC), Zinc-Coated
2. CCR –California Code of Regulations, Title 24
 - a. Part 2 -California Building Code (CBC); International Building Code (IBC) with California amendments
 - b. Part 3 -California Electrical Code (CEC); NFPA 70 National Electrical Code (NEC) with California amendments
3. NECA –National Electrical Contractors Association
 - a. 101, Standard for Installing Steel Conduit (Rigid, IMC, EMT)
 - b. 111, Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) (ANSI)
4. NEMA –National Electrical Manufacturer’s Association
 - a. FB 1; Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

- b. FB 2.10; Selection and Installation Guidelines for Fittings for Use with Non-flexible Electrical Metal Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing)
 - c. FB 2.20; Selection and Installation Guidelines For Fittings for Use With Flexible Electrical Conduit and Cable
 - d. OS 1; Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
 - e. OS 3; Selection and Installation Guidelines for Electrical Outlet Boxes
 - f. RN 1; Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
 - g. TC 2; Electrical Plastic Tubing and Conduit
 - h. TC 3; PVC Fittings for Use with Rigid PVC Conduit and Tubing
 - i. TC 14; Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
5. OSHPD Anchorage Pre-approvals
- a. OPA-0003; Superstrut Seismic Restraint System
 - b. OPA-0114; B-Line Seismic Restraints
 - c. OPA-0120; Unistrut Seismic Bracing System
 - d. OPA-0242; Power-Strut Seismic Bracing System
6. UL –Underwriter’s Laboratories, Inc.
- a. 1; Standard for Flexible Metal Conduit
 - b. 6; Rigid Metal Electrical Conduit
 - c. 360; Standard for Liquid-Tight Flexible Steel Conduit
 - d. 514A; Metallic Outlet Boxes, Electrical
 - e. 514B; Fittings for Conduit and Outlet Boxes
 - f. 651; Schedule 40 & 80 PVC Conduit
 - g. 797; Electrical Metallic Tubing
 - h. 1242; Intermediate Metal Conduit
 - i. 1684; Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1.03 SYSTEM DESCRIPTION

- A. Furnish, assemble, erect, install, connect and test all electrical conduits and related raceway apparatus required and specified to form a complete installation.

1.04 SUBMITTALS

- A. Submit manufacturer’s data for materials specified within this Section in accordance to Section 26 05 00.

1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the materials specified herein shall be new and unused, bearing UL labels where applicable.
- B. Installation shall conform to the NECA installation guidelines unless otherwise indicated within this Section

PART 2 - PRODUCTS

2.01 MATERIALS

A. Conduits and Fittings

1. Rigid steel conduit (RMC)

- a. Conduit: Standard weight, mild steel pipe, and zinc coated on both inside and outside by a hot dipping or shearardizing process manufactured in accordance with UL 6 and ANSI C80.1 specifications.
- b. Fittings (couplings, elbows, bends, etc.)
 - 1) Shall be steel or malleable iron.
 - 2) Coupling and unions shall be threaded type, assembled with anti-corrosion, conductive and anti-seize compound at joints made absolutely tight to exclude water.
- c. Bushings
 - 1) Insulating bushings: Threaded polypropylene or thermosetting phenolic rated at 150°C minimum.
 - 2) Insulating grounding bushing: Threaded cast body with insulating throat and steel "lay-in" ground lug.
 - 3) Insulating metallic bushing: Threaded cast body with plastic insulated throat rated at 150°C minimum.

2. Coated rigid steel conduit (CRMC)

- a. Conduit: Equivalent to RMC with a Polyvinyl chloride (PVC) coated bonded to the galvanized outer surface of the conduit. The bonding between the PVC coating and conduit surface shall be ETL PVC-001 compliant. The coating thickness shall be a minimum of 40mil.
- b. Fittings (couplings, elbows, bends, etc.)
 - 1) Equivalent to RMC above with bonded coating same as conduit.
 - 2) The PVC sleeve over fittings shall extend beyond hub or coupling approximately one diameter or 1 1/2" whichever is smaller.
- c. Bushing equivalent to RMC above.

3. Intermediate metallic conduit (IMC)

- a. Conduit: Intermediate weight, mild steel pipe, meeting the same requirements for finish and material as rigid steel conduit manufactured in accordance with UL 1242 and ANSI C80.6 specifications.

- b. Fittings (couplings, elbows, bends, etc.) equivalent to RMC above.
 - c. Bushing equivalent to RMC above.
4. Electrical metallic tubing (EMT)
- a. Conduit: Cold rolled steel tubing with zinc coating on outside and protective enamel on inside manufactured in accordance with UL 797 and ANSI C80.3 specifications.
 - b. Couplings: Steel or malleable iron with compression type fastener via a nut.
 - c. Connectors: Steel or malleable iron with compression type fastener via a nut with plastic insulated throat rated at 150°C minimum.
5. Rigid non-metallic conduit (PVC)
- a. Conduit: PVC composed Schedule 40, 90°C manufactured in accordance with NEMA TC 2 and UL 651 specifications.
 - b. Fittings: Molded PVC, slip on solvent welded type in accordance to NEMA TC 3.
6. Reinforced thermosetting resin conduit (RTRC)
- a. Conduit: Fiber impregnated with a cured thermosetting resin compound in accordance with NEMA TC 14 and UL1684.
 - b. Fittings: Molded resin with glass reinforcement manufactured in the same process as the conduit bonded with an epoxy adhesive.
7. Flexible metallic conduit (FMC)
- a. Conduit: Continuous, flexible steel spirally wound with zinc coating on both inside and outside in accordance with UL 1.
 - b. Connectors: Steel or malleable iron with compression type fastener via a nut with plastic insulated throat rated at 150°C minimum.
8. Liquidtight flexible metallic conduit (LFMC)
- a. Conduit: PVC coated, continuous, flexible steel spirally wound with zinc coating on both inside and outside in accordance with UL 360.
 - b. Connectors: Steel or malleable iron with compression type fastener via a nut with plastic insulated throat rated at 150°C minimum.
9. Miscellaneous Fittings and Products
- a. Conduit sealing bushings: Steel or cast malleable iron body and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Supplied with neoprene sealing rings between body and PVC sleeve.
 - b. Watertight cable terminators: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel screws and zinc plated cast iron locking collar.
 - c. Watertight cable/cord connectors: Liquidtight steel or cast malleable iron body with sealing neoprene bushing and stainless-steel retaining ring.

- d. Expansion fittings: Multi-piece unit of hot dip galvanized malleable iron or steel body and outside pressure bussing design to allow a maximum of 4" movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. UL listed for both wet and dry locations.
- e. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve; internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling to provide minimum of 3/4" movement and 30 degrees deflection from normal. UL listed for both wet and dry locations.
- f. Conduit bodies: Raintight, malleable iron, hot-dip galvanized body with threaded hubs, stamped steel cover, stainless steel screws and neoprene gasket.
- g. Other couplings, connectors and fittings shall be equal in quality, material and construction to items specified herein.

B. Boxes

1. Outlet boxes

- a. Standard: Galvanized one-piece of welded pressed steel type in accordance with NEMA OS 1 and UL 514. Boxes shall not be less than 4" square and at least 1 1/2" deep.
- b. Concrete: Galvanized steel, 4" octagon ring with mounting lug, backplate and adapter ring type in accordance with NEMA OS 1 and UL 514. Depth as required by application.
- c. Masonry: Galvanized steel, 3.75" high gang box in accordance with NEMA OS 1 and UL 514.
- d. Surface cast metal: Cast malleable iron body, surface mounted box with threaded hubs and mounting lugs as required in accordance with NEMA OS 1 and UL 514. Furnish with ground flange, steel cover and neoprene gasket.

2. Pull and junction boxes

- a. Sheet metal boxes: Standard or concrete outlet box wherever possible; otherwise use 16-gauge galvanized sheet metal, NEMA 1 box sized per CEC with machine screwed cover.
- b. Cast metal boxes: Install standard cast malleable iron outlet or device box when possible.
- c. Flush mounted boxes: Install overlapping cover with flush head screws.
- d. In-ground mounted pull holes/boxes: Install pre-cast concrete box, sized per Drawing or CEC with pre-cast or traffic rated lid.

3. Floor boxes

- a. Floor boxes shall be adjustable, cast metal body with threaded conduit openings, adjustable rings, brass flange or Lexan ring and cover plate with threaded plug. Include provisions to accommodate surface mounted telephone or receptacle outlet, or flush floor mounted telephone or receptacle outlet where shown on Drawings.

C. Pull line/cord

1. Polypropylene braided line or Let-line #232 or equal of 1/8" diameter with a minimum break strength of 200 pounds.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Thoroughly examine site conditions for acceptance of wire and cable installation to verify conformance with manufacturer and specification tolerances. Do not commence with work until all conditions are made satisfactory.

3.02 PREPARATION

A. Conduit

1. Provide all necessary conduit fittings, connectors, bushings, etc. required to complete conduit installation to meet the CEC and intended application whether noted, shown or specified within.
2. Location of conduit runs shall be planned in advance of the installation and coordinated with other trades.
3. Where practical, install conduits in groups in parallel vertical or horizontal runs that avoid unnecessary offsets.
4. All conduits shall be parallel or at right angles to columns, beams and walls whether exposed or concealed.
5. Conduits shall not be placed closer than 12" to a flue, parallel to hot water, steam line or other heat sources; or 3" when crossing perpendicular to the above said lines when possible.
6. Install exposed conduit as high as practical to maintain adequate headroom. Notify Engineer if headroom will be less than 102".
7. Do not obstruct spaces required by Code in front of electrical equipment, access doors, etc.
8. The largest trade size conduit in concrete floors and walls shall not exceed 1/3 thickness or be spaced a less than three conduit diameters apart unless permitted by Engineer. All conduits shall be installed in the center of slab or wall, and never between reinforcing steel and bottom of floor slab.
9. Install additional pull boxes, not shown on Drawings, in sufficient quantities to facilitate pulling of conductors and cables such that total spacing does not exceed 150 feet or 270 degrees, total; and maximum pulling tension will not be exceeded.
10. When installing underground conduits to specified depth; depth shall be taken from finished grade as it will be at project completion. Should finish grade be above existing grade by an amount equal to or greater than specified depth, conduit shall be installed not less than 6" below existing grade.

11. Verify that information concerning finish grade is accurate, for should the underground run be less than the specified depth, Contractor may be required to re-install conduit to meet the required depth.
12. Unless otherwise specified, underground conduits shall be installed with top side not less than 24" below finished grade; this depth applies to all conduits outside of building foundations including those under walks, open corridors or paved areas.
13. Utility company service conduits installation depth shall be as directed by their respective specifications and requirements.

B. Boxes

1. Before locating outlet boxes, check Construction Documents for type of construction and make sure that there is no conflict with other equipment. Locate outlet boxes as shown and locate so as not to interfere with other Work or equipment.
2. Install all outlet boxes flush within walls, ceiling and floors except where installed within non-finished rooms, cabinetry, attic spaces or as indicated on Drawings.
3. Locate pull boxes and junction boxes within concealed, accessible locations where possible.
4. Do not install outlet boxes back-to-back with same stud space. Where shown back-to-back, offset as required, and fill void with sound dampening material where requested by Owner.
5. In fire rated walls separate boxes by 24" minimum and with stud member.
6. Adjust position of outlet boxes within masonry wall to accommodate course lines.

3.03 *INSTALLATION*

A. Conduit

1. Minimum conduit size shall be 3/4" unless otherwise indicated.
2. All conduit work shall be concealed unless otherwise indicated. Exposed conduits shall be permitted within unfinished rooms/spaces to facilitate installation.
3. Install conduit in complete runs prior to installing conductors or cables.
4. Make long radius conduits bends free from kink, indentations or flattened surfaces. Make bends carefully to avoid injury or flattening. Bends 1 1/4" size and larger shall be factory made ells or be made with a manufactured mechanical bender. Heating of steel conduit to facilitate bending or that damage galvanized coating will not be permitted.
5. Remove burrs and sharp edges at end of conduit with tapered reamer.
6. Protect and cover conduits during construction with metallic bushings and bushing "pennies" to seal exposed openings.
7. Assemble conduit threads with anti-corrosion, conductive, anti-seize compound and tighten securely.
8. Install conduits shall that no traps to collect condensation exist.

9. Fasten conduit securely to boxes with locknuts and bushings to provide good grounding continuity.
10. Install pull cords/line within any spare or unused conduits of sufficient length to facilitate future cable installation.
11. Penetrations
 - a. Locate penetrations within structural members as shown on Drawings and as directed by Engineer. Should it be necessary to notch any framing member, make such notching only at locations and in a manner as approved by Engineer.
 - b. Do not chase concrete or masonry to install conduit unless specifically approved by Engineer.
 - c. Cutting or holes
 - 1) Install sleeves for cast-in-place concrete floors and walls. After installing conduit through penetration, seal using dry pack grouting compound (non-iron bearing, chloride free and non-shrinking) or fire rated assembly if rated floor or wall. Use escutcheon plate on floor underside to contain compound as necessary.
 - 2) Cut holes with a hole saw for penetrations through non-concrete or non-masonry members.
 - 3) Provide chrome plated escutcheon plates at all publicly exposed wall, ceiling and floor penetrations.
 - d. Sealing
 - 1) Non-rated penetration openings shall be packed with non-flammable insulating material and sealed with gypsum wallboard taping compound.
 - 2) Fire rated penetration shall be sealed using a UL classified fire stop assembly suitable to maintain the equivalent fire rating prior to the penetration.
 - 3) Use escutcheon plates to hold sealing or fire rated compound as necessary.
 - e. Waterproofing
 - 1) Make penetrations through any damp-proofed/waterproofed surfaces within damp/wet locations as such as to maintain integrity of surface.
 - 2) Install specified watertight conduit entrance seals at all below grade wall and floor penetrations.
 - 3) At roof penetrations furnish roof flashing, counter flashing and pitch-pockets compatible to roof assembly.
 - 4) Where possible conduits that horizontally penetrate a waterproof membrane shall fall away from and below the penetration's exterior side.
 - 5) Make penetrations through floors watertight with mastic, even when concealed within walls or furred spaces.

12. Supports

- a. Conduits shall be support and braced per OSHPD pre-approved anchorage systems when those methods are implemented and installed.
- b. Sizes of rods and cross channels shall be capable of supporting 4 times and 5 times actual load, respectively. Anchorage shall support the combined weight of conduit, hanger and conductors.
- c. Support individual horizontal conduit 1 1/2" and smaller by means of 2-hole straps or individual hangers.
- d. Galvanized iron hanger rods sizes 1/4" diameter and larger with spring steel fasteners, clips or clamps specifically design for that purpose for 1 1/2" conduits and larger.
- e. Support multi-parallel horizontal conduits runs with trapeze type hangers consisting of 2 or more steel hanger rods, preformed cross channels, 'J' bolts, clamps, etc.
- f. Support conduit to wood structures by means of bolts or lag screws in shear, to concrete by means of insert or expansion bolts and to brickwork by means of expansion bolts.
- g. Support multi-parallel vertical conduits runs with galvanized Unistrut, Power-Strut or approved equal type supports anchored to wall. Where multi-floored conduits pass through floors, install riser clamps at each floor.
- h. Maximum conduit support spacing shall be in accordance with NECA Standard of Installation:
 - 1) Horizontal runs:
 - a) 3/4" and smaller at 60" on centers, unless building construction prohibits otherwise, then 84" on centers.
 - b) 1" and larger at 72" on centers, unless building construction prohibits otherwise or any other condition, then 120" on centers.
 - 2) Vertical runs:
 - a) 3/4" and smaller @ 84" on centers.
 - b) 1" and 1 1/4" @ 96" on centers.
 - c) 1 1/2" and larger @ 120" on centers.
 - d) Any vertical condition such as shaftways and concealed locations for any sized conduit, 120" on centers.
- i. Anchorage for RMC/IMC supports unless otherwise specified:
 - 1) < 1" IMC/RMC = #10 bolt/screw.
 - 2) 1" IMC/RMC = 1/4" bolt/screw.
 - 3) 1 1/2" and 2" IMC/RMC = 3/8" bolt/screw.
 - 4) 3" IMC/RMC, 4" EMT = 1/2" bolt/screw.
 - 5) > 3" IMC/RMC = 5/8" bolt/screw.
- j. Anchorage for EMT supports unless otherwise specified:

- 1) < 1 1/2" EMT = #10 bolt/screw.
- 2) 1 1/2" EMT = 1/4" bolt/screw.
- 3) 2, 2 1/2" and 3" EMT = 3/8" bolt/screw.
- 4) 4" EMT = 1/2" bolt/screw.
- 5) > 4" EMT = 5/8" bolt/screw.

B. Boxes

1. Install boxes as shown on Drawings and as required for splices, taps, wire pulling, equipment connections and Code compliance.
2. Install additional pull boxes, not shown on Drawings, in sufficient quantities to facilitate pulling of conductors and cables such that total spacing does not exceed 150 feet or 270 degrees, total; and maximum pulling tension will not be exceeded.
3. Install plaster rings on all outlet boxes in stud walls or in furred, suspended or exposed ceilings. Covers shall be of a depth suited for installation.
4. Provide gasketed cast metal cover plates where boxes are exposed in damp or wet locations
5. Install access door for boxes installed within concealed locations without access.
6. Install approved factory-made knockout seal where knockouts are not present.
7. Refer to Architectural interior elevations and details shown for exact mounting heights of all electrical outlets. In general, locate outlets as shown or specific and complies with Americans with Disabilities Act:
 - a. Convenience outlets: +18" AFF or +6" above counter or splash.
 - b. Local switches: +48" AFF or +6" above counter or splash.
 - c. Telecommunication outlets: +18" AFF or +48" AFF for wall telephone or intercom device.
 - d. Verify all mounting heights with Drawings, and where heights are not suited for construction or finish please consult Engineer.
8. Use conduit bodies to facilitate pulling of conductor or cables or change conduit direction. Do not splice within conduit bodies.
9. Enclose pull box with additional rated gypsum board as necessary to maintain wall's original fire rating.
10. Install galvanized steel coverplates on all open boxes within dry listed areas.
11. Install in-ground pull holes/boxes flush to grade finish at finished areas or 1" above finished landscaped grade. Seal all conduits terminating in pull hole/box watertight. Install and grout around bell ends where shown. Cover and lids shall be removable without damage to adjacent finish surfaces.
12. Support
 - a. Accurately place boxes for finish, independently and securely supported by adequate blocking or manufacturer channel type heavy-duty box hangers for stud walls. Do not use nails to support boxes.

- b. Support boxes independent of conduit system.
- c. Mount boxes installed within ceilings to 16-gauge metal channel bars attached to main runners or joists.
- d. Support boxes within suspended acoustical tile ceilings directly from structure above when light fixture are to be installed from box.
- e. Use auxiliary plates, bar or clips and grouted in place for masonry, block or pour-in-place concrete construction.

3.04 APPLICATION

A. Conduit

1. RMC/IMC suitable for all damp, dry and wet locations except when in contact with earth. IMC not suitable for hazardous locations as stated within CEC.
2. CRMC suitable for damp or wet locations, concealed within concrete or in contact with earth.
3. EMT suitable for exposed or concealed dry, interior locations.
4. PVC/RTRC suitable for beneath ground floor slab, except when penetrating, and direct earth burial. Do not run exposed within concrete walls or in floor slab unless indicated on Drawings or per Engineer's permission.
5. FMC suitable for dry locations only for connections to motors, transformers, vibrating equipment/machinery, controllers, valves, switches and light fixtures in less than 6 foot lengths.
6. LFMC application same as FMC above but for damp or wet locations.

B. Termination and joints

1. Use raceway fittings compatible with associated raceway and suitable for the location.
2. Raceways shall be joined using specified couplings or transitions where dissimilar raceway systems are joined.
3. Conduits shall be securely fastened to cabinets, boxes and gutters using (2) two locknuts and insulating bushing or specified insulated connector. Where joints cannot be made tight and terminations are subject to vibration, use bonding jumpers, bonding bushings or wedges to provide electrical continuity of the raceway system. Use insulating bushings to protect conductors where subjected to vibration or dampness. Install grounding bushings or bonding jumpers on all conduits terminating at concentric or eccentric knockouts.
4. Terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using specified connectors and hubs.
5. Stub freestanding equipment conduits through concrete floors for connections with top of coupling set flush with finished floor. Install plugs to protect threads and entrance of debris.
6. Install specified cable sealing bushings on all conduits originating outside the building walls and terminating within interior switchboard, panel, cabinet or

gutters. Install cable sealing bushings or raceway seal for conduit terminations in all grade level or below grade exterior pull, junction or outlet boxes.

7. Where conduits enter building from below grade inject into filled raceways pre-formulated rigid 2 lbs. density polyurethane foam suitable for sealing against water, moisture, insects and rodents.
8. Install expansion fitting or expansion/deflection couplings per manufacturer's recommendations where:
 - a. Any conduit that crosses a building structure expansion joint; secure conduit on both sides to building structure and install expansion fitting at joint.
 - b. Any conduit that crosses a concrete expansion joint; install expansion/deflection at joint.
 - c. Any conduit greater than 1-1/4" is routed along roof top in runs greater than 100 feet; install expansion fittings every 100 feet.
 - d. Engineer may allow FMC or LFMC in lieu of expansion fitting or expansion/deflection couplings on conduits 2" and smaller within accessible locations upon further review and written consent.

C. Boxes

1. Standard type suitable for all flush installations and all dry concealed locations.
2. Concrete type suitable for all flush concrete installations.
3. Masonry type suitable for all flush concrete and block installations.
4. Surface cast meta type suitable for all exposed damp and wet surface mounted locations, and dry surface mounted locations less than 96" from finished floor

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes requirements for:
 - 1. Identifying electrical, instrumentation, and process equipment and components.
 - 2. Material, manufacturing, and installation requirements for identification devices.

- B. Related Sections:
 - 1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its subcontractors to review all sections to ensure a complete and coordinated project.

1.02 REFERENCES

- A. Refer to Section 26 05 00.

1.03 DEFINITIONS

- A. Refer to Section 26 05 00.

1.04 SYSTEM DESCRIPTION

- A. Nameplates:
 - 1. Provide a nameplate for each control device or major item of electrical equipment, either located in the field or within panels.
 - 2. Provide all nameplates of identical style, color, and material throughout the facility.
 - 3. Device nameplates information:
 - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
 - b. Device tag and loop number ID (e.g. EDV-60.0101.01).
 - c. Circuit ID (e.g. LPA-11).
 - d. Area served (e.g. Lighting Chemical Building).

- B. Wire Numbers:
 - 1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
 - a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
 - b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
 - c. Internal panel wires on a common terminal shall have the same wire number.

- d. All instrumentation cables shall be identified at pull points as described above.
- 2. Provide the following wiring numbering schemes throughout the project for field wires between Process Control Module, (PCM), Vendor Control Panels, (VCP), Motor Control Centers, (MCC), field starters, field instruments, etc.

(ORIGIN LOC.)-(ORIGIN TERM.)/(DEST. LOC.)-(DEST. TERM.)

OR

(ORIGIN LOC.)-(ORIGIN TERM.)
(DEST. LOC.)-(DEST. TERM.)

Where:

ORIGIN LOC. = Designation for originating panel or device
ORIGIN TERM. = Terminal designation at originating panel or device
DEST. LOC. = Designation for destination panel or device
DEST. TERM. = Terminal designation at destination panel or device or PLC I/O address at destination panel

- a. Identify equipment and field instruments as the origin.
- b. PCM's are always identified as the destination.
- c. Location is the panel designation for VCP, LCP, or PCM. For connections to MCC's, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
- d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multiconductor cables, all terminal numbers shall be shown, separated by commas.
- e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g. T1, T2, T3, etc.).
- f. Terminal designations at PCM's where the field conductor connects to a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project):
 - 1) Discrete Point: W:X:Y/Z
 - Analog Point: W:X:Y.Z

Where:

W = I for input, O for output

X = PLC number (1, 2, 3...)

Y = Slot number (01, 02, 03...)

Z = Terminal number (00,01,02...) for a discrete point or a word number for an analog point (1,2,3...)

- g. Terminal designations at PCM's where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (e.g. 010). For common power after a fuse or neutrals after a switch, the

subsequent points shall have and capital letter suffix starting with “A” (e.g.. C0010A).

3. **Case 1:** Vendor Control Panel (VCP) to Process Control Module (PCM):
Field Wire Number/Label: A-B/C-D
A = Vendor Control Panel number without hyphen (VCP60.0101.01)
B = Terminal number within VCP (manufacturer’s or vendor’s standard terminal number)
C = Process Control Module number without hyphen (PCM60.0101)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a “C” prefix if not connected directly to a PLC I/O point (C0010)

Examples: VCP60.0101.01-10/PCM60.0101-I:1:01/01
 VCP60.0101.01-10/PCM60.0101-O:1:10/07
 VCP60.0101.01-10/PCM60.0101-C0100

4. **Case 2:** Field Instrument to Process Control Module (PCM):
Field Wire Number/Label: E-F/C-D
C = Process Control Module number without hyphen (PCM60.0101)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a “C” prefix if not connected directly to a PLC I/O point (C0010)
E = Field mounted instrument tag and loop numbers without hyphen (EDV60.0101.01)
F = Manufacturer’s standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma

Examples: TIT60.0101.01-2,3/PCM60.0101-I:1:01.1
 TSH60.0101-1/PCM60.0101-I:2:01/00

5. **Case 3:** Motor Control Center (MCC) to Process Control Module (PCM):
Field Wire Number/Label: G-B/C-D
B = Terminal number within Motor Control Center (manufacturer’s or vendor’s standard terminal number)
C = Process Control Module without hyphen (PCM60.0101)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a “C” prefix if not connected directly to a PLC I/O point (C0010)
G = Actual starter designation in the Motor Control Center without hyphen (MMS60.0101)

Examples: MMS60.0101-10/PCM60.0101-I:1:01/01
 MMS60.0101-10/PCM60.0101-O:1:10/07
 MMS60.0101-10/PCM60.0101-C0100

6. **Case 4:** Motor Control Center (MCC) to Vendor Control Panel (VCP):
Field Wire Number/Label: G-B/A-B
A = Vendor Control Panel number without hyphen (VCP60.0101.01)
B = Terminal number within motor control center or vendor control panel (manufacturer’s or vendors standard terminal number)
G = Actual starter designation in the Motor Control Center without hyphen (MMS60.0101)

Example: MMS60.0101-X2/VCP60.0101.01-10

7. **Case 5:** Motor leads to a Motor Control Center (MCC): Field Wire Number/Label: H-I/G-B
B = Terminal number within motor control center (manufacturer's standard terminal number)
G = Actual starter designation in the Motor Control Center without hyphen (MMS60.0101)
H = Equipment tag and loop number without hyphen (PMP60.0101.01)
I = Motor manufacturer's standard motor lead identification (e.g.T1, T2, T3, etc.)

Example: PMP-60.0101.01-T3/MMS60.0101.01-T3

8. **Case 6:** Remote or separately mounted starter or Variable Frequency Drive (VFD) to Process Control Module (PCM): Field Wire Number/Label: J-B/C-D
B = Terminal number within starter or Variable Frequency Drive (manufacturer's standard terminal number)
C = Process Control Module number without hyphen (VCP60.0101.01)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
J = Starter or Variable Frequency Drive tag and loop number without hyphen (MMS60.0101)

Examples: MMS60.0101-10/PCM60.0101.01-I:1:01/01
MMS60.0101-10/PCM60.0101.01-O:2:10/07
MMS60.0101-10/PCM60.0101.01-C0010

9. Terminate all spare conductors on terminal blocks and identify as required for other field wires with an "S" prefix:

Example: S MMS60.0101-10/PCM60.0101.01-C011

1.05 SUBMITTALS

- A. Furnish submittals in accordance with Sections 01 33 00 and 26 05 00.
- B. Product Data:
1. Nameplates:
 - a. Color.
 - b. Size:
 - 1) Outside dimensions.
 - 2) Lettering.
 - c. Material.
 - d. Mounting means.
 2. Nameplate Schedule:
 - a. Show exact wording for each nameplate.
 - b. Include nameplate and letter sizes.

3. Wire Numbers:
 - a. Manufacturer's catalog data for wire labels and label printer.

C. Record Documents:

1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.06 QUALITY ASSURANCE

A. Schedule a pre-installation conference in accordance with Sections 01 43 00 and 26 05 00 in order to clearly define the requirements specified for equipment identification:

1. Representatives of the CONTRACTOR, OWNER, and ENGINEER shall convene before any major purchases of cable or conductors and before the installation or termination of any cables or conductors.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 26 05 00.

1.08 WARRANTY

- A. Refer to Section 26 05 00.

1.09 SYSTEM START UP

- A. Refer to Section 26 05 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nameplates and Signs:

1. One of the following or equal:
 - a. Brady.
 - b. Seton.

B. Conductor and Cable Markers:

1. Heat-shrinkable tubing:
 - a. One of the following or equal:
 - 1) Raychem.
 - 2) Brady.
 - 3) Thomas & Betts.
 - 4) Kroy.

C. Conduit and Raceway Markers:

1. One of the following or equal:
 - a. Almetek: Almetek type mini-tag.
 - b. Lapp Group: Maxi System

- D. Medium Voltage Raceway Voltage Labels:
 - 1. One of the following or equal:
 - a. Brady.
 - b. Seton.

2.02 MATERIALS

- A. Nameplates:
 - 1. Fabricated from white-center and red or black face laminated plastic engraving stock:
 - a. 3/32-inch thick material.
 - b. Two-ply.
 - c. With chamfered edges.
 - d. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:
 - 1) No characters smaller than 1/8-inch in height.
- B. Signs:
 - 1. Automatic equipment and high voltage signs:
 - a. Suitable for exterior use.
 - b. In accordance with OSHA regulations.
- C. Conductor and Cable Markers:
 - 1. Machine printed black characters on white tubing.
 - 2. Ten point type or larger.
- D. Conduit and Raceway Markers:
 - 1. UV resistant holder and letters.
 - 2. Black letters on yellow background.
 - 3. Minimum 1/2-inch high letters.
- E. Medium Voltage Circuit Raceway Labels:
 - 1. Vinyl plastic.
 - 2. Minimum 1-inch high letters.

2.03 SOURCE QUALITY CONTROL

- A. Nameplates:
 - 1. Provide all nameplates for control panel operator devices (e.g. pushbuttons, selector switches, pilot lights, etc.):
 - a. Same material and same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to Section 26 05 00.

- B. Nameplates:
 - 1. Attach nameplates to equipment with rivets, bolts or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
 - 2. On NEMA 4 or NEMA 4X enclosures, use epoxy-based cement to attach nameplates.
 - 3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:
 - a. Misaligned or crooked nameplates shall be remounted, or provide new enclosures at the discretion of the ENGINEER.
- C. Conductor and Cable Markers:
 - 1. Apply all conductor and cable markers before termination.
 - 2. Heat-shrinkable tubing:
 - a. Tubing shall be shrunk using a heat gun that produces low temperature heated air.
 - b. Tubing shall be tight on the wire after it has been heated.
 - c. Characters shall face the open panel and shall read from left to right or top to bottom.
 - d. Marker shall start within 1/32 inch of the end of the stripped insulation point.
- D. Conduit Markers:
 - 1. Furnish and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:
 - a. Conduit markings shall match the conduit schedule; refer to Section 26 05 53.
 - 2. Mark conduits at the following locations:
 - a. Each end of conduits that are greater than 10 feet in length.
 - b. Where the conduit penetrates a wall or structure.
 - c. Where the conduit emerges from the ground, slab, etc.
 - d. The middle of conduits that are 10 feet or less in length.
 - 3. Mark conduits after the conduits have been fully painted.
 - 4. Position conduit markers so that they are easily read from the floor.
 - 5. Secure all conduit markers with nylon cable ties:
 - a. Provide with ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
 - b. Adhesive labels are not acceptable.
 - 6. Mark conduits before construction review by ENGINEER for punch list purposes.
- E. Medium Voltage Raceway Labels:
 - 1. Apply at 50 foot intervals stating the voltage level contained within the raceway.
- F. Signs and Labeling:
 - 1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
 - a. Fasten warning signs with round head stainless steel screws or bolts.
 - b. Locate and mount in a manner to be clearly legible to operations personnel.

2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc. where the voltage exceeds 600 volts.
3. Furnish and install warning signs on equipment that has more than one source of power.
 - a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.
4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking.
 - a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.

3.02 FIELD QUALITY CONTROL

- A. Replace any nameplates, signs, conductor markers, cable markers, or raceway labels that in the sole opinion of the ENGINEER do not meet the ENGINEER's aesthetic requirements.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes
 - 1. Provide all labor, materials and equipment necessary to complete the installation required for the items specified under this Section, including but not limited to wiring devices.
- B. Related sections
 - 1. Where items specified in other Division 26 sections conflict with the requirements of this Section, the most stringent requirement shall govern.
 - a. 26 05 26 – Grounding and Bonding for Electrical Systems
 - 2. The requirements of this Section apply to all Division 26 work, as applicable.
 - 3. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.02 REFERENCES

- A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
 - 1. Federal Specification
 - a. W-C-596; Connector, Electrical, Power, General Specification for
 - b. W-S-896; Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification)
 - 2. NEMA –National Electrical Manufacturer’s Association
 - a. WD 1; General Color Requirements for Wiring Devices
 - b. WD 6; Wiring Devices-Dimensional Requirements
 - 3. UL -Underwriters Laboratories, Inc.
 - a. 20; General-Use Snap Switches
 - b. 498; Standard for Attachment Plugs and Receptacles
 - c. 943; Standard for Ground-Fault Circuit-Interrupters
 - d. 1449; Standard for Transient Voltage Surge Suppressors

1.03 SUBMITTALS

- A. Submit manufacturer’s data for materials specified within this Section in accordance to Section 26 05 00.

1.04 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the materials specified herein shall be new and unused, bearing UL labels where applicable.

PART 2 - PRODUCTS

2.01 SWITCHES

- A. Wall switches
 - 1. Specification grade, quiet, AC rated, mechanical, snap type with silver alloy contacts, and shall comply with NEMA WD-1 and Fed. Spec W-S-896.
 - 2. Rating shall be 20A at 120/277Vac, unless otherwise shown.
 - 3. Handles shall be nylon; color shall be compatible with adjacent wall finish.
 - 4. Manufacturers and types
 - a. Single pole, single throw
 - 1) Cooper Wiring Devices #CSB120, Hubbell #CSB120, or equal.
 - b. Double pole, single throw
 - 1) Cooper Wiring Devices #CSB220, Hubbell #CSB220, or equal.
 - c. Three way
 - 1) Cooper Wiring Devices #CSB320, Hubbell #CSB320, or equal.
- B. Wall dimmer switches
 - 1. Linear slide type dimmer with smooth and continuous square law dimming curve that complies with UL 20 and is UL listed for the specified load.
 - 2. Dimmers shall have power failure memory to bring lights back on at same level prior to power interruption.
 - 3. Dimmers shall incorporate air-gap switch accessible with wall plate installed.
 - 4. Furnish dimmer switch of rating to connected loads; de-rate as required by manufacturer's information for ganged installations.
 - 5. Coverplate shall be snap-on type with no visible attachments or fins. Color shall be compatible with adjacent wall finish.
 - 6. Manufacturer and type
 - a. Lutron Nova series or approved equal.

2.02 RECEPTACLES

- A. Standards
 - 1. Specification grade, NEMA 5-15R configuration grounding type, rated 15A at 125/250Vac that conform to NEMA WD-6 and Fed. Spec W-C-596.
 - 2. At dedicated receptacle locations and as otherwise noted, use specification grade, NEMA 5-20R configuration grounding type, rated 20A at 125/250Vac that conform to NEMA WD-6 and when possible Fed. Spec W-C-596.
 - 3. Specialty receptacles shall conform to NEMA WD-6 and UL standards as applicable.
- B. Color
 - 1. General purpose receptacle face shall be nylon; color shall be compatible with adjacent wall finish, unless otherwise indicated.

C. Receptacle types

1. General purpose single
 - a. Provide self-grounding back and side wired with binding head staked terminal screw.
 - b. Use Cooper Wiring Devices #5261, Hubbell #5261, or equal for NEMA 5-15R.
 - c. Use Cooper Wiring Devices #5361, Hubbell #5361, or equal for NEMA 5-20R.
2. General purpose duplex
 - a. Provide self-grounding back and side wired with binding head staked terminal screws and break-off strip for two circuit wiring.
 - b. Use Cooper Wiring Devices #5262, Hubbell #5262, or equal for NEMA 5-15R.
 - c. Use Cooper Wiring Devices #5362, Hubbell #5362, or equal for NEMA 5-20R.
3. Transient voltage surge suppressor (TVSS) duplex
 - a. Provide 20A, 125Vac receptacle consisting of NEMA 5-20R duplex device with integral TVSS protection circuit.
 - b. Provide LED indicator to verify surge protection and ground, and audible alarm to notify bad ground connection or surge protection expiration.
 - c. TVSS characteristics:
 - 1) 400V clamping voltage.
 - 2) 280J energy rating.
 - 3) 150Vac RMS MOV rating
 - 4) 18kA maximum surge current in all modes (L-N, L-G and N-G)
 - d. Use Cooper Wiring Devices #5362_S, no known equal.
4. Isolated ground
 - a. Provide receptacle specified within this Section with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
5. Ground fault circuit interrupter (GFCI) duplex
 - a. Provide 20A, 125Vac receptacle consisting of NEMA 5-20R duplex device with integral solid state sensing and signaling circuitry capable of detecting and interrupting a maximum 5mA line-to-ground fault current in approximately 1/40th of a second per UL 943.
 - b. Provide visual device with trip indication, manual reset and test mechanisms per UL 943.
 - c. Device shall be capable of point of use and multi-outlet protection.
 - d. Use Cooper Wiring Devices #XGF20, Hubbell #GF53, or equal.
6. Hospital grade and tamper resistant

- a. Provide receptacle specified within this Section that conforms to UL 498 "Hospital Grade" requirements.
 - b. Tamper resistance receptacle shall have integral protection mechanism to prevent accidental shock from foreign object contacting energized blades.
7. Special purpose
- a. Provide specification grade devices with NEMA configuration, voltage, ampacity, poles and ground provisions as noted on Drawings.

2.03 WALL PLATES

- A. Interior locations
 - 1. Finished Areas: 0.032" stainless steel, brushed or satin finish with required number of openings for location.
 - 2. Exposed Areas: galvanized, raised type.
- B. Exterior: die-cast copper-free aluminum, gasketed, raintight cover UL listed for exterior and wet locations while in use. Use Hubbell #WP8M (duplex), #WP26M (GFCI) or equal.
- C. Screws shall match plate.
- D. Tamper resistance receptacles shall have exposed screws of temper resistant type.
- E. Individual, gangable wall plates are not acceptable where two or more devices are installed at one location.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate device heights with architectural drawings and details.
- B. Locate switches on latch side of door, unless otherwise indicated.

3.02 INSTALLATION

- A. Mount and align device and wall plates level and plumb. Insure wall plates fit flat against wall and tight against device without strain on plate.
- B. Comply with manufacturer's instructions regarding termination of conductors to wiring device.
- C. Derate ganged dimmer switches as instructed by manufacturer and use dedicated neutrals within all dimmer circuits.
- D. Provide wall plates for all outlet boxes with devices.
- E. Install blank wall plates on all outlet boxes in which no device is present or installed.

END OF SECTION

SECTION 31 11 00 CLEARING AND GRUBBING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work of this section consists of clearing, grubbing, grinding, transporting, removing and disposing of unsuitable material, trees, stumps, roots, vegetation debris, and existing improvements, including curb, gutters, catch basins, storm drains, landscaping, fencing, utilities, and other protruding obstructions within the clearing limits.
- B. Protect trees, landscaping and shrubs that are not designated to be removed or near construction site that may be harmed by construction activities.

1.2 RELATED WORK

- A. Section 01 56 16 – Dust Control
- B. Section 01 57 23 – Storm Water Pollution Prevention Plan
- C. Section 02 41 00 – Demolition
- D. Section 31 23 00 –Earthwork

1.3 REGULATORY REQUIREMENTS

- A. Obtain all required permits.
- B. Dispose of removed materials in a legal manner at an approved disposal facility.
- C. One hundred percent of trees, stumps, rocks and associated vegetation and soils resulting from land clearing shall be reused or recycled.

1.4 REFERENCES

- A. Section 15 – Existing Facilities, State Standard Specifications
- B. Section 19 – Earthwork, State Standard Specifications

1.5 DEFINITION

- A. **Unsuitable Material:** Unsuitable material is material determined to be:
 - 1. Impossible to compact to specified density using ordinary methods at optimum moisture content.
 - 2. Material containing trash, debris, oversized material or other foreign and objectionable materials.

3. Incapable of being compacted to Specified density using ordinary methods at optimum moisture content.
4. Too wet to be properly compacted if circumstances prevent satisfactory in-place drying prior to incorporation into the work.
5. Non-native material containing a significant amount of permeable materials, such as sand or rock, that cannot be blended with other material and requires to be off hauled.
6. Expansive clays that cannot be mixed or treated and requires to be off hauled.
7. Otherwise unsuitable for the planned use.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 CLEARING AND GRUBBING

- A. Clear the specified areas by removing, above the natural ground surface, all existing improvements including curbs, gutters, catch basins, storm drains, landscaping fencing and utilities; vegetable growth such as trees, shrubs, logs, upturned stumps, roots of down trees, brush, and similar material.
 1. Trees of 4-inch diameter and larger shall not be removed without Owner's authorization.
- B. Grub the specified areas below the natural ground surface, except in embankment areas where the grading plane is two feet or more above the natural ground, to a depth necessary to remove all boulders, stumps, roots, buried logs, and other objectionable material including rock and concrete. Remove and stock pile the top 4 inches of topsoil in any area which is to receive structural fill.

3.2 PRESERVATION

- A. If indicated or required, preserve trees, plants, rock outcroppings, or other features designated to remain. Protect trees and plants from damage; fell trees in a manner which shall not injure standing trees, plants and improvements which are to be preserved.

3.3 SALVAGE EQUIPMENT

- A. Salvaged equipment shall be delivered to the Owner at a designated site.
- B. Equipment to be salvaged is designated in Section 02 41 00 – Demolition.

END SECTION

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SECTION 31 22 19

FINISH GRADING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. All areas within limits of grading and all areas outside limits of grading which are disturbed in the course of the work.

1.2 RELATED WORK

- A. Section 31 23 00 – Earthwork
- B. Section 01 57 23 – Storm Water Pollution Prevention Plan
- C. Section 01 57 27 – Dust Control

1.3 REFERENCES

- A. Section 19 – Earthwork, State Standard Specifications

1.4 QUALITY ASSURANCE

- A. Relative Compaction:
 - 1. Owner shall pay for all compaction tests.
- B. Tests for compaction shall conform to references listed in Part 1.3 of this section
- C. Sample backfill materials per ASTM D75.
- D. Compaction testing will be performed in accordance with Section 19-5.03, State Standard Specifications.
 - 1. Test every 10,000 square feet of engineered fill or aggregate base material placed.
- E. Where compaction tests indicate failure to meet the specified compaction, the Contractor will rework the entire failed area until the specified compaction has been achieved at his sole expense.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Soil:
 - 1. Original surface soil typical of the area.

2. Capable of supporting native and specified plant growth.

PART 3 EXECUTION

3.1 SURFACE FINSH WORK

- A. Grade all disturbed areas, blending with adjacent terrain. Minor irregularities will be permitted.
 1. Bring all sub-grades to specified contours, even and properly compacted.
- B. Remove all stones and debris over two inches in any dimension.
- C. Restore drainage ditches to appropriate line and grade, using approved surface erosion prevention techniques.
- D. Clean Up: Remove all rubbish and excess material for disposal as approved, and leave area in a neat, satisfactory condition.

3.2 TOLERANCES

- A. Prior to placing subsequent layers of material thereon, the grading plane shall conform to one of the following:
 1. Finish Grading Tolerance: ± 0.10 foot from required elevations
 2. When subbase of base material to be placed on the grading plane is to be paid for by the ton, the grading plane at any point shall not vary more than 0.10 FT. above or below the design grade established by the Engineer.
 3. When the material to be placed on the grading plane is to be paid for by the cubic yard, the grading plane at any point shall be not more than ± 0.05 foot above the design grade established by the Engineer.
 4. When asphalt concrete or asphalt concrete base is to be placed on the grading plane, the grading plane at any point shall not vary more than ± 0.05 foot from the design grade established by the Engineer.

3.3 ACCEPTANCE

- A. Upon completion, obtain Engineer's acceptance of grade and surface.

END SECTION

SECTION 31 23 00

EARTHWORK

PART 1 GENERAL

1.1 WORK INCLUDED

- A. All earthwork performed under this contract shall conform to the General Requirements set forth in this section, except as otherwise specified in other sections.
- B. Excavate earth and rock as necessary to allow the installation or construction of various items of work, regardless of character and subsurface conditions.
- C. Haul, place, rough grade, compact, and finish grade excavated material as engineered fill on those portions of the project site where it is necessary in order to construct the facilities indicated on the Plans.
- D. Dispose of unsuitable material off-site or in designated areas, as directed by the Engineer.
- E. Prepare excavation and fill for compaction testing.

1.2 RELATED WORK

- A. Section 31 11 00 – Clearing and Grubbing
- B. Section 31 22 19 – Finish Grading
- C. Section 31 23 31 – Compacting Earth Materials

1.3 REFERENCES

- A. ANSI/ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates.
- 3. ANSI/ASTM D1557 – Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 10 lb (4.54 kg) Hammer and 18-inch (457 mm) Drop.
- B. ANSI/ASTM D1556 – Density of Soil and base rock in Place by Sand-Cone Method.
- C. ASTM D75 Standard Practice for Sampling Aggregates
- D. ASTM D6938 – Density of soil and base rock in place by Nuclear method.
- E. ASTM D2937 – Density of soil and in place by Tube method.
- F. Section 26 – Aggregate Bases, State Standard Specifications.
- G. Section 15 – Existing Facilities, State Standard Specifications
- H. Section 18 – Dust Palliatives, State Standard Specifications

I. Section 19 – Earthwork, State Standard Specifications

1.4 *PROTECTION*

- A. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation.
 - 1. Trenches shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926, Subpart P – Excavations, CAL/OSHA requirements, and the Contract Documents.
- B. Notify Engineer of unexpected subsurface conditions.
- C. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- D. Grade excavation top perimeter to prevent surface water run-off into excavation.

1.5 *CONTROL AND DIVERSION OF WATER*

- A. The Contractor shall perform control of water operation in accordance with Section 31 23 21- Dewatering.
- B. General – The Contractor shall furnish or procure all materials and labor required for constructing and maintaining all necessary cofferdams, channels, flumes, drains, sumps, and/or other temporary diversion and protective works and shall furnish, install, maintain, and operate all necessary pumping and other equipment for removal of water from the various parts of the work and for maintaining the foundations and other parts of the work free from water.
- C. Plan – Prior to beginning any work on the removal of water from foundations, the Contractor shall submit for the Engineer's approval a water control plan showing his proposed method for the removal of water from foundations and other parts of the work.

1.6 *SUBMITTALS*

- A. Submittals shall be in accordance with Section 01 33 00 - Submittals.
- B. Submit plans as required for worker protection against caving ground in excavation. Designs for shoring, bracing, sloping, or similar provisions shall bear the seal of a registered civil or structural engineer licensed to practice in the State of California.

1.7 *QUALITY ASSURANCE*

- A. Compaction Testing:
- B. Compaction tests will be performed for each lift or layer.
- C. Tests for compaction shall conform to references listed in Part 1.3 of this section
- D. Sample backfill materials per ASTM D75.

- E. Compaction testing will be performed in accordance with State Standard Specifications, Section 19-6.03.

1.8 DEFINITION

- A. Unsuitable Material: Unsuitable material is material determined to be:
 - 1. Impossible to compact to specified density using ordinary methods at optimum moisture content.
 - 2. Material containing trash, debris, oversized material or other foreign and objectionable materials.
 - 3. Incapable of being compacted to Specified density using ordinary methods at optimum moisture content.
 - 4. Too wet to be properly compacted if circumstances prevent satisfactory in-place drying prior to incorporation into the work.
 - 5. Non-native material containing a significant amount of permeable materials, such as sand or rock, that cannot be blended with other material and requires to be off hauled.
 - 6. Expansive clays that cannot be mixed or treated and requires to be off hauled.
 - 7. Otherwise unsuitable for the planned use.

1.9 PROJECT CONDITIONS

- A. Underground utilities may exist at this site. Contractor shall take all necessary precautions to protect said utilities. Notify Engineer of any deviation in utility location from that which is shown on the drawings.
- B. Arrange construction sequences to provide the shortest practical time that trenches will be open to avoid hazard to the public, and to minimize the possibility of trench collapse.
- C. Obtain all required permits and licenses before installing utilities and follow the rules and requirements of the authority having jurisdiction.

1.10 EXCAVATION CLASSIFICATION

- A. Regardless of the nature of material excavated, all excavation will be considered unclassified.

1.11 HAND EXCAVATION

- A. Hand excavation will be required within the drip line of selected trees. The Engineer will designate these trees and will direct the performance of said hand excavation.
- B. Unless directed by the Engineer, roots two inches in diameter or larger shall not be cut.

PART 2 PRODUCTS

2.1 GENERAL

- A. All backfill material shall be approved before use and be free of cinders, ashes, ice, frozen soil, large hard clods, organic debris, or other deleterious items.
- B. Engineered fill materials for all fill areas shall be as required by State Standard Specifications, Section 19-6.
- C. Gravel: Pit run, natural stone; free of shale, clay friable materials and debris; graded in accordance with 1 ½" x ¾" aggregate grading in State Standard Specifications Section 90-1.02C (4).
- D. Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; No. 8 minimum to 3/8" maximum size per SSS Section 90-10C(4)(a).
- E. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter, graded in accordance with State Standard Specifications Section 90-1.02C (4)(c).
- F. Imported sand shall have a sand equivalent of 30 per ASTM D2419.
- G. Permeable material for use in backfilling under, around, and over underdrains; and permeable material for chimney drains, riprap bedding, or other subdrainage purposes shall consist of hard, durable, clean sand, gravel or crushed stone and shall be free from organic materials, clay balls, or other deleterious substances which meets State Standard Specification Section 68-2.02, Class 2.

2.2 UTILITY LINE MARKING

- A. As specified in Section 33 05 26 - Utility Line Marking.

2.3 MATERIALS FOR TRENCH BACKFILLING

- A. Refer to Section 31 23 17– Trenching Backfilling and Compacting.

PART 3 EXECUTION

3.1 GENERAL

- A. All fill and disturbed surfaces shall be compacted to a minimum of 90 percent relative compaction unless noted otherwise.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.

3.3 *MOISTURE CONTROL*

- A. Water development, hauling, and application shall be in accordance with State Standard Specifications Section 10-6, Watering.

3.4 *EXCAVATION*

- A. Excavate the specified areas as shown on the Plans.
- B. If the Plans require placement of fill prior to pipe, or structure excavation, the fill shall first be constructed to the design grade shown for a distance each side of the pipe or structure of not less than five times the diameter of the pipe or the width of the structure after which the trench shall be excavated and the pipe or structure installed.
- C. Paved Areas: Cut existing pavement to full depth to a true line before excavation and maintain the edge suitable for repaving. Pavement removed shall not be used as backfill.

3.5 *ENGINEERED FILL AND EMBANKMENT CONSTRUCTION*

- A. Unless otherwise noted, placement and compaction of engineered fill materials for all fill areas shall be performed according to the provisions of the State Standard Specifications, Section 19-6. Section 19-6.02A shall be amended to say that large rocky material or hard lumps large than three inches in greatest dimension will not be allowed.
- B. Before placing embankment, scarify ground surface to provide ample bond between old and new material, as shown on the Plans. Place embankment material in layers not exceeding eight inches, loose measurement.
- C. Compaction shall be in accordance with State Standard Specifications, Section 19-5. Compact each layer before placing the next layer. As the compaction of each layer progresses, continually level and manipulate to ensure uniform moisture and density. Add water to obtain optimum moisture content. Removal of excess water shall be accomplished through aeration by plowing, blading, disking, or other methods satisfactory to the Engineer.

3.6 *EXCAVATION FOR BUILDINGS, CONCRETE TANKS AND OTHER CONCRETE STRUCTURES*

- A. Refer to Section 31 23 19 – Structure Excavation & Backfilling.

3.7 *TRENCH EXCAVATION AND BACKFILLING*

- A. Refer to Section 31 23 17 – Trenching, Backfilling, and Compacting.

3.8 *UTILITY INSTALLATION*

- A. Install utility marking as specified in section 33 05 26 - Utility Line Marking.

- B. Utility Installation: Shape the trench bottom to ensure uniform contact with the full length of the installed line and remove any sharp-edged materials that might damage the line. Compaction shall be maintained beneath the line.

3.9 SAND CEMENT SLURRY, CONCRETE ENCASEMENT AND THRUST BLOCKS

- A. Concrete
 - 1. Place as shown on the Plans and in accordance with Section 03 30 00 - Cast-In-Place Concrete.
- B. Slurry Cement
 - 1. Slurry Cement is also referred to as Controlled Low Strength Material (CLSM).
 - 2. Place as shown on the plans and in accordance with State Standard Specifications, Section 19-3.03F.

3.10 CONTROL OF WATER

- A. The contractor shall keep all excavation free from water. Furnish, install, maintain, and operate all necessary pumping and other equipment for dewatering of excavations. The contractor shall at all times have on the project sufficient pumping equipment for immediate use, including stand by pumps for use in case other pumps become inoperable
- B. The dewatering operation shall be continuous, so that the excavated areas are kept free from water during the construction, until backfill has been placed to a sufficient height to anchor the work against possible floatation.
- C. Dewatering devices shall be adequately filtered to prevent the removal of fines from the soil.
- D. Repair any damage caused by the failure of any part of the protective works. Remove temporary protective works when they are no longer needed for dewatering purposes.
- E. Any drain rock required in the trench bottom to convey water or stabilize wet soil shall be included at no extra cost to the owner.
- F. Provision of dewatering and dewatering equipment shall be considered part of the project with no additional compensation allowed.

3.11 SURPLUS MATERIAL

- A. Unless otherwise specified, surplus excavated material shall be used to widen embankments uniformly or to flatten slopes.
- B. All surplus material shall be exported from the site.

3.12 SHORING AND SHEETING

- A. Construct and maintain all shoring, sheeting, and slope layback necessary to protect the excavation, as needed, for the safety of the employees and as required by applicable State and Federal laws. Provide suitable barricades for public safety, regardless of trench depth.

3.13 DEWATERING

- A. Refer to Section 31 23 21.

3.14 UNSUITABLE MATERIAL

- A. Unsuitable material shall be excavated and disposed of in a lawful manner off the project site in accordance with Section 31 23 35 - Disposal of Materials. All disposal shall be approved by the Engineer prior to initiating the work.

3.15 SURFACE FINISH WORK

- A. Paved Areas: Replace removed paving and base course with new material of equal or better quality and of the same texture and color as the adjacent paved areas. Saw cut pavement edges to a true line and broom as needed prior to repaving.
- B. Open Areas: Grade all disturbed areas, blending with adjacent terrain. Minor irregularities will be permitted.
- C. Drainage Ditches: Restore drainage ditches to appropriate line and grade, using approved surface erosion prevention techniques.
- D. Clean Up: Remove all rubbish and excess material for disposal as approved, and leave area in a neat, satisfactory condition.

3.16 TOLERANCES

- A. Tolerances are defined as allowable variations from specified lines, grades, and dimensions. The intent of this paragraph is to establish tolerances that are consistent with modern construction practice, yet are governed by the effect that permissible variations may have upon the construction.
- B. Variations from specified lines, grades, and dimensions:

Variation in elevation for invert of roads from those specified	±0.10 foot
Variation from specified width of section at any height	±0.25 foot

- C. Variation is defined as the distance between the actual dimension and grade of the alignment and the specified position in plan for the alignment. Plus or minus variations indicate a permitted actual position up or down and in or out from the specified position in plan. Variations not designated as plus or minus indicate the

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maximum deviation permitted between designated successive points on the completed element of construction.

END SECTION

EARTHWORK
31 23 00-8

SECTION 31 23 17

TRENCHING, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes material, testing, and installation for trench excavation, backfilling and compacting.

1.2 RELATED WORK

- A. Section 31 11 00 – Clearing and Grubbing
- B. Section 31 23 00 – Earthwork
- C. Section 40 05 00 – Pipe and Fittings

1.3 REFERENCES

- A. ANSI/ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates.
- B. ANSI/ASTM D1557 – Moisture-Density Relations of Soils and Sol-Aggregate Mixture Using 10 lb (4.54 kg) Hammer and 18-inch (457 mm) Drop.
- C. ANSI/ASTM D1556 – Density of Soil and base rock in Place by Sand-Cone Method.
- D. ASTM D6938 – Density of soil and base rock in place by Nuclear method.
- E. ASTM D2937 – Density of soil and in place by Tube method.
- F. Section 26 – Aggregate Bases, State Standard Specifications.

1.4 SUBMITTALS

- A. Submit plans as required for worker protection against caving ground in excavations. Submittals shall be in accordance with Section 01 33 00 – Submittals Procedures.

1.5 PROTECTION

- A. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation.
 - 1. Trenches shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926, Subpart P—Excavations, CAL/OSHA requirements, and the Contract Documents.
- B. Notify Engineer of unexpected subsurface conditions.

- C. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- D. When the pipe laying is not in progress, including the noon hours, close the open ends of pipe. Do not allow trench water, animals or foreign material to enter the pipe.

1.6 CONTROL AND DIVERSION OF WATER

- A. General – The Contractor shall furnish or procure all materials and labor required for constructing and maintaining all necessary cofferdams, channels, flumes, drains, sumps, and/or other temporary diversion and protective works and shall furnish, install, maintain, and operate all necessary pumping and other equipment for removal of water from the various parts of the work and for maintaining the foundations and other parts of the work free from water.
- B. Plan – Prior to beginning any work on the removal of water from trenches, the Contractor shall submit for the Engineer's approval a water control plan showing his proposed method for the removal of water from trenches and other parts of the work.
- C. Dispose of the water in a manner that will prevent damage to the adjacent property and in accordance with regulatory requirements.
- D. Do not drain trench water through the pipeline under construction.

1.7 PROJECT CONDITIONS

- A. Underground utilities may exist at this site. Contractor shall take all necessary precautions to protect said utilities. Notify Engineer of any deviation in utility location from that which is shown on the drawings.
- B. Obtain all required permits and licenses before installing utilities and follow the rules and requirements of the authority having jurisdiction.
- C. Arrange construction sequences to provide the shortest practical time that the trenches will be open to avoid hazard to the public, and to minimize the possibility of trench collapse

PART 2 MATERIALS

2.1 NATIVE EARTH BACKFILL

- A. Native earth backfill used above the pipe zone shall be fine-grained materials free from roots, debris, and rocks larger than 3 inches.

2.2 MATERIALS FOR TRENCH BACKFILLING

- A. Furnish required bedding, select backfill and backfill materials listed under the appropriate types of utility line in the sections to which this work relates.

- B. All fill material will be subject to the approval of the Engineer.
- C. Materials used in backfill, as shown in trench details, are defined as follows:
 - 1. Bedding: When rock, unstable material, or wet trench is encountered at the excavated grade for utility installation, bedding is required. Materials shall be predominantly sand and gravel, having a Plasticity Index less than 6.

- a. Gradation as follows:

<u>Sieve Size</u>	<u>Percent Passing</u>
½ inch	100
No. 4	50-80
No. 200	10-25

- b. Bedding material shall have a Sand Equivalent of 30, per ASTM D2419.
 - 2. Bedding may be omitted if, in the opinion of the Engineer, the excavated trench bottom will adequately support and not damage the utility line.
 - 3. Select Backfill: Materials shall be predominantly sand and gravel, having a Plasticity Index less than 6.

- a. Gradation as follows:

<u>Sieve Size</u>	<u>Percent Passing</u>
1½ inch	100
No. 4	50-80
No. 40	10-25

- b. Select backfill material shall have a Sand Equivalent of 30 per ASTM D2419.
 - 4. Backfill: Soils that contain no rock larger than three inches at greatest dimension. If expansive clays are present, such content shall not exceed one-third of the material by volume, and shall be well mixed with non-cohesive soils.

2.3 *SELECT AND IMPORT MATERIAL IN PIPE AND BEDDING ZONE*

- A. Gravel: Pit run, natural stone; free of shale, clay, friable materials and debris; graded in accordance with 1½" x ¾" aggregate grading in Section 90-3, State Standard Specifications.
- B. Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; 1/4-inch minimum to 5/8-inch maximum size.

- C. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter, graded in accordance with Section 90-3, State Standard Specifications, within the following limits:

Sieve Size	Percent Passing By Weight
No. 4	75 – 100
No. 200	0 - 10

- D. Imported sand shall have a sand equivalent of 30 per ASTM D2419.

2.4 SAND-CEMENT SLURRY

- A. Sand-cement slurry backfill shall be as specified in Section 03 30 10 – Cast-in-Place Concrete.

2.5 WATER FOR COMPACTION

- A. Water shall be free of organic materials injurious to the pipe coatings, have a pH of 7.0 to 9.3, maximum chloride concentration of 500 mg/l, and a maximum sulfate concentration of 500 mg/l.

PART 3 EXECUTION

3.1 GENERAL

- A. Excavation and backfilling of trenches used for construction of communications, power, process piping, and water distribution and sewer systems shall conform to State Standard Specifications, Section 19, Earthwork.
- B. Excavation shall be by open cut except that short sections of a trench may be tunneled if the utilities can be safely and properly installed and backfill can be properly compacted in such tunnel sections.

3.2 INSPECTIONS

- A. Verify stockpiled material has been approved for reuse.
- B. Verify areas to be backfilled are free of debris, snow, ice, or water, and surfaces are not frozen.

3.3 PREPARATION

- A. Identify required lines, levels, contours, and datum.

3.4 AC PAVEMENT AND CONCRETE REMOVAL

- A. Cut bituminous and concrete pavements, regardless of the thickness, curbs, gutters and sidewalks prior to excavation of trenches.

1. Width of material removed shall be at least equal to the required width of the trench at ground surface.
2. Width of material removed shall be as shown on the Plans
3. AC pavement and concrete rubble shall not be used for trench backfill.

3.5 TRENCH EXCAVATION

- A. Excavate the trench to the lines and grades shown on the Drawings for storm sewer, sanitary sewer, water, and other utilities and points of connection, with allowance for pipe thickness, sheeting and shoring if used, and for special bedding.
- B. Paved Areas: Cut existing pavement to full depth to a true line before excavation and maintain the edge suitable for repaving. Pavement removed shall not be used as backfill.
- C. Trenching Guidelines: Excavate the trench to the approximate level of the grade of the utility line to be installed, using adequate trench width and side slopes to safely accommodate worker access.
 1. Rocky Trench Bottom: Where ledge rock, hard pan, boulders, or sharp-edged materials are encountered, over excavate a minimum depth of 6 inches below the bottom of the utility exterior wall to permit adequate bedding preparation. The installed utility shall have at least 6 inches of clearance from any rock protrusion.
 2. Unstable Trench Bottom: Secure approval of depth of over-excavation and stabilization method. For wet trench construction, use approved method of dewatering through diversion, damming and pumping, well points, or underdrain systems. Dispose of removed fluidized materials as approved. Use bedding material to build a suitable foundation to within 6 inches of finished utility grade, prior to bedding with the specified material. Compact layers to 95 percent of maximum density in not greater than 6-inch layers. Do not proceed with utility installation until wet trench and unstable conditions are corrected to the satisfaction of the Engineer.
- D. Remove areas of sub-grade not readily capable of it-situ compaction.
 1. Backfill with Bedding or Select Backfill material and compact to density equal to requirements for subsequent backfill.
- E. Correct unauthorized excavation at no cost to Owner.
 1. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade.
 2. Place the refilling material over the full width of trench in compacted layers not exceeding eight inches deep to the established grade with allowance for special bedding.

- F. Trench widths in the pipe zone shall be as shown on the drawings. If no details are shown, maximum width shall be 24 inches greater than the pipe outside diameter.
 - 1. Trench width at the top of the trench will not be limited except where width of excavation would undercut adjacent structures and footings. In such case, width of trench shall be such that there is at least two feet between the top edge of the trench and the structure or footing.
- G. Hand trim for bell and spigot pipe joints.
- H. Remove lumped soil, boulders and rock.
- I. Excavation shall not interfere with normal 45 degree bearing splay of foundations.
- J. During trench excavation, place the excavated material only within the working area. Do not obstruct roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material.
- K. Foundation stabilization
 - 1. After the required excavation has been completed, the Engineer will inspect the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation be conducted in all areas within the influence of the pipeline where unsuitable materials exist at the exposed subgrade. Over excavation shall include the removal of all such unacceptable material that exists directly beneath the pipeline to a width 24 inches greater than the pipe outside diameter and to the depth required.

3.6 *LENGTH OF OPEN TRENCH*

- A. Limit the length of open trench to 300 feet in advance of pipe laying or amount of pipe installed in one working day.
- B. Complete backfilling, temporary or first layer paving, not more than 300 feet in the rear of pipe laying operation.

3.7 *TRENCH EXCAVATION IN EMBANKMENT AREAS*

- A. Construct and compact the embankment to an elevation one foot, minimum, over the top of the largest pipe or conduit to be installed prior to trench excavation.

3.8 *UNSUITABLE MATERIAL*

- A. Unsuitable material shall be excavated and disposed of in a lawful manner off the project site, all disposal shall be approved by the Engineer prior to initiating the work.

3.9 *DEWATERING*

- A. The Contractor shall keep all excavation free from water. Furnish, install, maintain, and operate all necessary pumping and other equipment for dewatering

of excavations. The Contractor shall at all times have on the project sufficient pumping equipment for immediate use, including stand-by pumps for use in case other pumps become inoperable.

- B. The dewatering operation shall be continuous, so that the excavated areas are kept free from water during the construction, until backfill has been placed to a sufficient height to anchor the work against possible floatation.
- C. Dewatering devices shall be adequately filtered to prevent the removal of fines from the soil.
- D. Repair any damage caused by the failure of any part of the protective works. Remove temporary protective works when they are no longer needed for dewatering purposes.
- E. Any drain rock required in the trench bottom to convey water or stabilize wet soil shall be included at no extra cost to the Owner.
- F. Provision of dewatering and dewatering equipment shall be considered part of the project with no additional compensation allowed.

3.10 TRENCH BACKFILLING

- A. Support pipe during placement and compaction of bedding fill.
- B. Backfilling and cleanup work shall be accomplished as sections of pipe or conduit are tested and approved. Vehicular travel through the work site shall be impeded or obstructed as little as possible.
- C. Compaction: Use vibratory compactors for sands and gravels (non-cohesive soils). Use mechanical tampers for sand and gravel containing a significant portion of fine-grained materials, such as silt and clay (cohesive soils). Hand tamp around pipe or cable to protect the lines until adequate cushion is attained. Puddling or water flooding for consolidation of backfill or compaction by wheel rolling will not be permitted.
- D. Bedding: Unless otherwise specified, compact the specified material to 95 percent of maximum density to the finished utility grade.
- E. Select Backfill: Fill by hand placement around the utility to just over half depth, and compact in a manner to ensure against lateral or vertical displacement. Place select backfill to 12 inches above the utility line by hand placement in not more than 6-inch layers.
- F. Backfill: To minimize settling, soils shall be backfilled in layers, with each layer compacted prior to addition of the next layer. Unless otherwise specified, place and compact the specified material as follows:
 - 1. Vehicular Traffic Areas: Fill and compact in 8-inch maximum layers as follows:

- a. From top of select backfill to two feet below top of subgrade, compact to 90 percent of maximum density.
 - b. From two feet below top of subgrade to top of subgrade, compact to 95 percent of maximum density/
2. Non-traffic Areas: Fill and compact in 8-inch maximum layers to 90 percent of maximum density.
- G. Employ a placement method that will not disturb or damage pipe or utilities.
- H. Maintain optimum moisture content of backfill materials to attain required compaction density.
- I. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction or hand tamping. Do not use high impact hammer type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe.
- J. Compact material placed within 12 inches of the outer surface of the pipe by hand tamping only.
1. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe.
 2. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.
- K. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 8-inch lifts, keeping the level of backfill the same on each side.
- L. Do not use any axle-driven or tractor-drawn compaction equipment within 5 feet of building walls, foundations, and other structures.
- M. Do not permit free fall of the material until at least two feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment over the pipe until at least 3 feet of backfill has been placed and compacted over the pipe.
- N. Remove surplus backfill materials from site.
- O. Leave stockpile areas completely free of excess fill materials.

3.11 TOLERANCES

- A. Top Surface of Backfilling: ± 0.1 foot.

3.12 SAND CEMENT SLURRY, CONCRETE ENCASEMENT AND THRUST BLOCKS

- A. Place in accordance with the Contract drawings.

3.13 COMPACTION REQUIREMENTS

- A. Relative compaction requirements shall be as shown on the Plans.

END SECTION

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SECTION 31 23 19

STRUCTURE EXCAVATION & BACKFILLING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work of this section consists of excavation and backfill for concrete structures, and preparation of subgrade for concrete flatwork.
- B. Haul, place, rough grade, compact, and finish grade excavated material as engineered fill on those portions of the project site where it is necessary in order to construct the facilities indicated on the Plans.
- C. Dispose of unsuitable material off-site or in designated areas, as directed by the Engineer.

1.2 RELATED WORK

- A. Section 31 23 00 – Earthwork
- B. Section 31 23 17 – Trenching Backfilling and Compacting
- C. Section 31 22 19 – Finish Grading
- D. Section 01 57 23 – Storm Water Pollution Prevention Plan
- E. Section 01 57 27 – Dust Control

1.3 REFERENCES

- A. ANSI/ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates.
- B. ANSI/ASTM D1557 – Moisture-Density Relations of Soils and Sol-Aggregate Mixture Using 10 lb (4.54 kg) Hammer and 18-inch (457 mm) Drop. (Curve)
- C. ANSI/ASTM D1556 – Density of Soil and base rock in Place by Sand-Cone Method.
- D. ASTM D6938 – Density of soil and base rock in place by Nuclear method.
- E. ASTM D2937 – Density of soil and in place by Tube method.
- F. Section 25 – Aggregate Subbases, State Standard Specifications
- G. Section 26 – Aggregate Bases, State Standard Specifications.

1.4 SUBMITTALS

- A. Submit plans as required for worker protection against caving ground in excavations. Submittals shall be in accordance with Section 01 33 00 – Submittals Procedures.

1.5 *SAMPLES*

- A. Submit 10 lb sample of each type of fill to testing laboratory, in airtight containers.

1.6 *QUALITY ASSURANCE*

- A. Compaction Testing
- B. Compaction tests will be performed for each lift or layer.
- C. Tests for compaction shall conform to references listed in Part 1.3 of this section
- D. Sample backfill materials per ASTM D75.
- E. Compaction testing will be performed in accordance with Section 19, State Standard Specifications.
 - 1. Test every structure location.
- F. Where compaction tests indicate failure to meet the specified compaction, the Contractor will rework the entire failed area until the specified compaction has been achieved.
- G. The cost of any retests, including time for the Engineer, shall be borne by the Contractor at no additional cost to the project.

1.7 *DEFINITION*

- A. Unsuitable Material: Unsuitable material is material determined to be
 - 1. Incapable of being compacted to specified density using ordinary methods at optimum moisture content.
 - 2. Too wet to be properly compacted if circumstances prevent satisfactory in-place drying prior to incorporation into the work.
 - 3. Otherwise unsuitable for the planned use.

1.8 *PROTECTION*

- A. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation.
- B. Notify Engineer of unexpected subsurface conditions
- C. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- D. Grade excavation top perimeter to prevent surface water run-off into excavation.

1.9 CONTROL AND DIVERSION OF WATER

- A. General – The Contractor shall furnish or procure all materials and labor required for constructing and maintaining all necessary cofferdams, channels, flumes, drains, sumps, and/or other temporary diversion and protective works and shall furnish, install, maintain, and operate all necessary pumping and other equipment for removal of water from the various parts of the work and for maintaining the foundations and other parts of the work free from water.

1.10 CLASSIFICATION

- A. Expected material that will be excavated at this site has been identified in the Geotechnical Report.
- B. Regardless of the nature of material excavated, all excavation will be considered unclassified.

1.11 SITE CONDITIONS

- A. Underground utilities may exist at this site. Contractor shall take all necessary precautions to protect said utilities. Notify Engineer of any deviation in utility location from that which is shown on the drawings.

PART 2 PRODUCTS

2.1 SELECT BED AND FILL MATERIALS

- A. Conform to Section 31 23 17, Trenching, Backfilling, and Compacting.

2.2 SELECT MATERIAL

- A. Gravel: Pit run, natural stone; free of shale, clay, friable materials and debris; graded in accordance with 1½" x ¾" aggregate grading in Section 90-1.02C, State Standard Specifications.
- B. Pea Gravel: natural stone; washed, free of clay, shale, organic matter; ¼ inch minimum to ⅝ inch maximum size.
- C. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter, graded in accordance with ANSI/ASTM C136 within the following limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	75-100
No. 200	0-10

- D. Class 2 Aggregate Base: material as specified for ¾" maximum grading in the State Standard Specifications, Section 26.

2.3 CONCRETE SLURRY

- A. Concrete slurry mix shall be as specified in Section 03 30 10, Cast in Place Concrete.

2.4 ENGINEERED FILL MATERIAL

- A. Native granular soil materials may be used as engineered fill. Pulverized asphalt concrete or Portland cement concrete may be incorporated into engineered fill provided no rock pockets or voids are produced. Particles larger than three inches shall be removed from trench backfill, particles larger than six inches shall be removed from engineered fill.
- B. All imported fill material placed in structural areas shall consist of predominantly granular soil that is non-expansive, and shall be approved by the Engineer prior to use.
 - 1. The R-value of the imported fill material shall be at least 50.

2.5 GRANULAR BACKFILL/AGGREGATE BASE COURSE

- A. Granular backfill and aggregate base course shall meet the requirements of State Standard Specifications, Section 26, Class 2 aggregate base, $\frac{3}{4}$ inch maximum.
- B. Material from concrete crushing operations may be used as granular backfill provided it meets the above requirements.

2.6 WATER

- A. Water development, hauling, and application shall be in accordance with the State Standard Specifications, Section 10-6, Watering.

PART 3 EXECUTION

3.1 GENERAL

- A. Provide required shoring, sheeting, and slope layback necessary to protect the excavation, as needed, for the safety of the employees and as required by applicable State and Federal laws. Provide suitable barricades for public safety, regardless of trench depth.
- B. Upon completion of excavation and before placing forms or structures, notify the Engineer who will inspect the excavation and may take tests to determine soil-bearing values.
- C. Identify required lines, levels, contours, and datum.
 - 1. Stake and identify the extent of all earthwork operations prior to starting work.
- D. Use suitable material removed from excavation before importing backfill.

- E. Verify that stockpiled fill to be reused is approved by the Engineer.
- F. Verify areas to be backfilled are free of debris, snow, ice, or water, and surfaces are not frozen.

3.2 DEWATERING

- A. The Contractor shall keep all excavation free from water. Furnish, install, maintain, and operate all necessary pumping and other equipment for dewatering of excavations. The Contractor shall at all times have on the project sufficient pumping equipment for immediate use, including stand-by pumps for use in case other pumps become in-operable.
- B. The dewatering operation shall be continuous, so that the excavated areas are kept free from water during the construction, until backfill has been placed to a sufficient height to anchor the work against possible floatation.
- C. Dewatering devices shall be adequately filtered to prevent the removal of fines from the soil.
- D. Repair any damage caused by the failure of any part of the protective works. Remove temporary protective works when they are no longer needed for dewatering purposes.
- E. Provision of dewatering and dewatering equipment shall be considered part of the project with no additional compensation allowed.
- F. Any drain rock required in the trench bottom to convey water or stabilize wet soil shall be included at no extra cost to the Owner.

3.3 EXCAVATION

- A. Carefully excavate to the established lines and grades shown on the drawings, or as revised and approved by the engineer, to provide a firm, uniform, and unyielding foundation for the proposed structures.
- B. Excavations for all footings, piers, finished walls and grade beams shall be sufficiently large so that forms for concrete may be properly placed, removed, and inspected.
 - 1. Excavation for footings may be made to the net footing size plus two inches if the earth banks are sufficiently stable to remain in position until the concrete is in place and if approved by the Engineer.
- C. The bottoms of footings, piers, slabs, walls, and grade beams to receive concrete shall be level before placing concrete. All foundations shall rest on firm bearing in undisturbed soil, or on controlled compacted fill.
 - 1. The exposed subgrade surface shall be scarified to a depth of 8 inches, conditioned to optimum moisture content and compacted to at least 95 percent of the maximum dry density.

- D. If any existing foundations, roots, stumps, debris, waste materials, pipes, or similar items have been removed, the Contractor shall excavate below these portions to solid undisturbed earth and foundations in these areas shall be built to necessary levels.
- E. If soil conditions in excavations are not in accordance with the geotechnical report and seem to indicate that footings need not be carried down as deep as shown, or must be carried deeper, the changes shall be made by the Contractor after approval by the Engineer.
 - 1. Over excavation shall be required a minimum of two feet below top of proposed slab grades under all structures, including but not limited to the tank, tank ring wall, all concrete slabs, etc., unless shown otherwise on the Plans.
 - 2. Engineered fill in over excavated areas shall be import fill material, free from organic materials or deleterious substances.
- F. Common Fill Material (native material) is not acceptable for use as Engineered fill under any structure, tank, tank ring wall, or concrete slab.

3.4 *SURPLUS MATERIAL*

- A. Unless otherwise specified, surplus excavated material shall be used to widen embankments uniformly or to flatten slopes, or it shall be disposed of in a uniform manner along the adjacent roadway around the site or otherwise as approved.
- B. Unless otherwise specified, surplus excavated material shall be used as fill for other areas requiring fill as shown on the Plans. Excess material that is not needed for engineered fill may be disposed of at an off-site spoil area. The location of the off-site spoil area, the limits of the fill area, the depths of fill, and the manner of work shall be as directed by the Engineer.
- C. Stockpile surplus material as shown on the plans and/or as directed by the Engineer
- D. Leave stockpile areas completely free of excess fill materials.

3.5 *UNSUITABLE MATERIAL*

- A. Unsuitable material shall be excavated and disposed of in a uniform manner off the project site, within the Owner's property as approved, however all disposal shall be approved by the Engineer prior to initiating the work.

3.6 *OFF-SITE BORROW AREAS*

- A. Engineered fill material may be obtained from off-site borrow areas, if on-site sources prove to be insufficient.

3.7 *BACKFILLING*

- A. Unless otherwise shown in the Plans, all backfill shall conform to Section 19-3 of the State Standard Specifications.

- B. Do not place backfill against concrete until concrete has cured sufficiently to accept the load as determined by Section 19-3.03E of the State Standard Specifications.
- C. Place and compact common fill material in continuous layers not exceeding eight inches loose depth.
- D. Employ a placement method so not to disturb or damage pipes or utilities.
- E. Maintain optimum moisture content of backfill materials to attain required compaction density.
- F. Remove surplus materials from site.

3.8 *TOLERANCES*

- A. Top Surface of Backfilling: ± 0.1 foot from design grade.

3.9 *SLURRY CEMENT*

- A. Slurry cement backfill shall be placed and shown on the Drawings and in accordance with State Standards Specifications, Section 19-3.02E.

END SECTION

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SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes designing, furnishing, installing, operating, maintaining, and removing a dewatering system. The system shall be of sufficient size and capacity to maintain a dry condition for construction of each part of the work without delaying construction operations. Control all water regardless of source. Comply with applicable environmental protection laws and requirements in operation of the dewatering system.

1.2 RELATED WORK

- A. Section 01 33 00 – Submittal Procedure
- B. Section 31 23 00 – Earthwork
- C. Section 31 23 17 – Trenching, Backfilling and Compacting

1.3 DATA AVAILABLE

- A. Logs of test borings, test pits, and trench excavations performed are shown in the geotechnical report. The subsurface conditions from the test borings and excavations apply only to the locations of the borings and at the times of the explorations. The subsurface conditions elsewhere at the site and at the time of construction may be different.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- B. Submit information on the proposed type of dewatering system including the arrangement, location and depths of system components.
- C. Complete description of equipment and instrumentation to be used with installation including operation and maintenance procedures.
- D. Type and sizes of desiltation equipment.
- E. Method of disposal of pumped water.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 GENERAL

- A. Review and evaluate the available subsurface data for the project site with respect to required dewatering facilities, including any additional groundwater monitoring data required.
- B. Provide means and devices to remove promptly and dispose of water entering excavations and keep the bottoms of the excavations firm and free of standing water and side slopes stable until the pipeline or structures to be constructed are completed and/or the backfill to be placed therein has been placed.
- C. Perform the pumping and dewatering operations such that no disturbance to the bearing soil or to soil supporting any other work will result from the dewatering operations. The dewatering discharge shall not cause siltation or other negative environmental impact on natural waterways or other property; such discharge shall be in accordance with applicable federal, state, and local regulations.
- D. Operate the dewatering system continuously to prevent flotation of partially completed pipelines, structures or other work and flooding/excess wetting of work areas.

3.2 DEWATERING REQUIREMENTS

- A. Design, furnish, install, maintain, and operate a dewatering system which shall prevent loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of bottoms of excavations so that every phase of the work can be performed in the dry with the exception of dredging. Prior to placement of concrete or pipe the subgrade shall be in a firm, well drained condition and of adequate and uniform load bearing nature to support construction personnel, materials, equipment and reinforcing steel mats without tracking, rutting, heaving or settlement. All soft, saturated or otherwise unsuitable material shall be removed and replaced with approved backfill.
- B. Water levels shall be a minimum of 2 feet below subgrade until all backfill is placed and compacted.

3.3 INSTALLATION AND OPERATION

- A. The location of every element of the dewatering system shall be such that interference with excavation and construction activity is minimized.
- B. Demonstrate to the Owner's Representative that the dewatering system meets the specified requirements.
- C. When the dewatering system does not meet the specified requirements and, as a consequence, loosening or disturbance of the foundations strata, instability of the slopes, or damage to the foundations or structures occurs, provide materials, labor, and work for restoration of foundations soil, fill soils, slopes, foundations, or structures at no cost to the Owner.

- D. When the dewatering system does not meet the specified requirements and consequently fill surfaces become too wet or the fill exceeds the specified moisture content, remove and replace the upper materials with materials placed and compacted to the specifications. Do not dry out overly wet fills resulting from failed or inadequate dewatering systems or mix with dry material and rework in-place to meet applicable fill specifications.

3.4 *STANDBY EQUIPMENT*

- A. Provide standby pumping and power equipment of sufficient capacity to maintain the dewatering system in an operable condition in the event of failure of any of the original equipment or power.

3.5 *DAMAGES*

- A. The Contractor shall be responsible for and shall repair without cost to the Owner any damage to work in place, other contractors' equipment, and the excavation, including damage to the bottom of the excavation due to heave and removal of material and pumping out of the excavated area that may result from the Contractor's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.

3.6 *REMOVAL*

- A. Remove the components of the dewatering system from the site at the completion of the dewatering work.

END SECTION

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SECTION 31 23 31

COMPACTING EARTH MATERIALS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The Contractor shall provide all labor, materials and equipment and perform all operations necessary to complete all earthwork required as specified, shown on the drawings, or as directed.

1.2 RELATED WORK

- A. Section 01 57 23 – Storm Water Pollution Prevention Plan
- B. Section 01 57 27 – Dust Control
- C. Section 03 33 10 – Concrete Site Work
- D. Section 31 11 00 – Clearing and Grubbing
- E. Section 31 22 19 – Finish Grading
- F. Section 31 23 00 – Earthwork
- G. Section 32 11 23 – Aggregate Base

1.3 REFERENCES

- A. ASTM D75 – Practice for Sampling Aggregates.
- B. ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates.
- C. ANSI/ASTM D1557 – Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 10 lb (4.54 kg) Hammer and 18-inch (457 mm) Drop.
- D. ASTM D1556 – Density and Unit Weight of Soil in Place by Sand-Cone Method.
- E. ASTM D2419 – Sand Equivalent Value of Soil and Fine Aggregate
- F. ASTM D6938 – Density of Soil and in Place by the Drive Cylinder Method.
- G. ASTM D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- H. ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- I. ASTM D5080 – Standard Test Method for Rapid Determination of Percent Compaction

- J. ASTM D6938 – In Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).
- K. ASTM D7382 - Standard Test Methods for Determination of Maximum Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibrating Hammer
- L. Section 26 – Aggregate Bases, State Standard Specifications.
- M. Section 16 – Clearing and Grubbing, State Standard Specifications
- N. Section 17 – Watering, State Standard Specifications
- O. Section 19 – Earthwork, State Standard Specifications

1.4 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 - Submittal Procedures.

1.5 QUALITY CONTROL

- A. In-Place Density:
 - 1. Compacted backfill for structures and structure foundations: At least one test per lift or per 500 cubic yards placed, whichever is more frequent.
 - 2. Subgrade preparation including scarification and re-compaction of native soils: At least 1 test per lift per 1,000 sf of surface area or 500 cubic yards of fill placed, whichever is more frequent
 - 3. Embankments and building pads: At least 1 test per lift per 1,000 sf of surface area or every 200 lineal foot of embankment, or 2000 cubic yards of fill placed, whichever is more frequent.
 - 4. Pipeline Trenches: At least 1 test per lift per every 200 feet of trench backfill placed or every 500 cubic yards placed, whichever is more frequent.
 - 5. A greater frequency of testing may be required at the start of work or when new materials, crews, or equipment are introduced to the site. A lesser frequency can be utilized if approved by the Owner's Representative.
- B. Laboratory Index Testing:
 - 1. Compacted backfill for structures, structure foundations, sub grade for roadways and paved areas, embankments, and pipelines: Maximum dry density and optimum moisture content, Plasticity Index, and Gradation (when applicable) shall be confirmed at least once for every 2,500 cubic yards of fill placed.
 - 2. In addition, at least one set of applicable index tests shall be performed for each distinct material type used as compacted fill at the site.

3. Additional tests may be performed, as directed by the Owner's Representative, whenever deviations in material properties or quality of workmanship are suspected.
- C. Tests for compaction shall conform to references listed in Part 1.3 of this section.
- D. Sample backfill materials per ASTM D75.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.1 GENERAL

- A. Where compacting of earth materials is required, the materials shall be deposited in horizontal layers and compacted as specified in this section. The excavation, placing, moistening, and compacting operations shall be such that the material will be uniformly compacted and will be homogeneous, free from lenses, pockets, streaks, voids, laminations, or other imperfections.
- B. Relative Compaction:
 1. All areas that fail to meet the minimum compaction requirements shall be reworked as required by the Owner's Representative and retested until minimum compaction requirements are obtained.

3.2 COMPACTION REQUIREMENTS

- A. Unless otherwise specified or shown on the Drawings, a minimum of 90 percent of relative compaction.

3.3 COMPACTING CLAYEY AND SILTY (COHESIVE) MATERIALS

- A. Where compaction of earth materials containing appreciable amounts of clay or silt is required, the materials shall be deposited in horizontal layers. The thickness of each horizontal layer prior to compaction shall not be more than eight inches. The excavating, placing, moistening and compacting operations shall be homogeneous, free from lenses, pockets, streaks, voids, laminations, or other imperfections such that the materials when compacted will be blended sufficiently to secure the highest practicable density.
- B. Moisture Content:
 1. Prior to and during compaction operations, the materials shall have an above optimum moisture content, but not greater than three percentage points of optimum moisture content, and the moisture content shall be uniform throughout each layer. The optimum moisture content is defined as that moisture content which will result in the laboratory maximum dry density of the soil as determined using ASTM D1557 (or ASTM D698).

2. Insofar as practicable, as determined by the Owner's Testing Agency, moistening of the material shall be performed at the site of excavation; but if necessary, such moistening shall be supplemented by sprinkling at the site of compaction.
 3. If the moisture content is less than optimum for compaction or is greater than optimum for compaction by more than three percentage points, the compaction operations shall not proceed, except with the specific approval of the Owner's Representative, until the material has been wetted or allowed to dry out, as may be required, to obtain a moisture content within the tolerances permitted above, and no adjustment in price will be made on account of any operations of the Contractor in wetting or drying the materials or on account of any delays occasioned thereby.
- C. When the material has been conditioned as herein before specified, it shall be compacted by rollers or by hand or power tampers. Where hand or power tampers are used to compact soils in confined areas such as under pipe, they shall be equipped with suitably shaped heads to obtain the required density.

3.4 *COMPACTING COHESIONLESS FREE-DRAINING MATERIALS*

- A. Where compaction of cohesion less free-draining materials, such as sands and gravels, is required, the materials shall be deposited in horizontal layers. The thickness of each horizontal layer prior to compaction shall not be more than eight inches. The excavating, placing, moistening and compacting operations shall be homogeneous, free from lenses, pockets, streaks, voids, laminations, or other imperfections such that the materials when compacted will be blended sufficiently to secure the highest practicable density.
- B. Moisture Content:
1. Prior to and during compaction operations, the materials shall have a moisture content at least equal to the optimum moisture content and shall be uniform throughout each layer. The optimum moisture content is defined as that moisture content which will result in the laboratory maximum dry density of the soil as determined using ASTM D1557 (or ASTM D698).
 2. Insofar as practicable, as determined by the Owner's Representative, moistening of the material shall be performed at the site of excavation; but if necessary, such moistening shall be supplemented by sprinkling at the site of compaction.
 3. If the moisture content is less than optimum for compaction, the compaction operations shall not proceed, except with the specific approval of the Owner's Representative, until the material has been wetted or allowed to dry out, as may be required, to obtain a moisture content above optimum, and no adjustment in price will be made on account of any operations of the Contractor in wetting or drying the materials or on account of any delays occasioned thereby.

3.5 *ROLLERS*

- A. Rollers used for compacting earth materials shall have staggered and uniformly spaced tamping feet and be of sufficient weight for proper compaction.
- B. The tamping heads and cleaner bars shall be properly maintained, and the spaces between the tamping feet shall be kept clear of materials which impair the effectiveness of the tamping rollers.

END SECTION

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SECTION 31 23 35 DISPOSAL OF MATERIALS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Disposal of unsuitable material, concrete, asphalt concrete, rubbish, and other debris, as described below.

1.2 RELATED WORK

- A. Section 01 57 23 – Storm Water Pollution Prevention Plan
- B. Section 01 57 27 – Dust Control
- C. Section 03 33 10 – Concrete Site Work
- D. Section 31 11 00 – Clearing and Grubbing
- E. Section 31 23 31 – Compacting Earth Materials

1.3 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 - Submittal Procedures.

1.4 GENERAL

- A. The Contractor shall be responsible for the cleanup and disposal of waste materials and rubbish. The disposal of waste materials and rubbish shall be in accordance with applicable Federal, State, and local laws and regulations, and with the requirements of this paragraph. Should a conflict exist in the requirements for cleanup and disposal of waste materials, the most stringent requirement shall apply.
- B. The Contractor shall keep records of the types and amounts of waste materials produced, and of the disposal of all waste materials on or off the jobsite.
- C. The cost of disposing of waste materials other than unsuitable materials shall be included in the prices bid in the schedule for other items of work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 DISPOSAL OF EXCAVATED MATERIAL

- A. All excess excavated material shall be hauled off site to a location selected by the Contractor, meeting the conditions of Paragraph 3.4 below.

- B. All unsuitable material that is hauled off-site shall be properly disposed.

3.2 *DISPOSAL OF CONCRETE AND A.C. SURFACING*

- A. All concrete, A.C. and pavement removed from the project site shall be disposed of at a site obtained by the Contractor and approved by the Owner's Representative. No recyclable material shall be disposed of at any landfill. All disposable recyclable materials shall be disposed in a manner that facilitates recycling. The Contractor shall report quantities of disposed material in a manner that enables the Owner to utilize diverted quantities as diversion credits pursuant to California Integrated Waste Management Act of 1989 (Public Resources Code Sections 40000 et seq.)

3.3 *DISPOSAL OF OTHER DEBRIS*

- A. All oil cake, wood debris, structure demolition, vegetation and any other debris removed from the project site shall be legally disposed of at a site(s) obtained by the Contractor with prior written permission of the Owner's Representative. Contractor shall identify the proposed Disposal Site(s) at the pre-construction conference. Such Disposal Site(s) shall be a properly licensed and permitted facility pursuant to state and local regulations for purposes of accepting delivery of the respective materials. No recyclable material shall be disposed of at any landfill. All disposable recyclable materials shall be disposed in a manner that facilitates recycling. In addition to the following, a certificate of compliance stating disposal location and manner of disposal of recyclable materials shall be submitted to the Owner's Representative.
 - 1. Disposal of combustible materials shall be by removal from the construction area. Disposal of combustible materials by burning will not be permitted. Disposal of waste materials by burying will not be permitted.
 - 2. Waste materials shall be disposed of or recycled at a State approved disposal or recycle facility. The Contractor shall make any necessary arrangements with private parties, and State and county officials pertinent to locations and regulations of such disposal or recycle facilities, and shall pay any fees or charges required for such disposition.

3.4 *CONTRACTOR'S DISPOSAL SITES*

- A. Contractor shall make arrangements for disposing of the materials at the Disposal Site(s) and pay all costs involved. Arrangements shall include, but not be limited to, obtaining written authorization from the property owner of the Disposal Site(s) and before disposing of any material off the project site, Contractor shall furnish to the Owner's Representative the authorization or a certified copy thereof together with a written release from the property owner absolving the Owner from any and all responsibility in connection with the disposal of material on the property of the Disposal Site(s). Before any material is disposed of on the Disposal Site(s), the Contractor shall obtain written permission from the Owner's Representative to dispose of the material at the location designated in the authorization.
- B. It is expressly understood and agreed that the Owner assumes no responsibility to the Contractor whatsoever by the granting of such permission and Contractor shall

assume all risks in connection with the use of the Disposal Site(s). The Contractor is cautioned to make such independent investigation and examination as the Contractor deems necessary to be satisfied as to the quantity and types of materials which may be disposed of on the Disposal Site(s) and the status of any permits or licenses in connection therewith.

- C. Within 24 hours of removing the respective material from the project site for disposal, Contractor shall provide Owner's Representative with a certified copy of the weight slip from the Disposal Site obtained by Contractor upon delivery of such debris, and a certified statement from Contractor identifying the material constituting the debris and that it was disposed of at the Disposal Site (identifying the and name of the owner) in accordance with all laws and applicable regulations promulgated by Federal, State, regional, or local administrative and regulatory agencies.

3.5 *DISPOSAL OF HAZARDOUS WASTE AND MATERIALS*

- A. Materials or wastes, defined as hazardous by 40 CFR 261.3, or by other Federal, State, or local laws or regulations, used by the Contractor or discovered in work or storage areas, shall be disposed of in accordance with these specifications and applicable Federal, State, and local laws and regulations. Unknown waste materials that may be hazardous shall be tested, and the test results shall be submitted to the Owner's Representative for review.
- B. Waste materials known or found to be hazardous shall be disposed of in approved treatment or disposal facilities. Hazardous wastes shall be recycled whenever possible. A copy of all hazardous waste manifest shall be sent to the Owner's Representative.
- C. Waste materials discovered at the construction site shall immediately be reported to the Owner's Representative. If the waste may be hazardous, the Owner's Representative may order delays in the time of performance or changes in the work, or both. If such delays or changes are ordered, an equitable adjustment will be made in the contract in accordance with the applicable clauses of the contract.
- D. If necessary, the Contractor will be required to conduct an environmental site assessment at the following Contractor use locations:
 - 1. All hazardous waste accumulation areas;
 - 2. All hazardous material and petroleum dispensing and storage areas where the aggregate storage of hazardous materials or petroleum at the site is or has been over 110 gallons.
 - 3. This site assessment shall be performed by a qualified environmental consultant or equivalent and shall document through appropriate analytical sampling that the site is free of the effects of contamination (i.e., contaminant concentrations less than State action cleanup levels).

3.6 *CLEANUP*

- A. The Contractor shall keep work and storage areas free from accumulations of waste materials and rubbish, and before completing the work, shall remove all plant facilities, buildings, including concrete footings and slabs, rubbish, unused materials, concrete forms, and other like materials, which are not a part of the permanent work.
- B. Upon completion of the work, and following removal of construction facilities and required cleanup, work areas shall be regraded and left in a neat manner conforming to the natural appearance of the landscape.

END SECTION

SECTION 32 11 23

AGGREGATE BASE

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish, spread, and compact aggregate base in roadways, driveways and other paved areas as shown on the Plans.
- B. The work of this section consists of furnishing and placing aggregate base material and/or lean concrete base materials, and filler if required, on the prepared subgrade.

1.2 RELATED WORK

- A. Section 31 23 00 – Earthwork
- B. Section 31 22 19 – Finish Grading
- C. Section 31 23 31 – Compacting Earth Materials
- D. Section 32 12 13 – Bituminous Prime and Tack Coat
- E. Section 32 12 16 – Asphalt Concrete Paving

1.3 REFERENCES

- A. Section 10-6 – Watering, State Standard Specifications.
- B. Section 26 – Aggregate Bases, State Standard Specifications.
- C. Section 28-2 - Lean Concrete Base, State Standard Specifications.
- D. ANSI/ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates.
- E. ANSI/ASTM D1557 – Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 10 lb (4.54 kg) Hammer and 18-inch (457 mm) Drop.
- F. ANSI/ASTM D1556 – Density of Soil and Base Rock in Place by Sand-Cone Method.
- G. ASTM D6938 – Density of Soil and Base Rock in Place by Nuclear Method.

1.4 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures.

- B. If materials are obtained from a commercial source, submit certification from the supplier certifying that aggregate base course meets the requirements of this section.
- C. Copies of certified weight tickets for each load of aggregate delivered to the project site.

1.5 QUALITY ASSURANCE

- A. Relative Compaction:
 - 1. All costs for initial compaction tests shall be borne by the Owner. All areas that fail to meet the minimum compaction requirements shall be reworked as required by the Engineer and retested until minimum compaction requirements are obtained.
 - 2. The cost of any retests, including time for the Engineer, shall be borne by the Contractor at no additional cost to the project. Testing will be required as directed by the Engineer. Test locations shall be determined by the Engineer upon notification from the Contractor that the grade is ready for tests. Contractor shall be present when samples of bedding, select backfill, and backfill materials are gathered for analysis or testing.
- B. Compaction tests will be performed for each lift or layer.
- C. Tests for compaction shall conform to references listed in Part 1.3 of this section.
- D. Sample backfill materials per ASTM D75.
- E. Compaction testing will be performed in accordance with Section 19-5 of the State Standard Specifications.
 - 1. Compaction testing of areas to be saw cut and replaced shall be one for every 300-LF of adjacent curb and gutter but not less than one for each curb cut area.
 - 2. The Contractor shall not proceed with work over the area being tested until results have been verified by the Engineer. Immediately upon completion of each compaction test, a copy of the results shall be given by the testing laboratory to the Engineer.
 - 3. Test every 10,000 square feet of engineered fill or aggregate base material placed. The Contractor shall not proceed with work over the area being tested until results have been verified by the Engineer. Immediately upon completion of each compaction test, a copy of the results shall be given by the testing laboratory to the Engineer.
- F. The percentage composition by weight shall conform to Class 2 aggregate base determined by Test Method No. Calif. 202, modified by Test Method No. Calif. 905 if there is a difference in specific gravity of 0.2 or more between the coarse and fine portion of the aggregate or between blends of different aggregates.

G. Aggregate base shall also conform to the following quality requirements:

<u>Tests</u>	<u>Test Method Calif. No</u>
R-Value	301
Sand Equivalent	217
Durability Index	229

H. Quality Control shall be under the provisions of Section 01 43 00 – Quality Control.

PART 2 PRODUCTS

2.1 MATERIALS

A. AGGREGATE BASE

1. Class 2 Aggregate Base, $\frac{3}{4}$ -inch maximum; as per Section 26-1.02B, State Standard Specifications.
2. Crushed Portland cement concrete which meets the gradation requirements of State Standard Specification Section 26, Class 2 Aggregate Base, $\frac{3}{4}$ -inch maximum, may be used as aggregate base course under new pavements.
3. Aggregate for Class 2 aggregate base shall be free from organic material and other deleterious substances.

B. LEAN CONCRETE BASE

1. Lean Concrete Base shall conform to the State Standard Specifications, Section 28-4, Lean Concrete Base Rapid Setting.
2. State Standard Specifications Section 28-4.04 shall not apply.

C. WATER

1. As specified in Section 01 51 36, Watering.
2. At the time aggregate base is spread, it shall have a moisture content sufficient to obtain the required compaction. Such moisture shall be uniformly distributed throughout the materials.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. As specified in Sections 31 23 00 – Earthwork.

3.2 *SPREADING*

- A. The aggregate base course material shall be deposited and spread to the required compacted thickness by means that will maintain the uniformity of the mixture. The aggregate base course shall be free from pockets of coarse or fine material.
- B. Deliver aggregate base to the area to be paved as a uniform mixture and spread each layer in one operation.
- C. Aggregate base placed at locations which are inaccessible to the spreading equipment shall be spread in two layers by any means to obtain the specified results.
- D. The aggregate shall not be treated with lime, cement or other chemical materials before the Durability Index test has been performed.
- E. The surface of the finished aggregate base at any point shall not vary more than ± 0.05 -foot from the grade shown.

3.3 *PLACING*

- A. If the required compacted depth of the aggregate base course exceeds 6 inches, place course in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.

3.4 *MIXING*

- A. Mixing shall be in accordance with one of the methods set forth in State Standard Specifications, Section 28-4.03B.

3.5 *MOISTURE CONTROL*

- A. When spread, aggregate base shall have a moisture content sufficient to obtain the specified compaction.

3.6 *SURFACE FINISHING*

- A. Use a smooth steel wheel roller for the final rolling of top surface base course. Water surface and evenly spread loose stones before final rolling. Make minimum of two complete passes over area to embed stones. Correct soft spots developed during rolling.
- B. Compacted aggregate base course surface shall be smooth and free from waves and other irregularities. Unsatisfactory portions of base course shall be corrected, at no additional expense to the Owner.

3.7 *MATERIAL ACCEPTANCE REQUIREMENTS*

- A. Acceptance will be based on periodic samples and tests taken following mixing and before placing.

3.8 TOLERANCES

- A. Surface: The finished surface of the base course will be tested with a 10-foot straightedge or other device. The variation between any two contacts with the surface shall not exceed ± 0.05 feet.
- B. Width: Plan dimension, ± 0.10 feet.
- C. Thickness: Plan dimension, ± 0.05 feet.
- D. Any areas not complying with these tolerances shall be reworked to obtain conformity, at no additional expense to the Owner.

3.9 MAINTENANCE

- A. Maintain base course in a satisfactory condition until surfaced or until final acceptance.

END SECTION

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SECTION 32 12 13
BITUMINOUS PRIME COAT AND TACK COAT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Prime Coat work consists of applying an application of asphalt or asphalt cutback, as specified, to the complete and compacted aggregate base course prior to placement of hot mix asphalt concrete.
- B. Tack Coat work consists of an application of asphalt cutback between asphalt layers. Applying a very light application of asphalt emulsion diluted with water as a tack between asphalt layers to create an adhesive surface for new asphalt concrete pavement to adhere to, and applied to all existing vertical surfaces where new pavement is to be surfaced.

1.2 RELATED WORK

- A. Section 31 22 19 – Finish Grading
- B. Section 32 11 23 – Aggregate Base
- C. Section 32 12 16 – Asphalt Concrete Paving

1.3 REFERENCES

- A. Section 94 – Asphaltic Emulsions, State Standard Specifications

1.4 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures.
- B. Two copies of manufacturer's certification for each load certifying the bituminous material is of the type, grade, and quality specified.
- C. One sample of asphalt cutback, in accordance with AASHTO T40-78, shall be taken for each load delivered to the project sites. Samples shall be stored in clean, airtight sealed containers at a temperature of not less than 40°F, until tested.

1.5 PROJECT CONDITIONS

- A. Apply bituminous material only during daylight hours, when surface is dry, temperature is above 50°F, and weather is not foggy or rainy.

PART 2 PRODUCTS

2.1 BITUMINOUS TACK COAT

- A. Asphalt for tack coat shall be RS-1 or RS-2, for Anionic asphalt emulsion or CRS-2 for Cationic asphalt emulsion.
 - 1. Engineer shall select which asphalt emulsion shall be used. Use tack coat between asphalt lifts only if applied surface has been in place over 24 hours, or has been in service.

PART 3 EXECUTION

3.1 GENERAL

- A. Protect the surface of sidewalks, curbs, other structures, and trees adjacent to the area being treated from being spattered or marred. If surfaces become spattered, clean in accordance with manufacturer's recommendations.
- B. Do not clean or discharge distributor outside the project limits of work.

3.2 DISTRIBUTOR

- A. Bituminous distributor and equipment for heating bituminous material shall be designed, equipped, maintained, and operated so that bituminous material, at even heat, may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.02 to 1.0 gallons per square yard, with uniform pressure. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and a full circulation spray bar adjustable laterally and vertically.
- B. When applying tack and prime coats, take care to give the surface a very light, even application of asphalt.

3.3 PREPARATION OF SURFACE

- A. Immediately before applying the tack or prime coat, remove loose material, dirt, clay or other objectionable material. Take particular care in cleaning the outer edges of the strip to be treated, to ensure that the prime or tack coat will adhere.
- B. Do not apply Prime Coat or Tack coat so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material.

3.4 APPLICATION

- A. Tack Coat: Apply tack coat uniformly in 1 application, per State Standards. Apply within 24 hours preceding placement of the covering course.

- B. Tack coat of asphaltic emulsion shall be furnished and applied in conformance with the provisions in Section 39 and 94, State Standards Specifications and shall be applied to surfaces to be paved and all vertical surfaces of existing pavement, curbs gutters and construction joints in the surfacing against which additional material is to be placed, and to other surfaces designated in the special provisions.

END SECTION

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BITUMINOUS PRIME COAT AND TACK COAT
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SECTION 32 12 16
ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work of this section consists of constructing one or more surface courses composed of a mixture of aggregate, filler if required, asphalt material and placed on a prepared base to lines, grades and details, as shown on the plans and covered within these specifications. This section includes asphalt patching for areas where utility lines cross existing paved surfaces, trench resurfacing, saw cutting and resurfacing additional paving widths as required in the contract or under permit requirements.
- B. Mix aggregate and asphalt binder at a central mixing plant. Haul, spread, and compact the mixture for paved areas as shown and as specified.
- C. Upon completion of all paving, finish the entire roadway. Trim and shape cut and fill slopes to produce smooth surfaces and uniform cross sections. Clean the finished pavement of all dirt and foreign material.
- D. Cross sections of paving shall be as indicated in the Plans.

1.2 RELATED WORK

- A. Section 31 23 00 –Earthwork
- B. Section 32 11 23 – Aggregate Base

1.3 REFERENCES

- A. Section 22 – Finishing Roadway, State Standard Specifications
- B. Section 39 – Asphalt Concrete, State Standard Specifications
- C. Section 92 – Asphalt Binders, State Standard Specifications
- D. Section 94 – Asphaltic Emulsions, State Standard Specifications
- E. Section 96 – Geosynthetics, State Standard Specifications

1.4 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittal Procedures.
- B. Certificates:
 - 1. Certification from the supplier that the asphalt concrete is of correct type and meets requirements of this section.

2. Job mix formula shall be submitted with certification that the mix formula meets the requirements of Standard Specification Specifications Section 39, Asphalt Concrete. The job mix formula shall include definite single values for:
 - a. The percent of aggregate passing the specified sieve, based on dry weight of aggregate.
 - b. The percent of bituminous material to be added, based on the total weight of the mix.
 - c. Kind and amount of chemical additives (anti-stripping, hydrated lime, etc.) as established by the design procedure.
 - d. Maximum theoretical density.
 - e. Temperature ranges for the bituminous material at the point of mixing with the aggregates and bituminous mixture at the paving machine.

1.5 QUALITY ASSURANCE

- A. Asphalt concrete supplier to prepare a mix design; to recommend adjustments to the proportions of the mix, as necessary, to conform to the mix design; and to consult with the Contractor and the Engineer during paving as required.
- B. Testing required to, determine compliance for the work of this section shall be performed by an independent testing laboratory, approved by the Engineer and appointed and paid for by the Contractor. The independent testing laboratory shall be used to sample and test asphalt concrete at the job sites. One test shall be taken for each paving period and at least one test every four hours. As a minimum, results of the test shall include items A, B, C and E of the job mix formula submittal.
- C. Density: Acceptable density of the in-place asphalt concrete pavement shall be 95 percent of the optimum values as determined from the mix design formula. Field sampling and density determination shall be made in accordance with an accepted nuclear procedure.
- D. Testing shall be performed in such a manner that will least encumber the performance of the work. The Contractor shall cooperate by rerouting equipment or by temporarily closing the immediate work area to be tested.
- E. Contractor shall instruct the testing laboratory to provide the test results to the Engineer immediately in the field and a copy of the written report sent directly to the Engineer.

PART 2 PRODUCTS

2.1 ASPHALTS

- A. Asphalt binder to be mixed with aggregate shall be liquid asphalt PG 64-10, conforming to State Standard Specifications Section 92, Asphalt Binders.

ASPHALT CONCRETE PAVING
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- B. Asphalt Concrete shall be Type A, in accordance with State Standard Specifications 39-2.02.

2.2 *AGGREGATE*

- A. The combined aggregate grading of the asphalt concrete shall be Type A, 1/2-inch maximum grading, per Section 39-2.02B(4)(b), of the State Standard Specifications.

2.3 *PAVEMENT REINFORCING FABRIC*

- A. Reinforcing fabric shall be non-woven, conforming to Section 96-1.02J, "Paving Fabric", of the State Standard Specifications.
- B. Fabric shall be protected from damage during storage, handling and installation in accordance with manufacturer's requirements.

2.4 *FORMS*

- A. Redwood header boards shall be two inches wide by six inches deep (nominal measurement).
- B. Metal forms shall be submitted to Engineer for approval prior to use.

PART 3 EXECUTION

3.1 *GENERAL*

- A. The pavement section shall comply with City of Turlock Standards and as shown on the Plans.
- B. Prior to any paving and surfacing operations, all pipes and conduits shall be installed and properly backfilled as shown.

3.2 *STORAGE*

- A. Storage of materials shall comply with the requirements of Section 39, State Standard Specifications.

3.3 *MIXING*

- A. Mixing shall conform to the approved mix design.
- B. The weight of asphalt binder to be mixed with aggregate shall be between 3 percent and 7 percent of the weight of the dry aggregate.

3.4 *SUBGRADE*

- A. Subgrade shall conform to Section 39-2.01C(3)(b), State Standard Specifications.

- B. Unless otherwise specified, the upper six inches of subgrade beneath the structural section shall be scarified, moisture conditioned as necessary and compacted to at least 95 percent relative density.

3.5 *EQUIPMENT*

- A. Spreading and compacting equipment shall conform to State Standard Specifications Section 39-2.01C(2), Spreading and Compacting Equipment.

3.6 *PLACING AND COMPACTING*

- A. Placing and compacting shall conform to State Standard Specifications Section 39-2.05A(3)(d), Placing and Compacting Hot Mix Asphalt.
- B. Apply mixture only during hours of daylight; when air temperature is 50 degrees F or higher; when surfaces to be paved are dry and free of frost, snow or ice; and when precipitation is not imminent.

3.7 *PAVEMENT REINFORCING FABRIC*

- A. Fabric shall be protected from damage during storage, handling and installation in accordance with manufacturer's requirements.
- B. Pavement reinforcing fabric shall be placed, with paint binder, on all surfaces to receive an asphalt concrete overlay in accordance with State Standard Specifications Section 39-2.01C(3)(g), Geosynthetic Pavement Interlayer, and the following provisions:
 - 1. Pavement surface shall be cleaned of loose material all cracks filled with emulsion slurry. The prepared surface shall be treated with paint binder at the rate of 0.25 gallons per square yard or as directed by the Engineer. Paint binder shall be un-cut asphalt or asphalt emulsion free of solvents and shall be applied at the proper temperature for the material.
 - 2. Reinforcing fabric shall be carefully placed to avoid wrinkles. Any wrinkles longer than 1 inch shall be cut and laid flat in the direction of the paving operation. Material shall be lapped four to six inches for transverse joints and two to four inches for longitudinal joints. Extra tack coat shall be applied to joints to ensure proper bonding.

3.8 *FORMS*

- A. Wood or metal. Place true to line and grade, and anchor securely. Use adequately sized forms or prevent bulging and bending while the bituminous surface is being worked.

3.9 *COLD PLANE ASPHALT CONCRETE PAVEMENT*

- A. Existing asphalt concrete shall be cold planed at the locations and to the dimensions shown on the plans and in accordance with these special provisions.

- B. The depth, width and shape of the cut shall be as indicated on the typical cross sections or as directed by the Engineer. The final cut shall result in a uniform surface conforming to the typical cross sections. The road surfacing to remain in place shall not be damaged in any way.
- C. The depth shown on the plans for cold plane wedge cuts along existing concrete gutter are to be measured from the surface of the concrete gutter. In some cases where a prior overlay surface was constructed above the gutter lip, the actual depth of cut will exceed the dimension shown on the Plans.
- D. The Contractor shall remove existing pavement overlay from the top surface of gutters adjacent to any area specified to be cold planed.
- E. The planing machine shall be self-propelled and especially designed and built for grinding flexible pavements. It shall plane without tearing or gouging the underlying surface and blade material in a windrow. Drum lacing patterns shall permit a grooved or smooth surface finish as selected by the Engineer and the drum shall be totally enclosed in a shroud to prevent discharge of any loosened material into adjacent work areas. A zero (0) to three (3) inches deep cut to predetermined grade may be required on one (1) pass. The machine shall be adjustable as to crown and depth. The equipment shall meet the standards set by the San Joaquin Valley Air Pollution Control District and the Air Quality Act of 1969 for noise and air pollution.
- F. The Contractor shall provide a smaller machine to trim areas inaccessible to the larger machine at manholes, curb returns and intersections. The smaller machine shall be equipped with a 12-inch wide cutting drum mounted on a three-wheel chassis allowing it to be positioned without interrupting traffic or pedestrian flow. Jack hammering areas not accessible to grinding machine will not be allowed.
- G. The surface tolerance produced shall be such that a ten-foot straight edge laid laterally will indicate variances of less than three-eighths (3/8) inch. The Contractor shall remove all loosened material from the roadway each day before leaving the site of the work.
- H. The Contractor shall protect structures and provide necessary traffic control and barricades as required by the Engineer.
- I. Temporary oil-sand ramps shall be constructed at intersecting streets, and along longitudinal joints, immediately after cold planing and prior to opening the lanes to traffic. Cold planing operations shall not commence until temporary oil-sand is on site with workers to place material.
- J. Cold planing cuts across travel lanes shall be the last cuts made at each side. After removal of loosened material from such cuts, temporary ramps shall be constructed of oil-sand at the deep end of cuts before opening the lane to traffic.
- K. Irregular, gouged, ripped or damaged areas, as determined by the Engineer, shall not be accepted. All such areas shall be repaired by methods approved by the Engineer, prior to resurfacing operations. The Engineer, at his discretion, may require substitution of planing machine and/or operating personnel if the cold-planed surface does not meet these specifications.

- L. Existing traffic detector loops damaged during cold plane operations will be returned to their original condition.
- M. After conducting cold planing operations on a given street, the Contractor shall begin pavement operations on that street within seven calendar days. Deviations from this requirement must be requested in writing and approved by the Engineer prior to the beginning of planing operations.

3.10 MISCELLANEOUS AREAS

- A. Paving miscellaneous areas shall conform to State Standard Specifications Section 39-2.01C(9), Miscellaneous Areas and Dikes.

3.11 FINISHING PAVED AREAS

- A. Finishing roadway and parking areas shall conform to the provisions of State Standard Specifications Section 22, Finishing Roadways.

3.12 TRENCH RESURFACING

- A. At areas where asphalt concrete had been removed due to pipeline construction, trench shall be resurfaced with asphalt concrete. Unless otherwise noted, asphalt concrete resurfacing shall match the existing thickness of the asphalt and base course removed.
 - 1. Base course shall be as specified in Section 32 11 23, Aggregate Base, and in this Section.
- B. If an edge of a trench resurfacing occurs within three feet of an existing edge of pavement, lip of gutter or the face of curb, or if no gutter is present, the Contractor shall remove all existing paving to the lip of gutter or curb face and or, edge of existing pavement and resurface with the applicable trench resurfacing section. The limits of removal are minimum requirements.
- C. If during the Contractor's operations pavement is disturbed outside the limits of removal, Contractor shall make the necessary repairs at no additional cost to the Owner.

3.13 ACCEPTANCE REQUIREMENTS

- A. Surface Tolerance: The variation between any two contacts with the surface shall not exceed ± 0.015 foot in 10 feet. Correct all humps or depressions exceeding the specified tolerance by removing defective work and replacing it with new material at no additional expense to the Owner.
- B. A uniform compacted thickness shall be obtained for each course equal to or greater than the thickness shown. Individual tests shall not vary by more than ± 0.02 foot.
- C. Width: Plan dimension, ± 0.02 foot.
- D. Thickness: Plan dimension, ± 0.02 foot.

END SECTION

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SECTION 32 12 36

SEAL COATS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish and apply a fog seal coat (asphalt emulsion without screenings) to asphalt concrete paving, including roadway, parking lots and driveway areas.

1.2 RELATED WORK

- A. Section 32 12 16 – Asphalt Paving

1.3 REFERENCES

- A. Section 37 – Bituminous Seals, State Standard Specifications.
- B. Section 94 – Asphaltic Emulsions, State Standard Specifications.

1.4 SUBMITTALS

- A. As specified in Section 01 33 00 – Submittals.
- B. The Contractor shall submit a certified copy of tests representing any shipment.
- C. A Certificate of Compliance shall accompany each shipment of asphalt to the work.
- D. The certificate shall include the shipment number, type of material, refinery, consignee, destination, quantity, contract or purchase order number, and date of shipment. The certificate shall state that the material complies with this section and shall be signed by the vendor or its representative.

1.5 PROJECT CONDITIONS

- A. Apply bituminous material only during daylight hours, when surface is dry, air temperature is above 65° F, the surface temperature is 80 degrees or above, and weather is not foggy or rainy.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Asphaltic Emulsion shall conform to Section 94 of the State Standard Specifications
 - 1. Asphaltic Emulsion shall be polymer modified, rapid setting and shall be anionic (PMRS2h) or cationic (PMCRS2h) in accordance with the type of aggregate to be used.

PART 3 EXECUTION

3.1 MAINTAINING TRAFFIC

- A. At locations where public traffic is being routed over a surface upon which a seal coat is to be applied, the seal coat shall not be applied to more than one-half the width of the traveled way at a time, and the remaining width shall be kept free of obstructions and open for use by public traffic until the seal coat applied is ready for use by traffic.
- B. Provide for the passage of public traffic through the work and when applicable or required, route traffic through the work under one-way control.

3.2 APPLICATION

- A. Apply the fog seal coat in accordance with Section 37, "Bituminous Seals", State Standard Specifications.
- B. Seal coat shall consist of a fog seal applied to all asphalt concrete surfaces, including existing pavement, new pavement, overlays, and dikes in accordance with Section 37-4, "Fog Seals and Flush Coats", of the State Standard Specifications and the following provisions:
 - 1. Seal coat shall be applied five days after the completion of all asphalt concrete pavement construction, overlays, and dike construction and after all surfaces have been cleaned of loose material.
 - 2. Material shall be "Topein C" rejuvenator and sealant or approved equivalent and shall be applied at the rate of 0.10 gallons per square yard or as directed by the Engineer.

3.3 SURFACE PREPARATION

- A. Immediately before application of seal coat, clean surface with a power or hand broom. Do not begin seal coating operation until the surface is approved by Engineer.

3.4 APPLICATION

- A. Asphaltic Emulsion: Apply uniformly at the approximate rate of between 0.28 to 0.40 gallons per square yard at the specified temperature. The actual application rate will be determined in the field by the Engineer. If the texture of the surface is such that asphaltic emulsion penetrates too rapidly, a preliminary application of from 0.05 to 0.10 gallon per square yard of surface may be required.
 - 1. Use approved devices to insure that the beginning and end of the asphaltic emulsion covered areas are positive and clean.
 - 2. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Correct any skipped areas or deficiencies. Make junctions of spreads carefully to ensure a smooth riding surface.

3. Do not spread asphaltic emulsion in excess of the length that can be immediately covered with aggregate.
4. When operating under part-width construction, leave a strip of bituminous material, approximately six inches wide, uncovered to permit a slight overlap of the bituminous material.

END SECTION

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SECTION 33 05 26 UTILITY LINE MARKING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The work of this section consists of furnishing and installing utility line marking tape in the trench above newly constructed utility lines.

1.2 SUBMITTALS

- A. As specified in Section 01 33 0 0 – Submittal Procedures.
- B. Samples: 24-inch strips of tape and two markers.
- C. Certification that the materials used in the tape fabrication meet the requirements of this section.
- D. Installation procedure if the cable is installed by plowing.

PART 2 PRODUCTS

2.1 MARKING TAPE

- A. Capable of being inductively detected electronically.
- B. Construction: Metallic foil laminated between two layers of impervious plastic film not less than 3 inches wide. Total thickness of tape shall not be less than 0.005 inch (5 mil), ± 10 percent manufacturing tolerances.
 - 1. Film: Inert plastic. Each film layer shall be not less than 0.001 inch (1.0 mil) thick.
 - 2. Foil: Not less than 0.001 inch (1.0 mil) thick.
 - 3. Adhesive: Compatible with foil and film.
- C. Imprint: 3/4-inch or larger bold black letters.
- D. Legend: Identify buried utility line tape with imprint such as "Caution: Sewer Line Below". Repeat identification at approximately 24 inch intervals.
- E. Background Color: APWA color code and as specified in the following table.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam, Dangerous Materials

Color	Utility
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer
Safety Brown	Force Mains and Effluent Lines
Purple	Reclaimed Water

- F. Manufacturer: Lineguard, Inc., Wheaton, Illinois; Reef Industries, Inc., Houston, Texas; Thor Enterprises, Inc., Sun Prairie, Wisconsin; or Engineer-approved equivalent.

2.2 SURFACE MARKERS

- A. All markers shall have an identifying letter either cast or routed into marker. The Contractor has the option of any of the following. However, only one type shall be used on any one project:
- B. Cast-In-Place Concrete.
1. Concrete: As specified in Section 03 30 00 – Concrete Site Work.
 2. Reinforcement: One No. 5 bar in center of the marker.
- C. Precast Concrete: Commercially fabricated concrete marker meeting design dimensions and concrete reinforcing requirements.
- D. Timber Posts: Any softwood lumber species meeting PS 20-70. Grade No. 1 or better, free of heart center, S4S as shown. Pressure treat timber posts for soil contact with waterborne preservative in accordance with AWPA C2-90.

2.3 TRACER WIRE

- A. Minimum: No.10, solid, 12 AWG copper wire with Type TW insulation. Join so as to form a mechanically and electrically continuous line throughout the length of the marked pipe.

PART 3 EXECUTION

3.1 MARKING TAPE

- A. Install tape in backfill directly over each buried utility line as shown on the detailed drawings.
- B. Unless otherwise shown, tape shall be installed a minimum 1.5 feet below finish grade. However, in no case shall tape be placed closer than two feet above the top of the pipe.

- C. Where utilities are buried in a common trench, identify each line by a separate warning tape. Bury tapes side by side directly over the applicable line.

3.2 *TRACER WIRE*

- A. Wherever PVC or Polyethylene pipe is installed in the ground, a tracer wire shall be installed. Conductors shall be spliced in accordance with Division 26, Electrical.
 - 1. Tracer wire shall be brought to the surface at all gate and butterfly valves, air valves, blow-offs, Fire Hydrants, Water Services, and other pipeline appurtenances
- B. Tracer Wire: Attachment of the wire to the pipe shall be made with plastic tie-wraps or other approved method.
- C. Contractor shall conduct a satisfactory continuity test prior to Owner acceptance.

3.3 *SURFACE MARKERS*

- A. In addition to marking tape, install surface markers at all changes in horizontal direction and at intervals not exceeding 400 feet.
- B. Tracer wire shall be wrapped around cast iron valve boxes; while ensuring wire conductors are making contact with valve box.
 - 1. Tracer wires shall be tied together to a No. 5 rebar cast in a concrete utility line marker and terminate above grade. Allow sufficient slack in tracer wire along pipe to allow for pipe shrinkage and expansion.

END SECTION

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SECTION 33 13 00
DISINFECTION OF WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Disinfection of all new potable piping, components, and appurtenances.
- B. This shall include disinfection of all potable water piping, well, hydropneumatic tank, finished water storage tank, and pumps.
- C. New facilities shall be kept isolated from the active distribution system using a backflow, double check valve device per ANSI/AWWA C651 - Disinfecting Water Mains.
- D. Before allowing water from the municipal supply system to enter the new potable water system, all its components shall be cleaned and disinfected.
- E. Test and report results. Cost of all testing shall be borne by the Contractor.
- F. Connect new system and existing water distribution mains, after all required test are satisfactory and approved by the Engineer.

1.2 RELATED WORK

- A. Section 40 05 00 – Pipe and Fittings

1.3 REFERENCE

- A. ANSI/AWWA C651 – Disinfecting Water Mains
- B. ANSI/AWWA C652 – Disinfection of Water Storage Facilities
- C. ANSI/AWWA C653 – Disinfection of Water Treatment Plants
- D. ANSI/AWWA C654 – Disinfection of Wells

1.4 SUBMITTALS

- A. Submit five copies of each compliance report to Engineer. Reports shall include the following information:
 - 1. Disinfection report; accurately record:
 - a. Type and form of disinfectant used.
 - b. Date and time of disinfectant injection start and time of completion.
 - c. Test locations.

- d. Initial and 24-hour disinfectant residuals in parts per million (ppm) for each location tested.
 - e. Date and time of flushing start and completion.
 - f. Disinfectant residual after flushing in ppm for each location tested.
 - g. Persons present during the disinfection operation.
2. Bacteriological report; accurately record:
- a. Date issued, project name, and testing laboratory name, address, and telephone number.
 - b. Time and date of water sample collection.
 - c. Name of person collecting samples.
 - d. Test locations.
 - e. Initial and 24-hour disinfectant residuals in ppm for each location tested.
 - f. Coliform bacteria test results for each location tested.
 - g. Certification that water conforms, or fails to conform, to bacterial standards of the California State Water Resources Control Board.
 - h. Bacteriologist's signature.

B. Submittals shall be in accordance with Section 01 33 00 – Submittal Procedures.

1.5 *QUALITY ASSURANCE*

- A. Testing laboratory certified with the State of California for examination of drinking water.
- 1. Testing laboratory shall be selected by the Contractor and approved by the Owner.
 - 2. All samples shall be gathered and tested by said Laboratory.
 - 3. Contractor shall instruct the testing laboratory to provide the test results to the Engineer immediately upon results and a copy of the written report sent directly to the Engineer.

PART 2 PRODUCTS

2.1 *CHLORINE*

- A. All disinfectant chemicals shall be certified to ANSI/NSF Standard 60

- B. Chlorine-bearing compounds:
 - 1. Calcium hypochlorite (comparable to commercial products known for example as HTH, Perchloron, and Pittchlor, sold for swimming pool chlorination).
 - 2. Sodium hypochlorite (liquid bleach, sodium hypochlorite in powder or tablet form for pool chlorination).

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify that system has been cleaned, inspected, and pressure tested.
- B. Contractor shall first pressure test chemical dosing pumps and chemical storage tanks with water and flush to waste prior to testing with sodium hypochlorite.
- C. If a chlorine-bearing compound is to be used, the calcium hypochlorite or sodium hypochlorite shall be prepared as a water mixture before introduction into the potable water piping system. The powder shall first be made into a paste and then thinned to approximately a 1- percent chlorine solution (10,000 ppm). The preparation of 1- percent chlorine stock solution requires the following proportions of powder to water:

<u>Product</u>	<u>Amount of Compound</u>	<u>Quantity of Water (Gals)</u>
High-test Calcium Hypochlorite (65 to 70 percent Cl)	1 lb.	7.50
Sodium Hypochlorite liquid (5.25 percent Cl)	1 gal.	4.25

3.2 APPLICATION

- A. Provide and attach equipment required to execute work of this Section. This may include:
 - 1. A solution-feed chlorination device.
 - 2. A device to regulate rate of flow and provide effective diffusion of the gas into the water within the pipe being tested. Chlorinating devices for feeding solutions of the chlorine gas or the gas itself into the water shall provide means for preventing the backflow of water into the chlorine cylinder.
- B. Preliminary Flushing: Before disinfection, the system with outlets open shall be flushed thoroughly with water. Flushing shall be done after the pressure test has been made. Flushing shall develop a velocity in pipes of at least 2.5 feet per second (fps).

- C. Point of Application: The preferred point of application of the chlorinating agent is at the beginning of the pipeline extension of any valved section, and through a corporation stop inserted by the Contractor (except in new distribution systems) in the top of the newly laid pipe. The water injector for delivering the chlorine-bearing water into the pipe shall be supplied from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension.
- D. Retention Period: Treated water shall be retained for at least 24 hours.
- E. Chlorinating Valves and Hydrants: In the process of chlorinating newly laid pipe, all valves or other appurtenances shall be operated while the pipeline is filled with the chlorinating agent.
- F. Chlorinating water services: Water meters and services lines can be sprayed or swabbed with chlorine per AWWA C651, Section 4.11.3.1.
- G. Circulate and flush repeatedly until specified cleanliness is achieved. Before being placed in service, all new mains and repaired portions of, or extensions to, existing mains shall be chlorinated so that a chlorine residual of not less than 25 mg/l free available chlorine remains in the water after 24 hours standing in the pipe.
- H. Disposal of flushed chlorinated water shall be at the responsibility of the Contractor. If Contractor chooses to flush water in the local storm drain system, water shall be dechlorinated as described in AWWA C655.

3.3 TESTS

- A. Samples shall be tested in accordance with ANSI/AWWA C651 for water mains, C652 for bolted steel storage tanks and hydropneumatic tanks, and C654 for wells.
- B. If disinfection fails to produce satisfactory test results, the new pipes and facilities may be re-flushed and retested. If samples taken after re-flushing also fail to produce satisfactory results, sections represented by those results shall again be disinfected and retested. The cost of any retests, including time for the Engineer, shall be borne by the Contractor at no additional cost to the project.

END SECTION

SECTION 40 05 00 PIPE AND FITTINGS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish, install, and test all water, utility, pipe, fittings, and appurtenances as indicated and as specified.

1.2 RELATED WORK

- A. Section 03 30 00 – Concrete Site Work
- B. Section 09 90 01 - Painting and Coating
- C. Section 31 23 00 – Earthwork
- D. Section 31 23 17 – Trenching, Backfilling, and Compacting
- E. Section 40 05 20 – Process Valves
- F. Section 40 20 10 - Pipe Supports

1.3 REFERENCES

- A. California Plumbing Code
- B. American Water Works Association Standards

1.4 SUBMITTAL REQUIREMENTS

- A. Submittals shall be in accordance with Section 01 33 00 - Submittals Procedures.
- B. Submit manufacturer's catalog data. Show manufacturer's model number.
- C. Submit dimensions including wall thickness and materials of construction by reference standard and grade. Submit information on interior and exterior coatings as applicable.

1.5 QUALITY ASSURANCE

- A. All work performed under this section shall meet all recommendations and requirements of AWWA, California Plumbing Code, NFPA 24, ASTM D2774, and all other applicable national, state, local, standards and regulations.

1.6 MATERIALS

- A. All materials in contact with potable water shall be certified to ANSI/NSF Standard 61.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE

- A. General: Ductile iron pipe shall conform to ANSI A21.51 (AWWA C151) and shall be Class 52 unless shown otherwise. Pipe for grooved or flanged joints shall be no less than Class 53.
- B. Joints:
 - 1. Buried pipe and pipe fittings shall have push-on joints or mechanical joints conforming to AWWA C111. Flanged joints, sleeve-type mechanical couplings, and grooved-type couplings shall be used when shown.
 - 2. For push-on joints, shape of pipe ends shall conform to ANSI A21.11 (AWWA C111). Gaskets and lubricant for pipe and fittings shall conform to ANSI A21.11 (AWWA C111).
 - 3. For mechanical joints, dimensional and material requirements for pipe ends, glands, bolts, nuts, and gaskets shall conform to ANSI A 21.11 (AWWA C111). Pipe smaller than 4 inches shall have screwed or grooved joints
 - 4. For flanged joints, ends of pipe shall be provided with flanges conforming to ANSI A21.15 (AWWA C115), and to ANSI B16.5 for 150 lb. class. Bolts, nuts, and gaskets for flanged connections shall conform to ANSI B18.2.1. For grooved joints, groove specifications shall conform to ANSI/AWWA C606.
- C. Fittings: Fittings with push-on, mechanical joint, grooved joints and flanged ends shall conform to ANSI A21.53 (AWWA C153). Fittings shall have pressure rating of 350 psi for 3"-24" and 250 psi rating for 30"-48" pipe. Fittings shall have cement-mortar lining equivalent to that of the pipe lining.
- D. Coating and Lining: Pipe shall be bituminous seal-coated and cement-mortar lined. The lining shall conform to AWWA C104.
- E. All buried ductile iron pipe shall be encased in an 8-mil lining of polyethylene, installed per AWWA C105.

2.2 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. Pipe shall be high molecular weight, high-density polyethylene pipe. The material shall conform to AWWA C906, PPI designation PE 3608 and have a cell classification of 345444C as described in ASTM D3350 and shall be, TYPE III, Grade PE34. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of same specification from the same raw material pipe. Polyethylene pressure pipe shall also conform to the applicable requirements of ASTM F714.
- B. Pipe shall be rated for 250 PSI working pressure
- C. The pipe inside diameter shall not be less than the nominal diameter specified or shown.

- D. Unless shown otherwise on the Plans, the pipe dimension ratio shall be SDR 11 for pipes 10 inches and less.
- E. All joints for the buried polyethylene pipe shall be of the thermal fusion type.
- F. Polyethylene fittings shall conform to ASTM D3261. Each fitting shall be clearly labeled to identify its size and dimension ratio.

2.3 STEEL PIPE

- A. General: Steel pipe 12-inches in diameter and smaller shall conform to the requirements of the "Specifications for Black and Hot-Dipped Zinc-Plated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses (ASTM A53), and shall be "Standard Weight" Steel Pipe larger than 12 inches in diameter shall be ASTM A139, AWWA C200, wall thickness not less than 0.18 inches.
- B. Joints: Pipe 4-inches in diameter and larger shall be flanged or shall have grooved ends for Victaulic-type couplings. Where shown on the Plans, the pipe shall be flanged or plain end for flanged coupling adapters. Flanges shall be standard 150 psi flanges meeting the requirements of ANSI B16.1. Flanges shall be furnished with flat faces. Pipe smaller than 4 inches shall have screwed or grooved joints unless shown otherwise on the Plans.
- C. Fittings: All fittings shall be flanged cast or ductile iron, screwed malleable iron, or Victaulic-type fittings. The Contractor may substitute Victaulic-type fittings for flanged fittings or screwed fittings unless the particular joint requires a specific end for compatibility with a valve or special fitting. All Victaulic-type fittings shall be of strength equal to the pipes with lining and coatings equivalent to that specified for the pipe.
- D. Unless otherwise specified or noted in the Plans, all steel pipe 2-1/2 inch and smaller shall be Hot-Dipped galvanized, and pipes larger than 2-1/2 inch shall be black steel with epoxy or lining with minimum 10 mil dry thickness. Exterior surfaces of all pipe shall be shop primed. Finish coatings shall be as specified in Section 09 90 00 - Painting.

2.4 POLYVINYL CHLORIDE WATER PIPE (PVC)

- A. General: PVC pipe 4 inches through 12 inches in diameter shall conform to AWWA C900, unless otherwise specified. PVC pipe 14 inches in diameter and larger shall conform to AWWA C905, unless otherwise specified.
- B. The pipe shall be minimum PR 235 (DR 18) unless shown otherwise. Each length of pipe shall be marked with the manufacturer's name, nominal size, pressure classification, and date of manufacture.
- C. Joints: Joints shall be push-on type couplings or integral socket bell PVC pipe unless otherwise shown with rubber gaskets conforming to ASTM D3139 and ASTM F477. Integral socket bells of PVC pipe or separate couplings shall meet the same strength requirements as that of the pipe. All component parts of each joint including

gaskets and coupling shall be clearly marked for use with the pipe for which they are intended.

- D. Fittings: Fittings shall be of ductile iron conforming to ANSI A21.10 (AWWA C 153) for mechanical joints. Dimensional and material requirements for pipe ends, glands, bolts, nuts, and gaskets shall conform to ANSI A 21.11 (AWWA C111). Pipe smaller than 4 inches shall have screwed or grooved joints.

2.5 POLYVINYL CHLORIDE SCHEDULE PIPE

- A. Refer to Section 40 20 90.

2.6 POLYVINYL CHLORIDE GRAVITY SEWER PIPE (PVC)

- A. PVC gravity sewer pipe 4-inches through 15-inches in diameter shall conform to ASTM D3034, SDR 35. PVC gravity sewer pipe 18-inches through 36 inches in diameter shall conform to ASTM F679.
- B. Each length of pipe shall be marked with the manufacturers name, nominal size and ASTM designation. Pipe shall be made of PVC plastic having a cell classification of 12454B or 12364B as defined in ASTM D1784 and shall have SDR of 35 and minimum pipe stiffness of 46 PSI according to ASTM Test D2412.
- C. Joints: Pipe shall include an integral bell section with a factory assembled rubber ring gasket conforming to ASTM F477. Joint shall conform to ASTM D3212. Bells shall meet the same strength requirements as that of the pipe.
- D. Fittings: Fittings shall be supplied by the pipe manufacturer and shall meet the strength requirement of the pipe. Integral bells and gaskets shall conform to the requirements for joints in this section. Fittings shall be marked with nominal size, manufacturers name and ASTM designation.
- E. PVC sewer pipe 3 inches to 6 inches, for chemical drain shall conform to ASTM D2729 and D2949. Fittings shall be PVC with socket welded joints and shall conform to ASTM D2949 and ASTM D2665.

2.7 FLEXIBLE COUPLINGS FOR GRAVITY PIPES

- A. Transition type couplings shall be factory manufactured to ensure watertight fit and smooth flow transition at the joint. Couplings shall be made of resilient elastomeric PVC, with all stainless-steel coupling bands including screw and housing. All materials shall be rustproof and unaffected by soil conditions or normal sewer gases, and shall be flexible with earth movement while maintaining seal. Poured concrete collar and similar coupling methods will not be accepted.

2.8 STAINLESS STEEL TUBING

- A. Stainless steel tubing shall be made of Type 316 L stainless steel to the requirements of ASTM A269, of minimum 1/4-inch inside diameter, or as indicated, for the test pressure required. The fittings shall be swage ferrule design of Type 316 L stainless steel, of the double acting ferrule design, providing both a primary seal

and a secondary bearing force. Flare bite or compression type fittings are not acceptable.

2.9 COPPER PIPE AND TUBING

- A. Copper tubing shall conform to ASTM B88. Copper tubing for water piping shall have a weight of not less than Type K. Type L copper tubing shall be permitted to be used for water piping when piping is above ground in, or on, a building or underground outside of structures
- B. Fittings:
1. Use soldered joints and fittings in exposed tubing service.
 2. Use soldered joints and fittings in buried service.
 3. Fittings and joints 3/8" and smaller in exposed service may be of the nut-and ferrule type with flared end connections or compression joint connections.
 4. Use threaded joints and fittings in buried and exposed copper and brass piping.
- C. Joints from copper tubing to threaded pipe shall be made using brass adapter fittings. The joint between the copper tubing and the fitting shall be a soldered brazed flared, or pressed joint and the connection between the threaded pipe and the fitting shall be made with a standard pipe size screw joint.
- D. Joints in copper tubing shall be made by the appropriate use of approved copper or copper alloy fittings. Surfaces to be joined by soldering shall be cleaned bright by manual or mechanical means. The joints shall be properly fluxed with an approved type flux and made up with approved solder. Solder and fluxes shall be manufactured to approved standards.
1. Solders and fluxes with a lead content that exceeds two-tenths (0.02) of one (1) percent shall be prohibited in piping systems used to convey potable water.
 2. Solder shall be 95-5 (95% tin, 5% antimony) conforming to ASTM B32, Grade Sb5 or silver solder conforming to AMS 4773C.
 3. Soldering flux shall comply with ASTM B813.
- E. Only brazing alloys having a liquid temperature above 1000°F (538°C) shall be used.
- F. Nut and Ferrule Fittings: Fittings shall be brass and or the Swagelok type as manufactured by Crawford Fitting Company, utilizing a nut and dual ferrule design to connect to tubing. End connections shall be of the union type.
- G. Unions shall be the same size as the pipe or tube, three part, with copper flare end connections. Unions shall be bronze, ASTM B61 or B62. Unions shall be Mueller H-15400, Jones J-1528, or equal.

- H. Provide an insulating union at the point of transition from copper tubing or piping to ferrous piping.
- I. Buried tubing shall be polyethylene coated, tape wrapped, or encased in a PVC sleeve.

2.10 CHEMICAL PIPING AND TUBING

- A. Unless otherwise noted on the drawings, chemical piping shall be Schedule 80 PVC or CPVC in accordance with Section 40 20 90. Piping called out as secondary containment piping shall conform to Section 40 24 68.
- B. Where tubing inside of EPVC is called out on the drawings, chemical tubing and conduit shall be as follows:
 - 1. EPVC shall consist of Schedule 80 PVC conduit or pipe utilizing long radius sweep elbows.
 - 2. Chemical dosing tubing shall consist of FDA compliant PTFE tubing with a minimum working pressure of 90 psi at 150°F. HDPE, PVC, or PVDF tubing may be substituted provided that they meet the minimum working pressure requirement and are certified by the manufacturer to be suitable for the chemical service with an “excellent” chemical compatibility rating.
 - 3. Sample tubing shall consist of odorless, tasteless, flexible black polyethylene tubing. Minimum operating pressure shall be 125 psi up to ½-inch in size and shall be ¼ of the burst pressure of the tubing. Tubing shall comply with ASTM D1248, Type I, Class A, Category 4, Grade E and shall be certified to ANSI/NSF Standard 61.
 - 4. Fittings for tubing shall be compression type fittings rated at 150 psi minimum and constructed of a material compatible with the chemical service.

2.11 GROOVED COUPLINGS

- A. Groove dimensions shall conform to AWWA C606.
- B. Grooved couplings for ductile iron shall be Victaulic Style 31;
- C. Flexible grooved couplings for steel pipe shall be Victaulic Style 77 or equal; rigid grooved couplings for steel pipe shall be Victaulic Style 07 or equal. Couplings shall be rigid unless otherwise noted on the drawings.
- D. Grooved - Flanged adapters shall be Victaulic Style 341 for ductile iron pipe and Style 741 for steel pipe or equal.
- E. Grooved coupling for high density polyethylene pipe shall be Victaulic Style 995 or 997 or equal.

2.12 FLANGED JOINTS

- A. Flange shall conform to ANSI B16.5, Class 150.

- B. All steel hardware installed underground shall be coated with a rust preventative, wrapped with 4 mil polyethylene sheeting, and secured with PVC tape.
- C. Gaskets shall be meet the pressure requirements of the adjoining flanges and shall conform to AWWA C-207. Gaskets for flat faced flanges shall be 1/8-inch thick.
- D. Gaskets for metallic pipe and non-potable 150 psi or less services shall be acrylic or aramid fiber bound with nitrile; Garlock Blue-Gard 3000 or equal. EPDM rubber gaskets, Garlock 98206 or equal, are also acceptable.
- E. Gaskets for metallic pipe and potable water service shall be NSF/ANSI-61 certified EPDM rubber, Garlock 98206 or equal.
- F. Gaskets for non-metallic flat faced flanges shall be constructed of a fluoroelastomeric material with a hardness of 70 durometer designed specifically for lower seating stress. Gaskets shall be certified to NSF/ANSI-61 for potable water service. Gaskets shall be Garlock Style XP or equal.

2.13 FLEXIBLE SLEEVE COUPLINGS

- A. Flexible sleeve couplings shall be one of the following, or Engineer approved equivalent:
 - 1. Dresser, Inc., Style 38 for Steel Pipe, and Style 253 Wide- Range for Steel, PVC, Copper, and Cast/Ductile Iron pipe.
 - 2. Smith Blair, Inc., Series 411 or Wide-Range 461
 - 3. Romac Industries, Inc., Style 400 for 12" and larger pipe or XR501 Extended Range Coupling, 4" thru 12" pipe size.
- B. Center sleeves shall comply with the following

Nominal Pipe Diameter	Minimum Sleeve Length
6 inch and smaller	Manufacturer's Standard
8 through 14 inch	7 inch
14 inch and larger	10 inch

2.14 FLEXIBLE SPOOL-TYPE EXPANSION COUPLINGS

- A. Flexible rubber coupling shall be flexible joints, which includes a tube, body cover and flanges. The tube shall be a leak proof liner and the body shall consist of fabric and rubber compound, reinforced with steel wire or rings for strength. Flexible rubber coupling shall be either a single arch or double arch construction as indicated in the Plans. Couplings shall have control rods to limit extension and flanges shall have backing rings. Couplings used for services with pressures greater than 75 psi shall have stainless steel flanges – rubber flanges with backing rings shall not be acceptable. Flexible couplings shall have minimum pressure ratings of 100 psi; couplings installed on suction of pumps shall have a minimum vacuum (pressure) rating of 30 inches Hg column.

- B. Flexible coupling shall have Buna N liner and cover and shall be manufactured by Proco, Red Valve Company Inc., Metraflex Company or equal.

2.15 *DOUBLE-SOCKET EXPANSION JOINT*

- A. Flexible expansion joints shall be manufactured of ductile iron conforming to the material requirements of ASTM A536 and ANSI/AWWA C153/A21.53.
- B. Each flexible expansion joint shall be pressure tested prior to shipment against its own restraint to a minimum of 250 PSI. A minimum 2:1 safety factor, determined from the published pressure rating, shall apply.
- C. Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 25°, 4" - 8"; 20°, 10" - 12"; 15°, 14+" and 8-inches minimum expansion. The flexible expansion fitting shall not expand or exert an axial imparting thrust under internal water pressure. The flexible expansion fitting shall not increase or decrease the internal water volume as the unit expands or contracts.
- D. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.
- E. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16.
- F. Joints shall be The Force Balanced FLEX-TEND as manufactured by EBAA Iron, or equal.

2.16 *MARKER TAPE FOR BURIED PIPING*

- A. Refer to 33 05 26, Utility Line Marking

2.17 *TRACER WIRE*

- A. Install No. 10 solid-core copper tracer wire.

2.18 *CONCRETE FOR THRUST BLOCKS*

- A. As specified in Section 03 30 00 – Cast-In-Place Concrete. Thrust blocks shall be used only where specifically permitted on the drawings or with pre-approval from the Engineer.

2.19 *JOINT RESTRAINT COUPLINGS*

- A. Mechanical joint restraint coupling shall be of the type that utilizes the follower gland, and shall consist of several individual lug bolts with gripping mechanism that prevents the joints from pulling apart. Glands shall be ductile iron conforming to ASTM A536, and dimensions shall be compatible to be used with standard mechanical joint fittings for ductile rim pipe. The mechanical restraint joint shall have a minimum working pressure rating equal to that of the pipe with a safety factor of

not less than 2. Restrained joints shall have twist off nuts to insure proper installation of restraining grip mechanism. Mechanical joint restrained coupling shall be EBAA, Iron, Inc. MEGALUG; with Mega-Bond coating.; or approved equal. Coating of gland follower body shall be electrostatically applied and heat cured polyester based powder. Wedge assemblies and bolts shall be coated with heat cured fluoropolymer coatings. Restraints shall be designed for the specific type of pipe to be restrained.

- B. Restrained joint fittings shall meet Uni-B-13 for PVC and be FM and UL approved through 12-inch for both ductile iron and PVC.
- C. Restrained joint fittings for high density polyethylene pipe shall be Victaulic 995 or 997 style coupling.

2.20 FASTENERS

- A. All fasteners shall include washers under both bolt head and nut unless the use of washers is incompatible with the fitting design.
- B. Unless otherwise noted, all bolts, tie rods, and T-bolts used to secure flanges, fittings, and couplings located underground or submerged in liquid shall be Type 304 or 316 stainless steel per ASTM A320 or ASTM A193. Nuts shall be 304 or 316 stainless steel per ASTM A194 and washers shall be ASTM F436 Type 3.
- C. Unless otherwise noted, all bolts, tie rods, and T-bolts used to secure flanges, fittings, and couplings located indoors, above grade, and in vaults shall be carbon steel conforming to ASTM A307, Grade B with ASTM A563, Grade A nuts and ASTM F436 washers. Bolts, nuts, and washers shall be hot dipped galvanized in accordance with ASTM F2329. Stainless steel meeting the requirements of Paragraph B shall also be acceptable.

2.21 INSULATING FLANGE SETS

- A. Insulating flange sets shall be provided where indicated on the plans and shall consist of insulating gaskets, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2-inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2-inch, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic. Steel washers shall comply with ASTM A325. Insulating gaskets shall be full-face.

PART 3 EXECUTION

3.1 HANDLING AND DISTRIBUTION OF MATERIALS

- A. Delivery: Handle pipe carefully to ensure delivery at the project site in sound, undamaged condition. Contractor shall replace damaged pipe at no additional expense to the Owner.

- B. Storage: Do not store materials directly on the ground. Adequately support piping to prevent warping. Use protective covers where pipe may be damaged by direct sunlight.
- C. No more than one week's supply of material shall be distributed in advance of pipe laying operations, unless otherwise approved or required.
- D. Before laying, pipe shall be inspected for cracked, broken, or defective pieces. Such pieces shall be rejected. Pipe shall be carefully lowered into the trench to prevent damage. All dirt or other foreign matter shall be removed from inside the pipe before lowering into the trench.

3.2 COATING

- A. Unless otherwise indicated in Part 2, all pipe and fittings shall be coated in accordance with specification 09 90 00.

3.3 INSTALLATION OF UNDERDRAINS

- A. Perforated pipes shall be laid with the perforations down.

3.4 INSTALLATION OF BURIED PRESSURE PIPING

- A. General: Pipe, fittings, and appurtenances shall be installed in accordance with the manufacturer's instructions and in accordance with the following references as appropriate:
 - 1. Ductile Iron Pipe - AWWA C600
 - 2. Polyvinyl Chloride Pipe and HDPE pipe - AWWA C605
 - 3. Steel Pipe – AWWA C604
- B. Handling: The pipe shall be protected to prevent entrance of foreign materials during laying operations. When laying is not in progress, open pipe ends shall be protected with a watertight plug or other approved means to exclude water or foreign material.
- C. Alignment:
 - 1. Mains shall be installed to the grades and elevations indicated and shall have a minimum cover of 30-inches from the top of the pipe to existing ground or paved surface unless otherwise indicated.
 - 2. The allowable angle of deflection at any joint shall not exceed the amount recommended by the pipe manufacturer for the particular pipe size used. Deviation of any pipe section from the line and grade indicated shall not exceed 1/2-inch.
- D. Joints:

1. Pipe shall be assembled and joined in accordance with the manufacturer's published instructions for the type of pipe and joint used. All portions of the joints shall be thoroughly cleaned before the sections of pipe are assembled. The ends of each pipe shall abut against the next pipe section in such a manner that there shall be no unevenness of any kind along the bottom half of the interior of the pipe. Where mechanical joints are used, the pipe shall be marked in such a manner that it can be determined after installation that the pipe is properly seated.
 2. Where flexible couplings are used as expansion joints, the ends of the pipes shall be separated 1-inch to allow for expansion. The welded seam at the end of each coupled steel pipe shall be ground smooth for approximately 12-inches. Couplings shall be centered on pipe ends. Runs of pipe containing flexible couplings shall be properly blocked, anchored or tied to the structure to prevent joints from separating.
 3. Mechanical restrained joints shall be installed in accordance with joint manufacturer's instructions and recommendation.
- E. Installation of Marker Tape: Install tape in backfill directly over each pipeline, 24 inches over top of pipe, unless shown otherwise on the Plans. Where utilities are buried in a common trench, identify each line by a separate marker tape. Place tapes directly over the applicable line.

3.5 *THRUST BLOCKS OR MECHANICAL RESTRAINED JOINTS*

- A. Thrust blocks shall be used only where specifically allowed on the drawings or with prior approval by the Engineer.
- B. Place concrete thrust blocks at all tees, elbows, plugs, and other locations where unbalanced forces exist in underground pipe in accordance with details shown. Place blocks between undisturbed ground and fitting to be anchored. Place blocking so that pipe and fittings will be accessible for repairs. Thrust blocks shall be of such size as to give bearing against undisturbed vertical earth banks sufficient to absorb the thrust from line pressure, allowing a maximum earth bearing pressure of 500 pounds per square foot per foot of depth below natural grade or as shown.
- C. Restrained joint fittings may be used in-lieu of thrust blocks, at the discretion of the Engineer. Contractor shall submit shop drawings showing methods of joint restraint for each type of restrained joint fitting to be used including the length of pipe having restrained push-on joints on all pipes which connect to the restrained fitting.
- D. When it is necessary to restrain push-on joints adjacent to restrained fittings, a harness restraint device shall be used. All harnesses shall have a pressure rating equal to that of the pipe on which it is used. Harness assemblies including tie bolts conform to ASTM A536.

3.6 *INSTALLATION OF EXPOSED PIPING*

- A. General - Pipe shall be installed as specified, as indicated on the Plans or, in the absence of detail piping arrangement, in a manner acceptable to the Engineer.

- B. Pipe shall be cut from measurements taken at the site and not from the Plans. All necessary provisions shall be taken in laying out piping to provide throughout for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction so as not to transmit noise resulting from expansion.
- C. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, dirt, and other foreign matter when erected. The interior of all lines shall be thoroughly cleaned, to the satisfaction of the Engineer, before being placed in service.
- D. Stuffing box leakage from water sealed pumps shall be contained and not allowed to into storm drains.
- E. Taps for pressure gauge connections on piping and equipment shall be provided with a nipple and a ball type shutoff valve. Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.
- F. A union shall be provided within 2 feet of each end of threaded end valves unless there are other connections that facilitate easy removal of the valve. Unions shall also be provided in piping at locations adjacent to devices or equipment that may require removal in the future and at locations required by the Plans or other sections of the Specifications.
- G. Provide unions on exposed piping and tubing 3-inches and smaller as follows:
 - 1. At every change in direction (horizontal and vertical).
 - 2. Downstream of valves, 6 to 12 inches.
 - 3. As shown on plans.
- H. In all piping except air piping, insulating fittings shall be provided to prevent contact of dissimilar metals.
- I. Pipe Joints - Pipe joints shall be carefully and neatly made in accordance with the requirements that follow.
 - 1. Threaded - Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be full and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed, after threading and before assembly, to remove all burrs.

Threaded joints in plastic piping shall be made up with Teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with Teflon thread sealer and Teflon thread tape applied to all male threads. At the option of the Contractor, threaded joints in other piping may be made up with Teflon thread tape, thread sealer, or a suitable joint compound. Thread tape and joint compound or sealers shall not be used in threaded joints that are to be seal welded.

Threaded joints in steel piping for chlorine service shall be made up with Teflon thread tape or paste applied to all male threads.

2. Compression - Ends of tubing shall be cut square and all burrs shall be removed. The tubing end shall be fully inserted into the compression fitting and the nut shall be tightened not less than 1-1/4 turns and not more than 1-1/2 turns past finger tight, or as recommended by the fitting manufacturer, to produce a leak tight, torque-free connection.
3. Flared - Ends of annealed copper tubing shall be cut square and all burrs shall be removed prior to flaring. Ends shall be uniformly flared without scratches or grooves. Fittings shall be tightened as required to produce leak tight connections.
4. Soldered and Brazed - Where solder fittings are specified for lines smaller than 2 inches, joints may be soldered or brazed at the option of the Contractor. Joints in 2 inch and larger copper tubing shall be brazed.
5. Flanged - Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but not so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly. Connecting flanges shall have similar facings, i.e., flat or raised face.
6. Welded - Welding shall conform to the specifications and recommendations contained in the "Code for Pressure Piping", ANSI B31.1.
7. Grooved Couplings - Grooves for grooved couplings shall be cut with a specially designed grooving tool. Grooves cut in steel pipe shall conform to flexible grooving dimensions as set forth in AWWA C606 and shall be clean and sharp without burrs or check marks.

3.7 ACCEPTANCE TESTS AND INSPECTION FOR GRAVITY PIPING

A. General

1. All testing and inspection shall be performed after final backfill and compaction operations are complete. If the Contractor so desires, he may pretest the lines at his own expense, but final testing must be performed after compaction requirements have been approved.
2. If any of the tests or inspections covered in this section indicates that sewers require repair, then after repairs are complete, all testing and inspection shall be performed again. The cost of any retests, including time for the Engineer, shall be borne by the Contractor at no additional cost to the project.
3. Prior to testing, all lines shall be thoroughly cleaned by flushing, and shall have passed a Wayne ball of appropriate size. Contractor is to submit to the Engineer a detailed procedure on protecting the existing sewer system from contaminants during the flushing operation.

B. Mandrel

1. All sections of completed gravity pipe main lines shall be tested to assure that no potential obstructions are present in the lines. A rigid mandrel with a circular cross section having a diameter not less than 95% of the specified pipe diameter shall pass through the pipe without resistance.

C. Low-Pressure Air Test

1. Supply air to the test section slowly. A constant pressure of 3.5 psig shall be reached and maintain internal pressure of at least 3.0 psig for at least five (5) minutes.
2. After the stabilization period, disconnect the air supply. A pressure loss of 0.5 psig is used to compute the allowable pressure loss using the following formula.
3. The minimum allowable time in minutes for such a pressure drop is determined from the formula $T_{\min} = 0.000183D^2L$, where:
 - a. D = Nominal inside diameter of pipe (inches)
 - b. L = Length of pipe test section (feet)
4. Regardless of the formula, the minimum time allowed for pressure drop shall be eight (8) minutes.
5. The pressure gage for monitoring the air pressure shall have a minimum division of 0.10 psi increments.
6. A valid test is when the air pressure is released from the opposite end of the inlet air entry connection with an air release apparatus outlet connection.
7. Adjustment of Pressure for Groundwater. Should the pipe section being tested lie below the local groundwater table, the test pressures shall be raised in proportion to the depth of the centerline of the pipe below the water table. Additional pressure (beyond the 3.5 psig specified above) shall be added at the rate of 0.433 psig per foot of depth below groundwater.

D. Video

1. Video inspection shall be performed on all new sewer mains. Video inspections shall be paid for by the Contractor and shall be completed prior to the final acceptance of the improvements.
2. The inspection video shall be in color and shall be recorded on DVD. The video shall become the property of the Owner.
3. The Engineer shall be the sole judge as to the acceptability of construction revealed by such inspection.

4. Within 24 hours prior to testing, all lines shall be thoroughly flushed with water to assist camera in the identification of low areas.

3.8 ACCEPTANCE TESTS FOR BURIED PRESSURE PIPING

A. General

1. All testing and inspection shall be performed after final backfill and compaction operations are complete. If the Contractor so desires, he may pretest the lines at his own expense, but final testing must be performed after compaction requirements have been approved.

B. In general, tests shall be conducted in accordance with AWWA C600 and C651 except as otherwise herein specified.

C. All newly installed sections of buried pressure piping shall be pressure and leakage tested as described herein.

1. For buried pressure pipelines, tests shall be made on two or more valved sections not to exceed 2,500 feet in length. The Contractor shall furnish all necessary equipment, material and labor required.
2. Tests shall be made after the trench has been backfilled and compacted, but not until at least 5 days have elapsed since any thrust blocks in the section have been poured.
3. The pipe shall be slowly filled with water and ensuring all air expelled from section being tested. The line shall stand full of water for at least twenty-four hours prior to testing to allow all air to escape. A test pressure equal to 1.5 times the design pressure, of the pipe measured at the point of lowest elevation pressure, or 100 psi, whichever is greater, shall be applied.
4. The test pressure in the line shall be maintained for a period of 2 hours. Test pressure shall be maintained within 5 psi during the test period. Conduct a leakage test concurrently with the pressure test. Leakage is defined as the volume of water that must be supplied into the newly laid pipeline to maintain pressure within +/- 5 psi of the test pressure after it is filled and purged of air. The water required to maintain test pressure shall be measured by means of a graduated barrel, drum, or similar device at the pump suction or through a meter.

Allowable leakage at the specified test pressure shall not exceed the amounts allowed by AWWA C600, $L = \frac{SD\sqrt{P}}{148,000}$

Where:

L = Allowable fluid loss, in gallon per hour.

S = Length of pipe tested, in feet.

D = Nominal diameter of the pipe, in inches.

P = Average test pressure during the hydrostatic test, in pounds per square inch (psi).

Hydrostatic testing allowance per 1,000 ft. of pipeline in gph.

PSI	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99
125	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62

5. Should testing disclose any visible leaks or leakage greater than that allowed, the defective joints or pipe shall be located, repaired, and re-tested until satisfactory. The cost of any retests, including time for the Engineer, shall be borne by the Contractor at no additional cost to the project.

3.9 ACCEPTANCE TEST FOR EXPOSED PIPING

- A. Pipe to be Tested - All new installed piping sections shall be pressure and leakage tested as specified herein.
- B. Pressure Testing - After the section of line to be tested has been filled with water or other test media, the test pressure shall be applied and maintained without interruption for 2 hours plus any additional time required for the Engineer to examine all piping undergoing the test and for the Contractor to locate all defective joints and materials.
 1. Test medium shall be potable water for potable water piping; all other piping may be tested using plant water subject to Engineer's approval.
 2. Pipe system shall be tested at 1-1/2 times the operating pressure, or 100 psi, whichever is greater, using the appropriate test fluid medium.
 3. All piping shall be tight and free from leaks. All pipe, fittings, valves, pipe joints, and other materials that are found to be defective shall be removed and repaired or replaced with new and acceptable material, and the affected portion of the piping be retested until satisfactory. The cost of any retests, including time for the Engineer, shall be borne by the Contractor at no additional cost to the project.

Compressed air or gas under pressure shall not be used to test plastic piping unless specifically recommended by the pipe manufacturer.

Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method acceptable to the Engineer. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

END SECTION

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SECTION 40 05 23

VALVES AND APPURTENANCES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes materials, testing, and installation of manually operated valves and check valves including gate, butterfly, ball, hose bibbs, globe, check, solenoid, mud valves, vacuum breakers and flap valves.

1.2 RELATED WORK

- A. Section 09 90 00 – Painting and Coating
- B. Section 40 05 60 – Air-Release and Vacuum-Relief Valves

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. American Water Works Association (AWWA)

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with the General Conditions and Section 01 33 00 - Submittals.
- B. Submit manufacturer's catalog data and detail construction sheets showing all valve parts. Describe each part by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type.
- C. Show valve dimensions including laying lengths. Show port sizes. Show dimensions and orientation of valve actuators, as installed on the valves. Show location of internal stops for gear actuators. State differential pressure and fluid velocity used to size actuators. For worm-gear actuators, state the radius of the gear sector in contact with the worm and state the handwheel diameter.
- D. Show valve linings and coatings. Submit manufacturer's catalog data and descriptive literature.
- E. Submit six copies of a report verifying that the valve interior linings and exterior coatings have been tested for holidays and lining thickness. Describe test results and repair procedures for each valve. Do not ship valves to project site until the reports have been returned by the Owner's Representative and marked "Resubmittal not required."

PART 2 PRODUCTS

2.1 GENERAL

- A. Valves are identified in the drawings by size, category and type number. For example, a callout in the drawings of 6" Type-1 butterfly valve refers to Type-1 valve in the butterfly valve category in these specifications, which is a Class 125 rubber seated butterfly valve.
- B. All valves installed in potable water applications shall conform to California AB 1953 no-lead regulations and ANSI/NSF Standard 61.
- C. Install valves complete with operating handwheels or levers, chainwheels, extension stems, floor stands, gear actuators, operating nuts, chains, and wrenches required for operation.
- D. Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently attached plate.

2.2 BOLTS AND NUTS FOR FLANGED VALVES

- A. Bolts and nuts for flanged valves shall be as described in Section 40 05 00.

2.3 GASKETS FOR FLANGES

- A. Gaskets for flanged end valves shall be as described in Section 40 05 00.

2.4 PAINTING AND COATING

- A. Coat metal valves located above ground or in vaults and structures the same as the adjacent piping. If the adjacent piping is not coated, then coat valves per Section 09 90 00. Apply the specified prime coat at the place of manufacture. Apply intermediate and finish coats in field.
- B. Coat buried metal valves at the place of manufacture per Section 09 90 00, System No. 7.
- C. Coat submerged metal valves, stem guides, extension stems, and bonnets at the place of manufacture per Section 09 90 00, System No. 1.
- D. Line the interior metal parts of metal valves 4 inches and larger, excluding seating areas and bronze and stainless-steel pieces. Lining shall be epoxy similar to Section 09 90 00, System No. 1. Apply lining at the place of manufacture.
- E. Alternatively, line and coat valves with fusion-bonded epoxy per Specification 09 97 61.
- F. Coat floor stands per Section 09 90 00.

- G. Test the valve interior linings and exterior coatings at the factory with a low-voltage (22.5 to 80 volts, with approximately 80,000-ohm resistance) holiday detector, using a sponge saturated with a 0.5% sodium chloride solution. The lining shall be holiday free.
- H. Measure the thickness of the valve interior linings per Section 09 90 00. Repair areas having insufficient film thickness per Section 09 90 00

2.5 PACKING, O-RINGS AND GASKETS

- A. Unless otherwise stated in the detailed valve specifications, packing, O-rings, and gaskets shall be one of the following nonasbestos materials:
 - 1. Teflon.
 - 2. Kevlar aramid fiber.
 - 3. Acrylic or aramid fiber bound by nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal.
 - 4. Buna-N (nitrile).

2.6 RUBBER SEATS

- A. Rubber seats shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/L in the fluid conveyed.

2.7 VALVES

- A. Ball Valves:
 - 1. Type 1—Full Port Threaded Bronze Ball Valves 2 Inches and Smaller (Non-Potable Service):

Ball valves, 2 inches and smaller, for air or water service shall have a pressure rating of at least 600 psi WOG at a temperature of 100°F. Provide full port ball and body design. Valves shall comply with MSS SP-110. Provide bronze (ASTM B62 or ASTM B584, Alloy C83600 or C84400) body and plug ball retainer. Ball and stem shall be Type 316 stainless steel. Valves shall have threaded ends (ASME B1.20.1), nonblowout stems, reinforced Teflon seats, and have plastic-coated lever actuators. Valves shall be Stockham T-285 Series, Apollo 77C-140 Series, or equal.
 - 2. Type 2—Full Port Threaded Bronze Ball Valves 2 Inches and Smaller (Low Lead):

Ball valves, 2 inches and smaller, for water service shall have a pressure rating of at least 600 psi WOG at a temperature of 100°F. Provide full port ball and body design. Valves shall comply with MSS SP-110. Materials of construction shall be as follows:

Component	Material	Specification
Body	Bronze	ASTM B584, Alloy C89836
Ball	Bronze	ASTM B584, Alloy C89836 or Alloy C27450, chromium plated
Ball retainer	Bronze	ASTM B584, Alloy C89836 or ASTM B371, Alloy C69430
Stem	Bronze	Alloy C27450
Seats	Reinforced Teflon	—

Bronze alloys having a maximum lead content of 0.25%, a maximum zinc content of 7.0%, and a minimum copper content of 80% may be substituted for the bronze alloys specified above. Valves shall have threaded ends (ASME B1.20.1), nonblowout stems, and have plastic-coated lever actuators.

Valves shall be Apollo 77CLF Series or equal.

3. Type 3—Bronze Ball Valve Curb Stops, 2 Inches and Smaller, for Water Service:

Ball valve curb stops shall be bronze with male inlet iron pipe threads and female outlet iron pipe threads and shall conform to AWWA C800. Components in contact with water shall be bronze (ASTM B584, Alloys C89833 or C89836). Components not in contact with water shall be bronze (ASTM B62 or ASTM B584, Alloys C83600, C89833, or C89836). Bronze alloys having a maximum lead content of 0.25%, a maximum zinc content of 7.0%, and a minimum copper content of 80% may be substituted for the bronze alloys specified above. Minimum pressure rating shall be 300 psi. Stops shall be Ford Ball Valve Curb Stop B81-777 with straight lever handle or equal.

4. Type 4—Bronze Ball/Corporation Stops, 2 Inches and Smaller, for Water Service:

Corporation stops shall be bronze with male inlet iron pipe threads and female outlet iron pipe threads and shall conform to AWWA C800. Components in contact with water shall be bronze (ASTM B584, Alloys C89833 or C89836). Components not in contact with water shall be bronze (ASTM B62 or ASTM B584, Alloys C83600, C89833, or C89836). Bronze alloys having a maximum lead content of 0.25%, a maximum zinc content of 7.0%, and a minimum copper content of 80% may be substituted for the bronze alloys specified above. Minimum pressure rating shall be 300 psi. Stops shall be Ford Ballcorp Type FB 1700, James Jones J-1931, or equal.

5. Type 5—Bronze Angle Meter Stops for Water Service:

Angle meter stops shall be bronze. Components in contact with water shall be bronze (ASTM B584, Alloys C89833 or C89836). Components not in contact with water shall be bronze (ASTM B62 or ASTM B584, Alloys

C83600, C89833, or C89836). Bronze alloys having a maximum lead content of 0.25%, a maximum zinc content of 7.0%, and a minimum copper content of 80% may be substituted for the bronze alloys specified above. Minimum pressure rating shall be 150 psi.

For 1-inch service and smaller, use Ford Ball Meter Valve No. BA13-444W, James Jones J-1966W, or equal. Provide valve with inlet iron pipe threads and meter saddle nut outlet.

For larger than 1- through 2-inch service, use Ford Ball Meter Valve No. BFA13-666W or BFA13-777W or equal. Provide valve with inlet iron pipe threads and meter flange outlet.

6. Type 6—True Union CPVC Ball Valves:

Ball valves, 2 inches and smaller, for chemical or water service shall be Schedule 80 full bore design, true union type. Where used in potable water service, the valve shall be ANSI/NSF-61 certified. Valves shall be constructed from CPVC Type IV, ASTM D1784 Cell Classification 23447 and rated for a pressure of 150 psi at a temperature of 105°F and 235 psi at a temperature of 73°F. All O-rings shall be EPDM or FKM as required for the compatibility with the chemical service and seats shall be constructed of PTFE. All valve components shall be replaceable. Valves for sodium hypochlorite and hydrogen peroxide service shall include vented balls. Valves shall be manufactured by Spears Manufacturing, Asahi, Plast-O-Matic, Harrington or equal.

7. Type 7—True Union PVC Ball Valves:

Ball valves, 3 inches and smaller, for chemical or water service shall be Schedule 80 full bore design, true union type. Where used in potable water service, the valve shall be ANSI/NSF-61 certified. Valves shall be constructed from PVC Type I, ASTM D1784 Cell Classification 12454 and rated for a pressure of 150 psi at a temperature of 105°F and 235 psi at a temperature of 73°F. All O-rings shall be EPDM or FKM as required for the compatibility with the chemical service and seats shall be constructed of PTFE. All valve components shall be replaceable. Valves for sodium hypochlorite and hydrogen peroxide service shall include vented balls. Valves shall be manufactured by Spears Manufacturing, Asahi, Plast-O-Matic, Harrington or equal.

B. Globe Valves, Angle Valves, Hose Valves, Hose Bibbs, and Fire Hydrants:

1. Type 1—Bronze Globe Valves 2 Inches and Smaller:

Globe valves, 2 inches and smaller, shall be all bronze (ASTM B62 or ASTM B584, Alloy C83600) with screwed ends, union bonnet, inside screw, rising stem, and composition or PTFE disc. Valves shall have a pressure rating of at least 300 psi at a temperature of 150°F. Stem shall be bronze: ASTM B371

(Alloy C69400), ASTM B99 (Alloy C65100), or ASTM B584 (Alloy C87600). Valves shall be Crane No. 7TF, Walworth Figure 3095, Stockham B-22T, or equal.

2. Type 2—Bronze Angle Hose Valves (1 1/2 and 2 1/2 inches):

Angle-type hose valves of sizes 1 1/2 and 2 1/2 inches shall be brass or bronze (ASTM B62 or ASTM B584, Alloy C83600) body with rising or nonrising stem, composition disc, and bronze or malleable iron handwheel. Stem shall be bronze, ASTM B62, ASTM B584 (Alloy C83600), or ASTM B198 (Alloy C87600). Valves shall have a cold-water service pressure rating of at least 150 psi. Provide cap and chain with valve. Threads on the valve outlet shall be American National Standard fire hose coupling screw thread. Valves shall be Powell Figure 151 with Figure 527 nipple adapter, Crane 17TF with hose nipple adapter, or equal.

3. Type 3—Brass or Bronze Angle Hose Valves 1 1/2 and 2 1/2 Inches (UL Listed):

Angle-type hose valves of sizes 1 1/2 and 2 1/2 inches shall be UL approved complying with UL 668, cast or forged brass or bronze, with handwheel. Inlet threads shall be female NPT. Outlet hose threads shall be male national standard fire hose (MNST). Minimum pressure rating shall be 300 psi. Provide caps with chains for the outlet. Products: Fire Protection Products, Inc. Series 07, National Fire Equipment, Guardian Fire Equipment Model 5000, NIBCO T-331-HC, American Fire Hose and Cabinet Series 400, or equal.

4. Type 4—Bronze Hose Bibbs:

Hose bibbs of size 1/2 inch, 3/4 inch, and 1 inch shall be all bronze (ASTM B62 or ASTM B584, Alloy C83600) with rising or nonrising stem, composition disc, bronze or malleable iron handwheel, and bronze stem (ASTM B99, Alloy C65100; ASTM B371, Alloy C69400; or ASTM B584, Alloy C87600). Packing shall be Teflon or graphite. Valves shall have a pressure rating of at least 125 psi for cold-water service. Threads on valve outlet shall be American National Standard fire hose coupling screw thread (ASME B1.20.7). Provide atmospheric vacuum breaker conforming to ASSE Standard 1011 and IAPMO code.

5. Wet Barrel Fire Hydrants (AWWA C503):

Not applicable.

6. Dry Barrel Fire Hydrants (AWWA C502):

Not applicable

7. Angle Fire Hydrants (Wharf Head Valves—AWWA C503):

Not applicable.

C. Check Valves:

1. Type 1—Bronze Check Valves 3 Inches and Smaller:

Check valves 3 inches and smaller shall be wye pattern, bronze, ASTM B61, B62, or B584 (Alloy C83600). Ends shall be female threaded, ASME B1.20.1. Disc shall be bronze, swing type.

Check valves 3 inches and smaller shall be Class 125, wye pattern, horizontal swing, conforming to MSS SP-80. Ends shall be female threaded, ASME B1.20.1. Minimum working pressure shall be 200 psi CWP at a temperature of 150°F. Materials of construction shall be as follows:

Component	Material	Specification
Body, bonnet, disc hanger	Bronze	ASTM B584, Alloy C87850
Hinge pin, hanger nut, seat disc nut, seat disc washer	Stainless steel	Type 304 or 316
Disc holder	Bronze	UNS C69300 or C87850
Seat disc	PTFE	—

Bronze alloys having a maximum lead content of 0.25%, a maximum zinc content of 7.0%, and a minimum copper content of 80% may be substituted for the bronze alloys specified above. Valves shall be Nibco T-413-Y-LF or equal.

2. Type 3—Bronze Check Valves 2 Inches and Smaller for Reciprocating Air Compressors:

Check valves 2 inches and smaller shall be Class 300, bronze, ASTM B61. Ends shall be female threaded ASME B1.20.1. Disc shall be Type 420 stainless steel or bronze (ASTM B61). Minimum pressure rating shall be 250 psi at 150°F. The disc shall provide air cushioning action of the compressor. Provide a disc guide to prevent cocking of the disc. The caps shall anchor the disc guide in alignment with disc travel. The bodies shall have pipe threads and clearances at ends of threads sufficient to permit tight pipe connections, precluding the possibility of pipe ends jamming against diaphragms, distorting seats, or choking the flow. Valves shall be Midwest Control Devices Series MCCB, Lunkenheimer Figure 1616, or equal.

3. Type 4—Cast-Iron Swing Check Valves 3 Inches and Larger, Class 125:

Swing check valves, 3 inches and larger, shall be iron body, bronze mounted complying with AWWA C508 with the following materials of construction.

Description	Material	Specification
Disc or clapper seat ring and valve body seat ring	Bronze or brass	ASTM B62 or B584 (Alloy C84400 or C87600)
Body and cap (bonnet)	Cast iron	ASTM A126, Class B
Disc and hinge or arm (valves 4 inches and smaller)	Bronze	ASTM B62 or ASTM B584 (Alloy C84400)
Disc and hinge or arm (valves larger than 4 inches)	Cast iron or bronze	ASTM A126, Class B; ASTM B62.
Hinge pin	Stainless steel	Type 303, 304, or 410 stainless
Cover bolts and nuts	Stainless steel	ASTM A193, Grade B8M; ASTM A194, Grade 8M
Internal fasteners and accessories	Bronze or Type 304 or 316 stainless steel	

Bronze or brass components in contact with water shall comply with the following requirements:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum 0.25% (potable use)
Copper + Nickel + Silicon	83% minimum

Ends shall be flanged, Class 125, ASME B16.1. Minimum valve working pressure shall be 150 psi. Provide check valves with outside lever.

The shop drawing submittal shall include a detail showing how the hinge pin extends through the valve body. Show packing gland, hinge pin gland, cap, and other pieces utilized.

Valves shall be M&H Style, Clow or equal.

4. Type 5—Cast-Iron Swing Check Valves 2 1/2 Inches and Larger for Fire Protection Service:

Swing check valves of sizes 2 1/2 through 12 inches for fire protection service shall be UL listed, FM approved, rated for at least 175 psi nonshock, cold water. Ends shall be flanged, Class 125, ASME B16.1. Materials of construction shall be as follows:

Description	Material	Specification
Body and cap	Cast iron	ASTM A126, Class B
Disc	Bronze or cast iron	ASTM B62; ASTM B584, Alloy C83600; or ASTM A126, Class B
Disc bushing, disc ring, and seat ring	Bronze	ASTM B62, or ASTM B584 (Alloy C83600)
Hinge pin	Brass	ASTM B16 or ASTM B21

Valves shall be Stockham G-939, Walworth Figure 8883 F, Nibco F-908, or equal.

5. Type 6—Swing Check Valves 10 Through 66 Inches With Controlled Closing Using Bottom-Mounted Hydraulic Buffer:

Controlled closing swing check valves shall be iron body with the following materials of construction:

Description	Material	Specification
Disc or clapper seat ring	Buna-N	
Valve body seat ring	Aluminum bronze	ASTM B148
Body and cap (bonnet)	Cast iron	ASTM A126, Class B
Disc and hinge or arm	Ductile iron	ASTM A536
Shaft and hinge pin	Stainless steel	Type 303, 304, or 410
Cover bolts and nuts	Stainless steel	ASTM A193, Grade B8M; ASTM A194, Grade 8M
Buffer rod	Stainless steel	ASTM A582: Type 303, 304, or 410

Ends shall be flanged, Class 125, ASME B16.1. Minimum valve working pressure shall be 150 psi. Provide check valves with outside lever and weight.

The cushion swing check valve shall conform to AWWA C508. Provide integral flanges (not wafer). The body shall have a flush and drain hole. The seat shall be locked in place with stainless steel lock screws and be field replaced without the use of special tools. The shaft shall be one piece, extending through both sides of the body with a lever and weight mounted on each side. The disc shall utilize a double clevis hinge to prevent disc tipping and be connected to a disc arm. The disc arm assembly shall be suspended from the shaft. The valve shall have a bottom hydraulic buffer to permit free open but positive nonslam control closure of the disc. The hydraulic buffer shall make contact with the disc during the last 10% of closure to instantly

control the valve disc until shutoff. The last 10% of closure shall be externally adjustable and variable. The line media to the buffer must be separated by a combination pressure sensing, oil/water separator device to protect the buffer cylinder against corrosion from the main line media. The hydraulic buffer assembly shall be removable from valve without need to remove the entire valve from the pipeline.

Cylinders shall be of tie-rod or bolted-flange construction and shall have a pressure rating of 150 psi minimum, as determined by National Fluid Power Association Specification T3.6.8. Cylinder mounting dimensions shall comply with National Fluid Power Association Specification T3.6.8 regarding mounting and physical dimensions with slight modifications where required to adapt to the valve cylinder mounting. Construction materials shall incorporate a design factor of safety of 4:1 based on tensile strength.

Cylinder barrels, heads, and caps shall be AISI Type 304 or 316 stainless steel, or bronze. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum 0.25% (potable use)
Copper + Nickel + Silicon	83% minimum

The shop drawing submittal shall include a detail showing how the hinge pin extends through the valve body. Show packing gland, hinge pin gland, cap, and other pieces utilized.

Valve shall be APCO Series 6000B or equal.

6. Type 7—Cast-Iron Ball Check Valves, 3 Through 14 Inches, Class 125:

Valve shall consist of a body with a sinking-type hollow steel ball and flanged access port. Design shall be such that the fluid flow forces the ball into a receiving cavity in the valve. When the fluid flow stops, the ball shall fall out of the cavity into a rubber seat in the body to shut off flow. Valve shall be suitable for vertical upward or horizontal flow conditions. Body material shall be cast iron (ASTM A48 or A126) with 15-mil fusion bonded epoxy lining and coating per AWWA C550. Provide nitrile coating on ball. Provide Type 316 stainless steel fasteners. Flanges shall be Class 125 per ASME B16.1. Products: Flygt Corporation ball check valve, Flomatic Corporation Model 408, or equal.

7. Type 8—Slanting Disc Check Valves With Controlled Opening and Closing, Class 125:

Slanting disc check valves of sizes 6 through 60 inches shall have materials of construction as described below:

Component	Material	Specification
Body	Cast or ductile iron	ASTM A126, Class B or ASTM A536, Grade 65-45-12
Seat ring and disc ring	Bronze	See paragraph below
Pivot pins	Stainless steel	ASTM A582, Type 303 or 304
Bushings	Stainless steel	ASTM A269, Type 304 or 316
Oil reservoirs	Stainless steel	AISI Type 316

Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum 0.25% (potable use)
Copper + Nickel + Silicon	83% minimum

Ends shall be flanged, ASME B16.1, Class 125. The body shall be of two-piece construction, bolted at the center to hold the seat at angle of 55 degrees. The area throughout the valve body shall equal the full pipe area.

Provide top-mounted hydraulic dashpot to control valve opening and closing. Dashpot shall have a control valve to adjust the speed of the opening and closing cycles. Time spreads shall be adjustable 5 to 30 seconds. Provide oil-filled dashpots to operate the opening and closing arrangement. The reservoir for the opening cycle shall contain pressurized air and shall have a 3-inch pressure gauge and pneumatic fill valve.

Provide oil-fitted bottom buffer to control valve closing (adjustable one to five seconds) over the last 10% of the closing range.

Valve shall be APCO Series 800, Val-Matic Series 9600 or 9800 or equal.

8. Type 9—Rubber Flapper Swing Check Valves (3 Through 24 Inches):

Valves shall consist of body, flapper, and bolted cover. Operating pressure shall be at least 175 psi at a temperature of 212°F. Valve seat shall be set at an angle of 35 to 45 degrees to the centerline of the pipe. Ends shall be

flanged, ASME B16.1, Class 125. Body and cover shall be cast iron (ASTM A48, Class 30, or ASTM A126, Class B). Flapper shall consist of a steel disk insert and a steel bar hinge bonded to the metal pieces. Provide O-ring seal bonded onto the disk. Lining shall have a hardness of 50 to 60 durometer, Shore A. Cover bolts shall be Type 316 stainless steel.

Products: APCO Series 100R, Val-Matic Series 500, or equal.

9. Type 10—Duckbill-Shaped Check Valves, 1 Through 54 Inches, Class 125:

Valve shall consist of a contoured rubber body with a duckbill sleeve-type exit. The body entrance shall be round, with a connecting Class 125 ASME B16.1 rubber flange to match the connecting pipe.. Provide synthetic fabric reinforcement. Provide stainless steel backing rings on the rubber body flanges. The valve shall open at a differential pressure of 2 inches of water column and shall close under a no-flow condition. Minimum body pressure rating shall be 50 psi. Maximum backpressure: 10 psi. Products: Red Valve Company “Tideflex” Model 35 or equal.

10. Type 11—Silent Check Valve 3 Inches and Larger:

Silent check valves, 3 inches and larger, shall be bronze mounted globe style. The seat and plug shall be hand replaceable in the field. Provide resilient seat. Flow area through valve shall be equal to or greater than the cross sectional area of the equivalent pipe size. Valve plug shall be center guided with a through integral shaft and spring loaded for silent shutoff operation. Ends shall be flanged Materials of construction shall be as follows:

Component	Material	Specification
Body	Cast Iron	ASTM A48, Class 30, or ASTM A126, Class B
	Ductile Iron	ASTM A536, Grade 60-45-10
Plug and seal	Bronze	ASTM B62 or B584 (Alloys C83600 or C87600)
Spring	Stainless steel	Type 316 stainless

Valve shall be APCO Series 600 or equal.

11. Type 12 – CPVC Ball Check Valves

Valve bodies and balls shall be fabricated with chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the service indicated. Valves shall include unions with socket connections. Seals shall have Viton O-rings and valve design shall minimize possibility of the balls sticking or chattering. Valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F. Valves

shall be manufactured by Spears Manufacturing, Asahi, Plast-O-Matic, Harrington or equal.

12. Type 13 – PVC Ball Check Valves

Valve bodies and balls shall be fabricated with polyvinyl chloride (PVC), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the service indicated. Valves shall include unions with socket connections. Seals shall have Viton O-rings and valve design shall minimize possibility of the balls sticking or chattering. Valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F. Valves shall be manufactured by Spears Manufacturing, Asahi, Plast-O-Matic, Harrington or equal.

PART 3 EXECUTION

3.1 VALVE SHIPMENT AND STORAGE

- A. Provide flanged openings with metal closures at least 3/16-inch thick, with elastomer gaskets and at least four full-diameter bolts. Install closures at the place of valve manufacture prior to shipping. For studed openings, use all the nuts needed for the intended service to secure closures. Alternatively, ship flanged valves 3 inches and smaller in separate sealed cartons or boxes.
- B. Provide threaded openings with steel caps or solid-shank steel plugs. Do not use nonmetallic (such as plastic) plugs or caps. Install caps or plugs at the place of valve manufacture prior to shipping. Alternatively, ship valves having threaded openings or end connections in separate sealed cartons or boxes.
- C. Store resilient seated valves in sealed polyethylene plastic enclosures with a minimum of one package of desiccant inside. Store resilient seated valves in the open or unseated position. Valves with adjustable packing glands shall have the packing gland loosened prior to storage. Inspect valves at least once per week, replace desiccant if required and repair damaged storage enclosures. Do not store valves with resilient seats near electric motors or other electrical equipment.
- D. Inspect valves on receipt for damage in shipment and conformance with quantity and description on the shipping notice and order. Unload valves carefully to the ground without dropping. Use forklifts or slings under skids. Do not lift valves with slings or chain around operating shaft, actuator, or through waterway. Lift valves with eyebolts or rods through flange holes or chain hooks at ends of valve parts.
- E. Protect the valve and actuators from weather and the accumulation of dirt, rocks, and debris. Do not expose rubber seats to sunlight or ozone for more than 30 days. Also, see the manufacturer's specific storage instructions.
- F. Make sure flange faces, joint sealing surfaces, body seats, and disc seats are clean. Check the bolting attaching the actuator to the valve for loosening in transit and handling. If loose, tighten firmly. Open and close valves having manual or power

actuators to make sure the valve operates properly and that stops or limit switches are correctly set so that the valve seats fully. Close valve before installing.

3.2 *FACTORY PRESSURE TESTING*

- A. Hydrostatically test the valve pressure-containing parts at the factory per the valve specification or per the referenced standard. If no testing requirement is otherwise specified or described in the referenced standards, then test with water for 30 minutes minimum at a pressure of 1.5 times the rated pressure but not less than 20 psig. Test shall show zero leakage. If leaks are observed, repair the valve and retest. If dismantling is necessary to correct valve deficiencies, then provide an additional operational test and verify that the valve components function.

3.3 *INSTALLING VALVES - GENERAL*

- A. Remove covers over flanged openings and plugs from threaded openings, after valves have been placed at the point to which the valves will be connected to the adjacent piping. Do not remove valves from storage cartons or boxes until they are ready to be installed.
- B. Handle valves carefully when positioning, avoiding contact or impact with other equipment, vault or building walls, or trench walls.
- C. Clean valve interiors and adjacent piping of foreign material prior to making up valve to pipe joint connection. Prepare pipe ends and install valves in accordance with the pipe manufacturer's instructions for the joint used. Do not deflect pipe-valve joint. Do not use a valve as a jack to pull pipe into alignment. The installation procedure shall not result in bending of the valve/pipe connection with pipe loading.
- D. Make sure valve ends and seats are clean. Check exposed bolting for loosening in transit and handling and tighten to manufacturer's recommendations. Open and close the valve to make sure it operates properly and that stops or limit switches are correctly set so that the vane, ball, gate, needle, diaphragm, disc, plug, or other seating element seats fully. Close the valve before installing. Check coatings for damage and repair. Handle valves carefully when positioning, avoiding contact or impact with other equipment or structures
- E. Prior to assembly, coat threaded portions of stainless steel bolts and nuts with lubricant.

3.4 *INSTALLING EXPOSED VALVES*

- A. Unless otherwise indicated in the drawings, install valves in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the floor with their operating stems vertical. Install valves in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the floor with their operating stems horizontal.
- B. Install valves on vertical runs of pipe that are next to walls with their stems horizontal, away from the wall. Valves on vertical runs of pipe that are not located next to walls shall be installed with their stems horizontal, oriented to facilitate valve operation.

3.5 *INSTALLING BURIED VALVES*

- A. Connect the valve, coat the flanges and place and compact the backfill to the height of the valve stem.
- B. Connect the valve, coat the flanges, apply polyethylene encasement, and place and compact the backfill to the height of the valve stem.
- C. Place block pads under the riser pipe to maintain the valve box vertical during backfilling and repaving and to prevent the riser pipe from contacting the valve bonnet.
- D. Secure the riser pipe with backfill and compact. Install the valve box and pour the concrete collar. In pavement areas pour the collar to 2 inches below the finished pavement grade to allow asphalt concrete to be placed over the collar. In non-paved areas, place the collar to the top of the valve box.

3.6 *FIELD COATING BURIED VALVES*

- A. Coat flanges of buried valves and the flanges of the adjacent piping, and the bolts and nuts of flanges and mechanical joints, per Section 09 90 00, System No. 07.
- B. Wrap buried metal valves 6 inches and in two layers of polyethylene conforming to AWWA C105, 8 mils in thickness each. Pass the two sheets of polyethylene under the valve and the coated flanges or joints with the connecting pipe and draw the sheets around the valve body, the valve bonnet, and the connecting pipe. Secure the sheets with plastic adhesive tape about the valve stem below the operating nut and about the barrel of the connecting pipe to prevent the entrance of soil. Fold overlaps twice and tape. Backfill the valve with care to avoid damaging the polyethylene.

3.7 *ASSEMBLING JOINTS*

- A. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseal or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.
- B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

3.8 *VALVE FIELD TESTING*

- A. Test valves for leakage at the same time that the connecting pipelines are hydrostatically tested. See Section 40 05 00 for pressure testing requirements. Protect or isolate any parts of valves, actuators, or control and instrumentation

systems whose pressure rating is less than the pressure test. Valves shall show zero leakage. Repair or replace any leaking valves and retest.

- B. Operate manual valves through three full cycles of opening and closing. Valves shall operate from full open to full close without sticking or binding. Do not backfill buried valves until after verifying that valves operate from full open to full closed. If valves stick or bind, or do not operate from full open to full closed, repair or replace the valve and repeat the tests.
- C. Gear actuators shall operate valves from full open to full close through three cycles without binding or sticking. The pull required to operate handwheel- or chainwheel-operated valves shall not exceed 40 pounds. The torque required to operate valves having 2-inch AWWA nuts shall not exceed 150 ft-lbs. If actuators stick or bind or if pulling forces and torques exceed the values stated previously, repair or replace the actuators and repeat the tests. Operators shall be fully lubricated in accordance with the manufacturer's recommendations prior to operating.

END SECTION

SECTION 40 05 75

PIPING AND EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes furnishing and installing markers, labels, tags, and signs for piping, valves, and equipment.

1.2 RELATED WORK

- A. Section 09 90 00 – Painting and Coating
- B. Section 33 01 00 – Piping and Fittings
- C. Section 40 05 23 – Valves and Appurtenances

1.3 REFERENCES

- A. American Society of Mechanical Engineers (ASME) A13.1
- B. American Society for Testing and Materials (ASTM)
- C. American Water Works Association (AWWA)

1.4 SUBMITTALS

- A. Submittals shall be in accordance with the General Conditions and Section 01 33 00.
- B. Submit list of wording, symbols, letter size, and color coding for all identification.
- C. Provide manufacturers catalog literature for each product required.
- D. Submit two samples of each product to be used.
- E. Submit manufacturer's installation instructions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Identification shall be by Brady Corporation, Seton, or equal.

2.2 VALVE TAGS

- A. Valve tags shall be brass or stainless steel. Plastic tags will not be accepted.
- B. Tags shall be 40 mils thick and shall include filled text for easy readability.

- C. Lettering shall be stamped letters with character size and words to ANSI A13.1.
- D. Valve tags shall be attached using stainless steel beaded chain, jack chain or wire. Nylon ties will not be accepted.

2.3 *PIPE MARKERS*

- A. Pipe markers shall include the service name and flow directional arrows. Labeling shall conform to ASME A13.1.
- B. Locate pipe markers at maximum 20 foot centers on straight runs including risers and drops, adjacent to each valve and tee, and at each side of penetration of structure or enclosure.
- C. Labels for indoor locations shall be mechanically fastened or self-adhesive vinyl.
- D. Labels for outdoor locations shall be UV resistant acrylic plastic
- E. Snap-on type markers made of UV resistant acrylic will be accepted for both indoor and outdoor use.
- F. Markers attached with nylon ties will not be accepted.

2.4 *MECHANICAL EQUIPMENT*

- A. Label all mechanical equipment with the equipment description and tag number shown on the drawings.
- B. Labels shall be a minimum of 1-1/2 inches by 4 inches in size and shall be fabricated of aluminum or fiberglass resistant to UV.

2.5 *HAZARDOUS MATERIALS WARNING SIGNS*

- A. Label all chemical storage tanks and entrances to areas containing chemicals with “diamond” warning signs complying with NFPA 704. Size shall be a minimum of 10-inch square.
- B. Install 1/8-inch fiberglass wall signs (Brady B-120 or equal). Signs attached to tanks shall be self-adhesive (Brady B-946 or equal).

2.6 *AUTOMATIC EQUIPMENT*

- A. Install automatic start warning signs adjacent to the following equipment. The signs shall include the wording “AUTOMATIC EQUIPMENT – MAY START AT ANY TIME”.

Well pump
Chemical enclosure entrances

Backwash supply pump
Backwash recycle pump
High service pumping station

2.7 NO SMOKING SIGNS

- A. Install "NO SMOKING" sign at the following locations. Sign shall be weather and UV resistant fiberglass with a minimum size of 10 inches by 7 inches.

Chemical enclosure entrances
Standby generator

2.8 UNDERGROUND MARKERS

- A. Non-Detectable Underground Markers
1. Material: Polyester
 2. Thickness: 0.09 mm thick to ASTM D1593
 3. Width: 6 inches
 4. Tensile Strength: 7 lb/in to ASTM D638
 5. Elongation: 300% to ASTM D638
 6. Color to American Public Works Association standards
- B. Detectable Underground Markers
- Install No. 10 solid-core copper tracer wire

PART 3 EXECUTION

3.1 INSTALLATION OF LABELS AND TAGS

- A. Install all tags, signs, and labels in clear view. Pipe markers shall be aligned with axis of pipe.
- B. Degrease and clean surfaces to receive adhesive labels prior to application.
- C. Install valve tags with corrosion resistant ties to the valve handwheel. Valves in main and branch piping shall be tagged.

- D. All valves included in a valve schedule or identified by tag number in the P&ID drawings shall be tagged.
- E. All exposed piping shall be labeled and marked with flow direction arrows.

3.2 *INSTALLATION OF WARNING TAPE*

- A. Bury non-detectable tape 12 to 18 inches below ground level, directly over the utility it identifies.
- B. Bury detectable tape 4 to 6 inches below ground level directly over the utility it identifies.

END SECTION

SECTION 40 20 10

PIPE SUPPORTS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. All pipe hangers, brackets, supports and accessories for newly installed piping as specified and indicated in the Contract Documents.
- B. All labor, materials, equipment and incidentals necessary and required for their completion.
- C. Concrete and fabricated steel supports shall be as indicated or specified in other sections or, in the absence of such requirements, as permitted by the Engineer.

1.2 RELATED WORK

- A. Section 03 30 10 – Concrete Site Work
- B. Section 09 90 00 – Paintings and Coatings
- C. Section 40 05 23 – Valves and Appurtenances

1.3 REFERENCES

- A. Seismic design requirements in applicable codes and regulations.

1.4 QUALITY ASSURANCE

- A. Except as modified or supplemented herein, all pipe supports shall comply with the applicable provisions of ANSI/MSS SP-58 AND MSS SP-69.
- B. In certain locations, pipe supports, anchors, and expansion joints have been indicated on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint. It shall be the Contractor's responsibility to provide a complete system of pipe supports, to provide expansion joints, and to anchor all piping, in accordance with the requirements set forth herein. Additional pipe supports may be required adjacent to expansion joints, couplings, or valves.

1.5 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 – Submittal Procedures.
- B. Data shall include a listing of the intended use and general location of each item submitted.

1.6 DELIVERY, STORAGE AND HANDLING

- A. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Unless otherwise specified or indicated on the drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.
- B. Pipe support types and application shall comply with Schedule I in paragraph 3.2.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design Criteria

- 1. Pipe supports shall be manufactured for the size and type of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item.
- 2. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports.
- 3. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead ending. Anchors shall be located as required to force expansion and contraction movement to occur at expansion joints, loops or elbows, and as required to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Pipe supports shall be designed to comply with the applicable seismic requirements in accordance with the seismic design requirements section.

2.3 DIMENSIONS

- A. Unless closer spacing is indicated on the drawings, the maximum spacing for pipe supports and expansion joints shall be as scheduled in Schedule II at the end of this section.

2.4 STRUCTURAL DESIGN

- A. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Approved anchors shall be used to fasten supports to concrete or masonry. Unless otherwise indicated on the drawings or permitted by the Engineer, piping shall be supported so that the closest distance from pipe wall or insulation covering is at least 1-1/2 inches from the face of walls and at least 3 inches below ceilings.

- B. Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Those portions of pipe supports which contact dissimilar metals shall be rubber or vinyl coated.

3.2 SCHEDULES

- A. SCHEDULE I: Pipe Support Types and Application Schedule:

<u>Description or Location</u>	<u>MSS SP-69</u> (Note 1)	<u>Other</u>
<u>Hangers</u>		
2-1/2 inch and smaller pipe:		
J-style	5	Elcen "90", Fee & Mason "210", Unistrut "J Hangers", or equal.
clevis	1	Elcen "12B", Fee & Mason "105", ITT Grinnell "65", or equal.
3-inch through 10-inch pipe:		
clevis	1	Elcen "12", Fee & Mason "239", ITT Grinnell "260" for steel pipe; Elcen "12C", Fee & Mason "104", ITT Grinnell "590" for cast iron pipe, or equal.
<u>Concrete Inserts, steel:</u>		
12-inch and smaller pipe	18	Channel 12 ga, galv. 1-5/8" x 1-3/8", min. 8 inches long, anchor lugs on 4" centers, at least three lugs, end caps, and filler strip.
<u>Wall Supports and Frames, steel :</u>		
12-inch and smaller pipe:		
brackets	32, 33	---
prefabricated channels	---	12 ga galv., 1-5/8" x 1-5/8", with suitable brackets and pipe clamps.
offset pipe clamp, (1-1/2 inch and smaller pipe)	---	Galv., 1-1/4" x 3/16" steel with 3/8" bolts.
offset pipe clamp, (2-inch to 3-1/2 inch pipe)	---	Galv., 1-1/4" x 1/4" steel, with 3/8" bolts.
<u>Floor Supports, steel or cast iron:</u>		
6-inch and small pipe	37 with base	---

Description or Location

MSS SP-69
(Note 1)

Other

B. SCHEDULE II: Spacing Schedule

1. Distance between supports shall not be more than that recommended by the pipe manufacturer.
2. Distance between supports shall not be more than that shown on the drawings.
3. Additional supports shall be added as required to prevent visible bowing of pipe.
4. In addition to the spacing requirements listed above, the distance between supports shall not be more than listed in the following schedule.

Type of Pipe	Pipe Support Max Spacing, ft	Max Run Without Expansion Joint, Loop. or Bend, ft	Expansion Joint Max Spacing, ft	Type of Expansion Joint
Ductile Iron, 4" and larger	15	80	80	Note 1
Steel for all services:				
1-1/4 inch and smaller	7	30	100	Note 1
1-1/2 to 4 inch	10	30	100	Note 1
Over 4 inch	15	80	80	Note 1
PVC, Schedule 40				
Smaller than 3"	4	20	60	Note 1
3" and larger	6	20	60	Note 1
PVC Schedule 80				
Smaller than 3"	5	20	60	Note 1
3" and larger	7	20	60	Note 1

Notes:

City of Turlock
Well 29 Chlorination

1. Expansion joint not required in straight run of pipe if overall length does not exceed the maximum run specified in schedule.

END SECTION

PIPE SUPPORTS
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SECTION 40 20 90
PVC AND CPVC PROCESS AND CHEMICAL PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes materials, installation, and testing of PVC and CPVC piping smaller than 4 inches used in process piping and chemical piping.

1.2 RELATED WORK

- A. Section 33 01 00 – Pipe and Fittings
- B. Section 33 13 00 – Disinfection of Water System
- C. Section 40 05 23 – Valves and Appurtenances
- D. Section 40 20 10 – Pipe Supports
- E. Section 40 24 68 – Secondary Containment Piping

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. American Water Works Association (AWWA)

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00 – Submittals.
- B. Submit materials description for pipe and fittings with ASTM reference and grade and manufacturer's certification of compliance with referenced standards.
- C. Submit wall thickness and pressure rating of pipe and fittings.

PART 2 PRODUCTS

2.1 PVC PIPE

- A. The material used in the manufacture of the pipe shall be domestically produced rigid polyvinyl chloride (PVC) compound, Type I Grade I, with a Cell Classification of 12454 as defined in ASTM D1784, trade name designation H707 PVC. This compound shall be gray in color as specified, and shall be approved by ANSI/NSF International for use with potable water (NSF Std 61).
- B. PVC pipe shall be manufactured in strict accordance to the requirements of ASTM D1785 for physical dimensions and tolerances. Each production run of pipe manufactured in compliance to this standard, shall also meet or exceed the test

PVC AND CPVC PROCESS AND CHEMICAL PIPING
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requirements for materials, workmanship, burst pressure, flattening, and extrusion quality defined in ASTM D1785. All belled-end pipe shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements and the minimum socket length for pressure-type sockets as defined in ASTM D2672. All PVC Schedule 80 pipe must also meet the requirements of NSF Standard 14 and CSA Standard B137.3 rigid PVC pipe for pressure applications, and shall bear the mark of these Listing agencies. This pipe shall have a flame spread rating of 0-25 when tested for surface burning characteristics in accordance with CAN/ULC-S102-2-M88 or equivalent.

- C. Product marking shall meet the requirements of ASTM D1785 and shall include: the manufacturer's name (or the manufacturer's trademark when privately labeled); the nominal pipe size; the material designation code; the pipe schedule and pressure rating in psi for water @ 73°F; the ASTM D1785; the independent laboratory's seal of approval for potable water usage; and the date and time of manufacture.

2.2 CPVC PIPE

- A. The material used in the manufacture of the pipe shall be a rigid chlorinated polyvinyl chloride (CPVC) compound, Type IV Grade I, with a Cell Classification of 23447 as defined in ASTM D1784. This compound shall be light gray in color, and shall be approved by NSF for use with potable water. Material used shall be domestically produced CPVC material as provided by Noveon, Inc. (formerly the BFGoodrich Company), or approved equal.
- B. CPVC Schedule 40 and Schedule 80 pipe shall be manufactured in accordance to the requirements of ASTM F441 for physical dimensions and tolerances. Each production run of pipe manufactured in compliance to this standard, shall also meet the test requirements for materials, workmanship, burst pressure, flattening, and extrusion quality defined in ASTM F441. All belled-end pipe shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements, and the minimum socket length for pressure-type sockets, as defined in ASTM D2672.
- C. Product marking shall meet the requirements of ASTM F441 and shall include: the manufacturer's name (or the manufacturer's trademark when privately labeled); the nominal pipe size; the material designation code; the pipe schedule and pressure rating in psi for water @ 73°F; the ASTM F441; and the independent laboratory's seal of approval for potable water usage. Marking shall also include the flame spread rating and smoke development rating when tested and listed for surface burning characteristics per CAN/ULC S102.2 (Flame Spread (F.S.) of <25 and Smoke Development (S.D.) of <50).

2.3 FITTINGS

- A. PVC fittings shall be schedule 80 grey, socket-type fabricated of ASTM D1784, Type I, Grade 1 conforming to ASTM D2467.
- B. CPVC fittings shall be schedule 80 grey, socket-type fabricated of ASTM D1784, Type IV, Grade 1 conforming to ASTM F439.

2.4 JOINTS

- A. All joints shall be solvent welded or union unless flanged connections are required for adjacent equipment.
- B. All solvent cements used for PVC, except for pipes carrying sodium hypochlorite and sodium hydroxide shall conform to ASTM D2564 and be listed by ANSI/NSF for potable use applications.
- C. All solvent cements used for CPVC, except for pipes carrying sodium hypochlorite and sodium hydroxide shall conform to ASTM F493 and be listed by ANSI/NSF for potable use applications.
- D. Solvent cement for pipes carrying sodium hypochlorite or sodium hydroxide shall conform to ASTM F493 and be specially formulated for use with corrosive chemicals. Solvent shall be IPS Weld-On 724 or equal.
- E. Unions shall be Schedule 80, shall conform to the materials specifications for fittings, shall be socket joint, and shall utilize EPDM or Viton O-rings compatible with the chemical service.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE OF PIPE

- A. Do not store pipe where exposed to direct sunlight or heat.
- B. Support the pipe uniformly.
- C. Do not install pipe that is gouged or scratched forming a clear depression.

3.2 SOLVENT CEMENTING

- A. Ensure that the pipe and fittings are at the same temperature prior to joining.
- B. Cut pipe ends square, remove all burrs, and slightly chamfer outside edge of pipe ends.
- C. Remove all dirt and moisture from the surfaces being joined.
- D. Measure the socket depth and mark distance on the pipe being inserted. Check the dry fit of the components prior to applying cement.
- E. Apply primer to both the pipe and fitting following the primer manufacturer's instructions.
- F. Apply solvent cement appropriate for the pipe material and service following the manufacturer's instructions.
- G. Allow the joint to set and cure following the cement manufacturer's instructions. Do not load the joint for at least 8 hours after joint assembly.

PVC AND CPVC PROCESS AND CHEMICAL PIPING
40 20 90-3

3.3 *INSTALLING UNIONS*

- A. Install unions at the following locations whether shown on the plans or not:
 - 1. Changes in direction
 - 2. Next to all valves and other equipment
 - 3. Every 10 feet on above grade straight pipe runs.
 - 4. Where shown on the drawings.

3.4 *INSTALLING BURIED PIPE*

- A. Follow standard ASTM D2774 installation practice.
- B. Snake the pipe in the trench per the pipe manufacturer's recommendations to account for thermal contraction and expansion.
- C. Support the pipe continuously on a smooth surface void of any stones or sharp objects.

3.5 *PAINTING AND COATING*

- A. PVC pipe is susceptible to degradation if left exposed to direct sunlight. Coat pipe exposed to direct sunlight per Section 09 90 00.

3.6 *DISINFECTION*

- A. Disinfect pipe used in potable water applications in accordance with Section 33 13 00.

END SECTION

SECTION 40 24 68
PVC SECONDARY CONTAINMENT PIPING

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes materials, installation, and testing of PVC secondary containment piping.

1.2 RELATED WORK

- A. Section 33 01 00 – Piping and Fittings
- B. Section 33 13 00 – Disinfection of Water System
- C. Section 40 05 23 – Valves and Appurtenances
- D. Section 40 20 10 – Pipe Supports
- E. Section 40 20 90 – PVC and CPVC Process and Chemical Piping

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. American Water Works Association (AWWA)

1.4 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00.
- B. Submit materials description for pipe, fittings, and other appurtenances with ASTM reference and grade and manufacturer's certification of compliance with referenced standards.
- C. Submit wall thickness and pressure rating of pipe and fittings.
- D. Submit manufacturer's installation instructions.

PART 2 PRODUCTS

2.1 SECONDARY CONTAINMENT SYSTEM

- A. Furnish a complete double-containment piping system including piping, fittings, anchors, terminations, access tees, carrier pipe supports and associated pipe joining method.
- B. The system design shall meet the requirements of ASME/ANSI B31.3 for design criteria where temperature and pressure fall within the limits of that code.

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40 24 68-1

- C. System shall provide the ability to incorporate leak detection. Access tees, pull ropes, and low-point instrumentation taps shall be provided as specified by the leak detection vendor and/or contract drawings. Supplier of Piping System shall specify Pipe Sizes to accommodate leak detection cable if utilized.

2.2 MANUFACTURER'S

- A. Secondary containment piping system shall be manufactured by Asahi/America, Spears Manufacturing, or equal.

2.3 DEFINITIONS

- A. Product Pipe: Inside Pipe/Carrier Pipe
- B. Containment Pipe: Outside Pipe

2.4 MATERIALS

- A. Product and containment pipe shall be PVC per the material, dimensional, and pressure rating requirements of Section 40 20 90.
- B. Any special fittings, not supplied as part of the normal product offering, shall be classified as unlisted components. Products falling into this category shall only be supplied by the manufacturer of the double containment System.

2.5 VALVES

- A. Valve arrangements that are to be double contained shall be supplied pre-assembled and tested to 150% of the maximum operating pressures. Actuators, stem extensions, and other accessories shall be part of a pre-assembled package.

2.6 PIPE SUPPORTS

- A. Centralizer supports, guides, etc. for product pipe shall be provided of same resin as product pipe. Supports shall be placed in a manner that a maximum of 0.1-inch deflection is allowed between supports. Supports shall allow axial movement of product pipe within containment pipe. Supports shall maintain a concentric relationship between product pipe and containment pipe. Supports shall be designed to allow the pulling of Leak Detection Cable through the pipe.
- B. Anchors shall be provided of same resin as product pipe and containment pipe. Anchors shall be of same wall thickness as product and containment pipe, and must be of unitary construction. Anchors shall be fully pressure rated.
- C. Support disks used to centralize fittings shall lock the product (carrier) fitting to the containment fitting. Free-floating fittings are not allowed. Support disks shall be designed to allow for flow and access cable in the annular space.

2.7 ACCESS TEES

- A. Access tees shall be provided per drawings and per leak detection manufacturer's requirements. Access tees shall be of same resin as pipe.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE OF PIPE

- A. Do not store pipe where exposed to direct sunlight or heat.
- B. Support the pipe uniformly.
- C. Do not install pipe that is gouged or scratched forming a clear depression.

3.2 INSTALLATION

- A. Install piping system per manufacturer's recommended procedures.
- B. Install continuous running pull rope for installation of leak detection cable if required for leak detection system.

3.3 SOLVENT CEMENTING

- A. Ensure that the pipe and fittings are at the same temperature prior to joining.
- B. Cut pipe ends square, remove all burrs, and slightly chamfer outside edge of pipe ends.
- C. Remove all dirt and moisture from the surfaces being joined.
- D. Measure the socket depth and mark distance on the pipe being inserted. Check the dry fit of the components prior to applying cement.
- E. Apply primer to both the pipe and fitting following the primer manufacturer's instructions.
- F. Apply solvent cement appropriate for the pipe material and service following the manufacturer's instructions.
- G. Allow the joint to set and cure following the cement manufacturer's instructions. Do not load the joint for at least 8 hours after joint assembly.

3.4 INSTALLING BURIED PIPE

- A. Follow standard ASTM D2774 installation practice.
- B. Snake the pipe in the trench per the pipe manufacturer's recommendations to account for thermal contraction and expansion.
- C. Support the pipe continuously on a smooth surface void of any stones or sharp objects.

3.5 FIELD HYDROSTATIC TESTING

- A. Test containment pipe using one of the following two procedures:

1. Test containment pipe hydrostatically per Section 40 05 15. The product pipe must be pressurized to the same pressure as the containment pipe to prevent collapsing of the product pipe.
2. To avoid moisture in the containment space, an air test can be conducted on the containment pipe using air at 5 psi. The inner carrier pipe shall be full of water and under pressure to avoid any possible collapse. When testing with air, the ambient temperature should be above 40° F and extra safety precautions for personnel shall be put in place during the test.

3.6 *DISINFECTION*

- A. Disinfect pipe used in potable water applications in accordance with Section 33 13 00.

END SECTION

SECTION 40 50 00

INSTRUMENTATION AND CONTROLS – GENERAL PROVISIONS

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall procure the services of a single Process Control System Supplier (PCSS) to furnish and install all materials, equipment, labor and services, except for those services and materials specifically noted, required to achieve a fully integrated and operational system as specified herein and in other Specification Sections listed below.
- B. Requirements specified in this Section apply to all equipment specified in the above sections, unless otherwise specified. The work shall include furnishing, installing and testing the equipment and materials detailed in the following Sections:
 - 1. 40 96 31 Control Loop Descriptions
 - 2. 40 50 01 I&C Testing
 - 3. 40 64 01 Control Systems: Programmable Logic Controllers
 - 4. 40 66 70 Control Systems: Wireless Communications -Radio
 - 5. 40 67 01 Control Systems: Panels, Enclosures and Panel Components
 - 6. 40 62 14 Control Systems: PCS Computer Equipment
- C. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, shall be included whether they are shown on the Drawings or not.
- D. Substitutions on functions or type of equipment specified shall not be acceptable unless specifically noted. In order to confirm compatibility between all equipment, coordinate all interface requirements with mechanical and electrical systems and furnish any signal isolation devices that might be required.
- E. Equipment shall be fabricated, assembled, installed and placed in operating condition in full conformity with the project Specifications, Drawings, engineering data, instructions, and recommendations of the equipment manufacturer as approved by the Engineer.
- F. To facilitate the Owner's future operation and maintenance, similar products (e.g., differential pressure transmitters, SCADA I/O cards) shall be supplied from the same manufacturer.
- G. All equipment and installations shall satisfy applicable Federal, State and local codes.
- H. Use the equipment, instrument, and loop numbering scheme that has been developed and shown on the Drawings and specifications in the development of the submittals. Do not deviate from or modify said numbering scheme without the Engineer's approval.
- I. The work of this project includes, but is not necessarily limited to the following:

1.02 RELATED WORK

- A. Process Flow Diagrams (PFD) are included in the Drawings.

- B. Control System Architecture Block Diagram is included in the Drawings.
- C. Specific control system and instrumentation materials and requirements are included in related Sections of Division 40.
- D. Instrumentation and Controls conduit systems are specified in Section 26 05 33.

1.03 SUBMITTALS

- A. General submittal requirements include:
 - 1. Refer to Division 1 for general submittal requirements.
 - 2. Other Division 40 Sections may have additional submittal requirements.
 - 3. Shop drawings shall be submitted as detailed herein. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these specifications and shall provide a complete record of the equipment as manufactured and delivered.
 - 4. Submittals shall be complete; giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.
 - 5. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all drawings reduced to a maximum size of 11-inch by 17-inch, then folded to 8.5 inch by 11 inch for inclusion within the binder. Maximum binder size shall be 3 inches.
 - 6. The submittal drawings' title block shall include, as a minimum, the PCSS registered business name and address, Owner and project name, drawing name, revision level, and personnel responsible for the content of the drawing.
 - 7. Incomplete or partial submittals not complying with the submittal arrangements outlined in this Section will be returned without review.
 - 8. Separate submittals shall be made as follows:
 - a. Project Plan, Deviation List and Schedule Submittal
 - b. Application Development System Submittal
 - c. Coordination Meetings Agenda
 - d. I/O List Submittal
 - e. Field Instrument Submittal
 - f. Hardware Submittal and Software Packages Submittal
 - g. Panel Layout Drawings and Wiring Diagram Submittal
 - h. Testing Plans Submittal
 - i. Training Plan Submittal
 - 1) Preliminary Training Plan Submittal
 - 2) Final Training Plan Submittal
 - j. Spares, Expendables, and Test Equipment Submittal
 - k. Final System Documentation

B. Project Plan, Deviation List, and Schedule Submittal

1. Submit a Project Plan within 21 calendar days from Notice to Proceed date. The Project Plan shall, as a minimum, contain the following:
 - a. Overview of the proposed control system in clear text format describing the PCSS understanding of the project work, preliminary system architecture drawing, interfaces to other systems, schedule, startup, and coordination.
 - b. Approach to work in clearly written format describing how the PCSS intends to execute the work. A discussion of switchover, startup, replacement of existing equipment with new, and other tasks as required by these specifications shall be included as applicable.
 - c. Preliminary HMI software, PLC software, and PLC hardware submittal information, including version numbers, solely to determine compliance with the requirements of the Contract Documents prior to development of system programming. Review and approval of software and hardware systems as part of this Project Plan stage shall not relieve the PCSS of meeting all the functional and performance requirements of the system as specified herein. Substitution of manufacturer or model of these systems after the submittal is approved is not allowed without Engineer approval.
 - d. Project personnel and organization including the PCSS project manager, project engineer, and lead project technicians. Include resumes of each key individual and specify in writing their commitment to this project.
 - e. Preliminary coordination meeting agendas as specified herein.
 - f. Preliminary testing plan
 - g. Preliminary training plan
 - h. Sample formats of the shop drawings to be submitted and in conformance with the requirements of the Specifications. At a minimum include samples of panel fabrication drawings, loop, I/O wiring diagrams, and graphical display presentations.
2. Exceptions to the Specifications or Drawings shall be clearly defined in a separate Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "or equal" or "exception" to the specifications shall be at the sole discretion of the Engineer. If no exceptions are taken to the specifications or drawings the PCSS shall make a statement as such. If there is no statement by the PCSS, then it is acknowledged that no exceptions are taken.
3. Project schedule shall be prepared and submitted using Primavera, Microsoft Project, or equal scheduling software. Schedule shall be prepared in Gantt chart format clearly showing task linkages for all tasks and identifying critical path elements. PCSS schedule must be based on the General Contractor schedule and must meet all field installation, testing, and start-up milestones in that schedule. The project schedule shall illustrate all major project milestones including the following:
 - a. All subsequent project submittals shall be scheduled. Include in the time allotment; the time required for Contractor submittal preparation, Engineer's review time, and a minimum of two complete review cycles.
 - b. Proposed dates for all project coordination meetings.

- c. Hardware purchasing, fabrication, and assembly (following approval of related submittals)
 - d. Software purchasing and configuration (following approval of related submittals)
 - e. Shipment of all instrument and control system equipment
 - f. Installation of all instrument and control system equipment
 - g. Testing: Schedule for all testing. Testing schedule shall include submittal of test procedures a minimum of 30 days prior to commencement of testing. Schedule shall also include submittal of completed test procedure forms for review and approval by the Engineer prior to shipment, startup, or subsequent project work.
 - h. Schedule for system cutover, startup, and/or going on-line for each major system. At a minimum include the schedule for each process controller and HMI server/workstation provided under this Contract.
 - i. Schedule for all training; including submittal and approval of O&M manuals, factory training, and site training.
- C. Coordination Meetings Agenda:
1. Agendas shall be submitted for the Coordination Meetings as specified herein. Submit proposed Control System Coordination Meeting Agenda a minimum of two weeks prior to the scheduled meeting date for review and comment by the Engineer.
- D. Input/Output (I/O) Address List Submittal
1. Submit a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
 2. I/O list shall be based on the P&ID's, the Drawings, the design I/O list (if included within these specifications), and requirements outlined in the Specifications.
 3. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format on a CD-ROM and an 8-1/2 inch by 11-inch hard copy.
 4. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O.
 5. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet tables shall include the following information:
 - a. TAG NUMBER(S): The identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
 - b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
 - c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
 - d. PHYSICAL POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
 - e. LOGICAL POINT ADDRESS: If the PCSS is performing the PLC programming, I/O address of each point.

- f. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO – Pulse Output.
 - g. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
 - h. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
 - i. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
6. The I/O list shall be sorted in order by:
 - a. Physical location
 - b. I/O Type
 - c. Loop Number
 - d. Device Tag
 7. After the I/O list is approved, do not modify the PLC I/O addresses without approval by the Engineer.
 8. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system. This applies to all I/O types.
- E. Field Instruments Submittal
1. Submit complete documentation of all field instruments using ISA-S20 data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment ordered by the loop numbering system as shown in the Contract Documents.
 2. Submit separate data sheets for each instrument including:
 - a. Plant Equipment Number and ISA tag number per the drawings
 - b. Product (item) name used herein and on the Contract Drawings
 - c. Manufacturer's complete model number
 - d. Location of the device
 - e. Input / output characteristics
 - f. Range, size, and graduations in engineering units.
 - g. Physical size with dimensions, enclosure NEMA classification and mounting details in sufficient detail to determine compliance with the requirements of the Contract Documents.
 - h. Materials of construction for enclosure and wetted parts.
 - i. Instrument or control device sizing calculations where applicable.
 - j. Certified calibration data for all flow metering devices.
 - k. Two-wire or four-wire device type as applicable.
 3. Submit index and data sheets in electronic format as well as hard copies on 8-1/2 by 11 inches formats. Electronic format shall be in Microsoft Excel or Word. Submit electronic copy on CD-ROM or DVD disk.

F. Hardware Submittal and Software Packages Submittal

1. For each hardware component indicated below, submit a cover page that lists, at a minimum, date, specification number, product name, manufacturer, model number, Location(s), and power required. Preferred format for the cover page is ISA S20, general data sheet; however, other formats will be acceptable provided they contain all required information.
2. Catalog cuts for supplied Programmable Logic Controller (PLC), process controller equipment, remote telemetry units (RTU), including central processing units, redundancy units, memory, input modules, output modules, modems, network interface modules, mounting racks, and power supplies. Submit descriptive literature for each hardware component that fully describes the units being provided. Any deviation of the hardware systems from the preliminary hardware submittal included in the Process Plan or Applications Development System submittal shall be described in detail.
3. Catalog cuts for HMI servers, HMI workstations, historian servers, memory, printers, mass storage devices, modems, peripherals, power supplies, networking and all other hardware being provided. Submit descriptive literature for each hardware component, which fully describes the units being provided.
4. Complete system architecture diagram showing in schematic form, the interconnections between major hardware components including control centers, panels, power supplies, consoles, computer and peripheral devices, networking equipment, processors, I/O modules, local operator interfaces, and like equipment. The system architecture shall be complete and shall depict all required cables, media type between components, network protocol used at each network level, details on connection requirements such as cable pin-outs, port numbers, and rack slot numbers. The intent of this specification requirement is for the PCSS to develop a diagram that is complete in every aspect to allow purchase of all required equipment by part number, and to allow a qualified technician to interconnect all equipment without having to refer to additional manuals or literature. Minimum sheet size shall be 11"x17" and using a larger sheet size or more than one sheet is acceptable.
5. Submit details of the controller development software package, the local operator graphic panel development software package, and the HMI software application packages to be used for each piece of equipment. Indicate all standard and optional features provided. Confirm in the submittal that the licenses will be assigned to the Owner at the time of purchase. Any deviation of the software platforms from the preliminary software submittal included in the Project Plan shall be described in detail.

G. Panel Layout Drawings and Wiring Diagrams Submittal

1. Where direct hardwired interfaces exist between the PCSS control panels and vendor provided control panels furnished under other Divisions, the Contractor shall provide to the PCSS the approved shop drawings and submittals in order for the PCSS to provide complete wiring diagrams showing all wiring connections in the I/O system. This includes but is not limited to terminal block numbering, relay contact information, instruments, equipment, and control panel names. These drawings will be included in the Final Documentation submittal. Leaving this information blank on the Final Documentation drawings is not acceptable.

2. Panel Layout Drawings: Drawings shall be furnished for all panels, consoles, and equipment enclosures specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11"x17" minimum in size. As a minimum, the panel drawings shall include the following:
 - a. Interior and exterior panel elevation drawings to scale.
 - b. Nameplate schedule.
 - c. Conduit access locations.
 - d. Panel construction details.
 - e. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
 - f. Fabrication and painting specifications including color (or color samples).
 - g. Submit construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
 - h. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
 - i. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL seal and any inspections shall be borne by the Contractor and included in the Project Bid Price.
3. Panel Wiring Diagrams: Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. If ISA Loop Wiring Diagrams are specified below, equipment external to the control panel and related external connections do not need to be shown on the Panel Wiring Diagrams. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. The diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the PCSS. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the PCSS and approved by the Engineer. I/O wiring shall be numbered with rack number, slot number, and point number. Two-wire and four-wire equipment shall be clearly identified, and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11" x17" minimum in size.
4. ISA Loop Wiring Diagrams: Detailed ISA loop wiring diagrams showing requirements for each loop which is shown on the contract drawings. The Loop Drawings shall be prepared in accordance with ISA Standard S5.4 latest edition with the layout following Figures 5 and 6 (shown in the S5.4 Standard), titled Minimum Required Items Plus Optional items". Loop drawings shall be 11"x17" minimum in size. The information

required on the Loop Drawings in order to satisfy the "minimum" and "optional" requirements is as follows:

- a. Minimum Required Items – The following information shall be provided on Loop Drawings in order to meet this requirement:
 - 1) Identification of the loop and loop components shown on the P&IDs. Other principal components of the loop to be shown and identified under ISA-5.1, "Instrumentation Symbols and Identification".
 - 2) Word description of loop functions within the title. If not adequate, use a supplemental note. Identify any special features or functions of shutdown and safety circuits.
 - 3) Indication of the interrelation to other instrumentation loops, including overrides, interlocks, cascaded set points, shutdowns and safety circuits.
 - 4) All point-to-point interconnections with identifying numbers or colors of electrical cables, conductors, pneumatic multitubes, and individual pneumatic and hydraulic tubing. This identification of interconnections includes junction boxes, terminals, bulkheads, ports, and grounding connections.
 - 5) General location of devices such as field, panel, auxiliary equipment, rack, termination cabinet, cable spreading room, I/O cabinet, etc.
 - 6) Energy sources of devices, such as electrical power, air supply, and hydraulic fluid supply. Identify voltage, pressure, and other applicable requirements. For electrical sources, identify circuit or disconnect numbers.
 - 7) Process lines and equipment sufficient to describe the process side of the loop and provide clarity of control action. Include what is being measured and what is being controlled.
 - 8) Actions or fail-safe positions (electronic, pneumatic, or both) of control devices such as controllers, switches, control valves, solenoid valves, and transmitters (if reverse- acting). These are to be identified in accordance with ISA-5.1, "Instrumentation Symbols and Identification".
- b. Additional Required Items – The following information shall be provided on Loop Drawings (in a tabular format as shown in Figures 5 and 6 of ISA 5.4) in order to meet this requirement:
 - 1) Process equipment, lines, and their identification numbers, source, designation, or flow direction.
 - 2) Reference to supplementary records and drawings, such as installation details, P&IDs, location drawings, wiring diagrams or drawings, and instrument specifications.
 - 3) Specific location of each device, such as elevation, area, panel subdivision, rack or cabinet number and location, I/O location.
 - 4) Cross reference between loops that share a common discrete component, such as multipen recorders, dual indicators, etc.
 - 5) References to equipment descriptions, manufacturers, model numbers, hardware types, specifications or data sheets, purchase order numbers.

- 6) Signal ranges and calibration information, including setpoint values for switches, and alarm and shutdown devices.
- 7) Software reference numbers, such as I/O addresses, control block types and names, network interfaces, point names.
- 8) Engraving or legend information that helps identify the instrument or accessory. Per ISA-5.4-1991 11.
- 9) Accessories tagged or otherwise identified, such as regulators, filters, purge meters, manifold valves, root valves.
- 10) References to manufacturer's documentation such as schematics, connection details, operating instructions.
- 11) Color code identification for conductors or tubes that use numbers for differentiation.

H. Testing Plan Submittals

1. Test Procedure Submittals: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each testing phase or loop with sign-off areas for the PCSS, Engineer, and Owner. Refer to Section 40 50 01 for specific testing requirements and submit separate procedures for each specified test phase.
2. Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and favorably reviewed. Submittal of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.
3. Each loop shall have a Loop Status signoff form to organize and track its inspection, adjustment and calibration. These forms shall include the following information and check-off items:
 - a. Project Name.
 - b. Loop Number.
 - c. Detailed test procedure indicating exactly how the loop will be tested including all required test equipment, necessary terminal block numbers, and simulation techniques required.
 - d. Tag Number for each component.
 - e. Checkoffs/signoffs for each component.
 - 1) Tag/identification
 - 2) Installation
 - 3) Termination - wiring
 - 4) Termination - tubing
 - 5) Calibration/adjustment
 - f. Checkoffs/signoffs for the loop.

- 1) Panel interface terminations
 - 2) I/O interface terminations
 - 3) I/O signal operation
 - 4) Inputs/outputs operational: received/sent, processed, adjusted
 - 5) Total loop operation
 - 6) Space for comments.
 - 7) Sign off and date fields for the Contractor, the Engineer, and the PCSS.
4. Each active analog subsystem element shall have a Component Calibration form. These forms shall have the following information including space for data entry:
- a. Project Name.
 - b. Loop Number.
 - c. ISA Tag Number and I/O Module Address.
 - d. Manufacturer.
 - e. Model Number/Serial Number.
 - f. Summary of Functional Requirements. For example:
 - 1) For Indicators: Scale ranges
 - 2) For Transmitters/Converters: Scale and chart ranges
 - 3) For Computing Elements: Function
 - 4) For Controllers: Action (direct/reverse) control modes (PID)
 - 5) For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
 - 6) For I/O Modules: Input or output
 - g. Calibrations; for example:
 - 1) For Analog Devices: Required and actual inputs and outputs at 0, 50 and 100 percent of span.
 - 2) For Discrete Devices: Required and actual trip points and reset points.
 - 3) For Controllers: Mode settings (PID).
 - 4) For I/O Modules: Required and actual inputs or outputs for 0, 50 and 100 percent of span.
 - h. Space for comments.
 - i. Sign off and date fields for the Contractor, the Engineer, and the PCSS.
- I. Spares, Expendables, and Test Equipment Lists Submittal
1. This submittal shall include for each Subsystem:
 - a. A list of, and descriptive literature for, spares, expendables, and test equipment as specified in Division 40.

- b. A list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the manufacturer.
 - c. Unit and total costs for the additional spare items specified or recommended for each subsystem.
- J. Final System Documentation
- 1. The Final System Documentation shall consist of operations and maintenance manuals as specified herein. The manuals shall be bound in three-ring binders, maximum size of three inches, with Drawings reduced to 11 inch by 17 inch, then folded to 8.5 inch by 11 inch for inclusion. Each section shall have a uniquely numbered tab divider, and each component within each section shall have a separate binder tab divider.
 - 2. The operations and maintenance manuals shall, at a minimum, contain the following information:
 - a. Table of Contents
 - 1) A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.
 - b. Instrument and Equipment Lists
 - 1) The following lists shall be developed in Excel and provided not only as a hardcopy in O&M but also electronically on a CD.
 - 2) An instrument list for all devices supplied including tag number, description, specification section and paragraph number, manufacturer, model number, serial number, range, span, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
 - 3) An equipment list for all non-instrument devices supplied listing description, specification section and paragraph number, manufacturer, model number, serial number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
 - c. Data Sheets with Vendor Operations and Maintenance Information
 - 1) ISA S20 data sheets shall be provided for all field instruments.
 - 2) Cover page for each device, piece of equipment, and OEM software that lists, at a minimum, date, specification number, product name, manufacturer, model number, Location(s), and power required. Preferred format for the cover page is ISA S20, general data sheet; however, other formats will be acceptable provided they contain all required information.
 - 3) Final vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project, or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages that do not apply at all to the specific model supplied shall be removed.

- 4) For any component requiring dip switch settings or custom software configuration, that information shall be included along with the corresponding data sheets and O&M information.
- d. As-Built Drawings
 - 1) Complete as-built drawings, including all drawings and diagram specified in this section under the "Submittals" section. These drawings shall include all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the PCSS.
 - 2) As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.
- e. Original Licensed Software
 - 1) Submit original software diskettes or CD-ROMs of all software provided under this Contract. Submit original paper based and electronic documentation for all software provided. Submit license agreement information including serial numbers, license agreements, User Registration Numbers and related information. All software provided under this Contract shall be licensed to the Owner at the time of purchase. Provide media in software sleeves within O&M manual.
- f. Electronic O&M Information
 - 1) In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals CDROM or DVD. Electronic documents shall be supplied in Adobe Acrobat format.
 - 2) Provide electronic files for all custom-developed manuals. Text shall be supplied in both Microsoft Office format and Adobe Acrobat format.
 - 3) Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in Adobe Acrobat format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, and fonts into individual zip files along with the drawing file.
 - 4) Each computer system hardware device shall be backed up onto CDROM or DVD after Substantial Completion and shall be turned over to the Owner.
 - 5) If specified in the training section, provide digital copies of all training videos. Videos shall be in a format that is readable by standard DVD players and by standard PC DVD drives. Format and shall be a minimum of 800 by 600 pixels and shall include sound.
3. The cover and edge of each volume shall contain the following information:
 - a. Project Name (refer to Contract Documents)
 - b. Contract Number (refer to Contract Documents)
 - c. Instrumentation and Control System Hardware [or Applications Engineering] Operations and Maintenance Manual
 - d. Specification Sections [List appropriate section]
 - e. Subcontractor Name

- f. Date
- g. Volume X of Y [Where X is the volume number and Y is the number of volumes]

1.04 REFERENCE STANDARDS

- A. Publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition in effect at the time of bid opening shall apply.
- B. International Society of Automation (formerly the Instrumentation, Systems and Automation Society) (ISA)
 - 1. ISA S5.2 Binary Logic Diagrams for Process Operations
 - 2. ISA S5.3 Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
 - 3. ISA S5.4, Instrument Loop Diagrams
 - 4. ISA S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - 5. ISA RP60.3, Human Engineering for Control Centers
 - 6. ISA RP60.6, Nameplates, Labels, and Tags for Control Centers
- C. National Electrical Manufacturers Association (NEMA)
- D. National Fire Protection Agency (NFPA)
 - 1. NFPA 70, National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL)
 - 1. UL 508 – Industrial Control Equipment
- F. American Society for Testing and Materials (ASTM)
 - 1. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless-Steel Tubing for General Service.

1.05 QUALITY ASSURANCE

- A. The Process Control System Supplier (PCSS) shall be a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. For the purposes of this Specification Section, a "systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:
 - 1. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. The Company shall be a member of Control System Integrators Association Certified (CSIA) and key personnel shall hold ISA CCST Level 1 certification, or have a minimum of 10 years of verifiable plant startup experience. Key personnel shall include, as a minimum, the lead field technician.
 - 2. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Successful completion shall be defined as a

finished project completed on time, without any outstanding claims or litigation involving the PCSS. Potential references shall be for projects where the PCSS's contract was of similar size to this project.

3. Has been actively engaged in motor control centers, industrials control panels, and system integration for the type of work specified in this Specification Section for a minimum of five years.
- B. The PCSS shall maintain a permanent, fully staffed and equipped service facility within 250 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the PCSS shall be capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.
 - C. PCSS shall hold a valid UL-508 certification for their panel fabrication facility.
 - D. Actual installation of the instrumentation system need not be performed by the PCSS's employees; however, the PCSS as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.
 - E. Only approved suppliers will be accepted. The Contractor must name the proposed system supplier per Division 0.
 - F. The listed approved PCSS's shall not be required to submit a qualification proposal. Suppliers interested in being listed as an equal shall submit three copies of a qualification proposal to the ENGINEER no later than 21 days before the bid opening date. A list of approved equals shall be issued no later than 13 days before the bid opening date.
 1. The qualification proposal shall provide details and a description of how the supplier proposes to fulfill the requirements set forth in these specifications. The PCSS shall present the proposal in sufficient detail so that proper evaluation regarding the experience and capabilities of the supplier can be performed.
 - a. The proposal shall contain evidence that the PCSS has sufficient financial resources to meet the obligations incidental to the performance of the work including available bonding. (This requirement may be provided in the form of a verifiable or certified financial report for the company's latest fiscal year.)
 - b. The proposal shall contain a list of personnel available for assignment to the responsible positions of Project Manager, Project Engineer, Installation Supervisor, and Area Service Representative. Also, include a concise resume of each individual's education, work experience, and accomplishments.
 - c. The proposal shall contain the following specific information:
 - 1) Maintenance services available for hardware and software: Evaluation shall be based on the PCSS's capability to provide the required routine and emergency services. The PCSS's proposal is to describe the capabilities and location of his/her nearest (to jobsite) service organization. The intent of the specifications is to obtain all system maintenance services from the PCSS. If the PCSS intends to subcontract all or portions of the service requirements, it must be stated as such along with the name and address of the organization.
 - 2) Technical validation, examples of recently completed and similar scope projects: The PCSS shall provide information regarding type, size, complexity, and

performance of five systems recently completed, along with names, addresses, and telephone numbers of persons qualified to verify PCSS's statements approximate cost of the instrumentation system supplied, project completion date and description. Evaluation shall be based on the similarity of system requirements and supplier's performance.

- 3) A description of how the supplier plans to execute the various functions and locations where the various portions of the work shall be performed, coordinated and managed (e.g., design, engineering, manufacturing, programming, testing and scheduling). The PCSS is required to state in his/her proposal those functions which he/she intends to subcontract to other organizations and include the name, address and capabilities of these organizations.
- 4) The PCSS shall be required to demonstrate a minimum of five years' past control systems of comparable size, type and complexity to the proposed project. The PCSS shall be required to have his/her own in-house capability to handle complete system engineering, fabrication, and testing.
- 5) The PCSS shall indicate that he/she has in his/her employment capable personnel for detailed engineering, coordination, drafting, procurement and expediting, scheduling, construction, testing, inspection, installation, training start up service for calibration and commissioning and warranty compliance for the period specified.

1.06 *DELIVERY, STORAGE, AND HANDLING*

A. Delivery, storage, and handling shall be in accordance with Division 1.

B. Shipping Precautions

1. After completion of shop assembly, factory test and approval of all equipment, cabinets, panels and consoles shall be packed in protective crates and enclosed in heavy duty (5 mil) polyethylene envelopes or secured sheeting to provide protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.
2. Manufacturer's special instructions for field handling, storage and installation required for protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other means of protection.
3. None of the HMI control and monitoring equipment shall be shipped to the site until the control room areas comply with specified ambient temperature and humidity. Have qualified personnel accept the equipment on delivery and supervise unloading within the control room areas.
4. If any apparatus has been damaged, such damage shall be repaired at no additional cost to the owner.

1.07 *NOMENCLATURE AND IDENTIFICATION*

A. Field Instrument Tags

1. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section. Equipment shall be tagged before shipping to the site.
 2. Provide 1/8-in by 3/8-in, Type 316 stainless steel button head machine screws.
 3. All supplied field instrument transmitters and field instrument transmitter elements shall have a stainless-steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via stainless steel chain or stainless-steel wire (24 gauge inches). Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-in high alphanumeric characters.
- B. Panel Nameplates
1. See Section 40 51 50.

1.08 WARRANTY

- A. Provide warranty per Section 00 65 36, Warranties and Bonds, and as specified herein.

1.09 PROJECT/SITE REQUIREMENTS

- A. Environmental Requirements. Refer to Section 26 05 00 and the Electrical Drawings for specific environmental and hazardous area classifications.
- B. Elevation: Equipment shall be designed to operate at the project ground elevation.
- C. Temperature:
1. Outdoor areas' equipment shall operate [between - 30 to 50 C degrees ambient].
 2. Equipment located in indoor locations shall operate between [10 to 35 C] degrees ambient minimum.
 3. Storage temperatures shall range from [0 to 50 C] degrees ambient minimum.
 4. Additional cooling or heating shall be furnished if required by the equipment as specified herein.
- D. Relative Humidity: Air-conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between 0 to 100 percent relative, condensing humidity.

PART 2 -PRODUCTS

2.01 PRODUCTS GENERAL

- A. All instrumentation and electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture and fungus. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
- B. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks unless otherwise noted. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel. Provide stainless steel fasteners only in corrosive areas rated NEMA 4X on the Drawings or as defined under Division 26. Provide and size anchors in accordance with

Division 1 and 5 as required per the seismic calculations. Provide minimum size anchor of 3/8-inch.

- C. All indicators shall be linear in process units, unless otherwise noted. All transmitters shall be provided with indicators in process units, accurate to two percent or better.
- D. All equipment, cabinets and devices furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.
- E. All electronic/digital equipment shall be provided with radio frequency interference protection.
- F. Electrical
 - 1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
 - 2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).
 - 3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.
 - 4. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.
 - 5. Switches and/or signals indicating an alarm, failure or upset condition shall be wired fail-safe to the SCADA system. A fail-safe condition is an open circuit when in an alarm state.
 - 6. Materials and equipment shall be UL approved. Where components are not available with UL approval, integrate the device with ground fault protective devices, isolation transformers, fuses, or other protective equipment necessary to achieve compliance with UL 508 requirements.
 - 7. All equipment furnished shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.
 - 8. All transmitter output signals shall include signal and power source isolation.

2.02 ELECTRICAL SURGE PROTECTION

- A. General - Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the plant electrical system. The protection systems shall be such that the protective level shall not interfere with normal operation but shall be lower than the instrument surge

withstand level. Protection shall be maintenance free and self-restoring. Devices shall have a response time of less than 50 nanoseconds and be capable of handling a discharge surge current (at an 8x20 μ s impulse waveform) of at least 8 kA. Ground wires for all instrumentation device surge protectors shall be connected to a low resistance ground in accordance with Section 26 05 00.

- B. Provide protection of all analog signal (4-20 mA) circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Protection devices located near the transmitter shall be mounted in a separate enclosure, unless conduit mounted, and shall be Phoenix Contact PT Series, MTL Surge Technologies (Telematic) TP48, Citel TSP-10 series, or equal. Substitution of a single device to protect both 120 VAC and 4-20 mA wires to an instrument is acceptable. Protection devices in control panels shall be MTL Surge Technologies (Telematic) SD Series, Phoenix Contact PT Series, Citel BP1-24, or equal.
- C. Provide protection of all 120 VAC power feeds into control panels, instruments, and control room equipment. Surge arresters shall be Transtector ACP-100BW Series, Phoenix Contact "Mains-PlugTrab", MCG Surge Protection 400 Series, or equal.
- D. Non-Fiber Based Data Highway or Communications Circuits – Provide protection on all communication and data highway circuits that leave a building or are routed external to a building. Circuit protection shall be provided at both ends of the line. Surge protection devices shall be Phoenix Contact PlugTrab Series, Transtector FSP Series, MTL Surge Technologies (Telematic) NP Series, or equal.
- E. Inductive Loads – At a minimum, provide coil surge suppression devices, such as varistors or interposing relays, on all process controller outputs or switches rated 120 VA or less that drive solenoid, coil, or motor loads.
- F. Telephone Circuits - At a minimum, provide Telephone Company approved line protection units for all telephone lines used for telemetry or SCADA system use under this Contract.

2.03 TUBING AND FITTINGS

- A. All instrument air header takeoffs and branch connections less than 2-in shall be 316 stainless steel.
- B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. The materials for fittings and valves shall be compatible with process fluids. Where metallic fittings and valves are compatible, wetted materials shall be Type 316 stainless steel.
- C. The materials for instrument tubing shall be compatible with process fluids. Where metallic tubing is compatible, tubing shall be fully annealed ASTM A269 Seamless 316 grade free of OD scratches having the following dimensional characteristics as required to fit the specific installation:
 - 1. 1/4-in to 1/2-in O.D. by 0.035 wall thickness
 - 2. 5/8-in to 1-in O.D. by 0.049 wall thickness
 - 3. 1-in O.D. by 0.065 wall thickness
 - 4. 1-1/4-in O.D. by 0.065 wall thickness

5. 1-1/2-in O.D. by 0.083 wall thickness
 6. 2-in O.D. by 0.095 wall thickness
- D. All process connections to instruments shall be annealed 1/2-inches O.D. stainless steel tubing, Type 316.
- E. All tube tracks shall be supported by stainless steel and installed as per manufacturer's installation instructions.

2.04 SPARE PARTS

- A. Spare parts of the type and quantity as recommended by the manufacturer shall be furnished for all devices furnished under these sections.
- B. All spare parts shall be wrapped in bubble wrap, sealed in a polyethylene bag complete with dehumidifier, then packed in cartons and labeled with indelible markings. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by the Engineer.
- C. As a minimum, furnish the following spare parts for control panels:
1. Timers - Five of each type installed
 2. Relays - Five of each type installed
 3. Fuses and circuit breakers - 10% (minimum of 10 fuses and 2 circuit breakers) of each type and size installed
 4. Light bulbs - 10% (minimum of 10) of each type installed
 5. Power supplies - one of each type installed.
 6. Manufacturer's cables - one of each type installed.
 7. Selector switches/pushbuttons - Two of each type installed including 5 contact blocks.
 8. Surge protection devices - One of each type installed.
 9. Provide one quart of touch-up paint, for each type and color used for all RTU cabinets, panels, and consoles supplied.
- D. The following field Instrument related Spare Parts shall be furnished:
1. Miscellaneous: One-year supply of items recommended by the manufacturer of the equipment including all reagents, dissolved oxygen probes, batteries, and calibration standards as needed to operate and maintain the furnished equipment.
- E. PLC components
1. One spare CPU of each type supplied for each plant
 2. Two spare I/O modules of each type supplied for each plant
 3. One spare specialty interface module of each type supplied for each plant
 4. One spare power supply of each type supplied for each plant

PART 3 -EXECUTION

3.01 GENERAL INSTALLATION

- A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices indicated are approximate only. Exact locations of all devices shall be as approved

by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control equipment and in case of any interference with other work, proceed as directed by the Contractor and furnish all labor and materials necessary to complete the work in an approved manner at no additional cost to the Owner.

- B. All equipment used in areas designated as hazardous shall be designed for the Class, Group and Division as required for the locations as shown on the Drawings and specified in Division 26. All work shall be in strict accordance with codes and local rulings.
- C. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, 5-valve manifolds for calibration, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.
- D. All piping and tubing to and from field instrumentation shall be provided with necessary unions, calibrations and test tees, couplings, adaptors, and shut-off valves. Process tubing shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained. Process tubing shall be installed rigidly with supports to prevent significant vibrations.
- E. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed as shown and not interfere with any other equipment.
- F. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.
- G. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, ship material in sections sized to permit passing through restricted areas in the building. Provide on-site service to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval. Certify that field wiring associated with his/her equipment is installed in accordance with best industry practice. Schedule and coordinate work under this section with that of the electrical work specified under applicable Sections of Division 26.
- H. Installation of fiber optic cable within control panel and console assemblies. Refer to cable manufacturer's specifications for bend radius. Use cable breakout assembly as recommended by the cable manufacturer. Provide wire basket, strain relief as required to meet manufacturer's strain requirements.
- I. Provide local electrical shutoffs and disconnects for all 4-wire field instruments requiring 120 VAC power. Electrical disconnects shall be suitably rated disconnect switches or manual motor starters as specified under Division 26.
- J. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare on LED, LCD, or other digital readouts.
- K. Loop Tuning - All electronic control stations incorporating PID controllers shall be tuned following field installation and calibration of instrumentation and control system components,

but prior to commencement of the specified field tests. Field testing will be immediately 'failed' if loop tuning for the entire installed system is not complete.

1. Optimal loop tuning shall be achieved either by auto-tuning software or manually by trial and error, Ziegler-Nichols step-response method, or other documented process tuning method. Assigning common PID factors for identical loops following field tuning of a single typical loop is acceptable. However, tuning documentation shall be submitted for each loop individually as specified in Part 1 of these Specifications.
2. Determine and configure optimal tuning parameters to assure stable, steady state operation of final control elements running under the control of field mounted, dedicated PID controllers or software based PID controllers residing as part of the programmable logic controller system. Each control loop that includes anti-reset windup features shall be adjusted to provide optimum response following startup from an integral action saturation condition.
3. Tune all PID control loops to eliminate excessive oscillating final control elements. Loop parameters shall be adjusted to achieve 1/4 amplitude damping or better. In addition, loop steady state shall be achieved at least as fast as the loop response time associated with critical damping.
4. Loop performance and stability shall be verified in the field following tuning by step changes to setpoint. Submit loop tuning methodology and verification as part of the final system documentation as specified in Part 1.
5. For cascade loops, tune both sets of controllers so that the cascade loop achieves the loop tuning characteristics specified herein.

3.02 TESTING

- A. Refer to Section 40 50 01.

END OF SECTION

SECTION 40 50 01

I&C – TESTING

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor and materials required and installed. Complete as shown on the Drawings and as specified herein.
- B. This section covers the testing requirements for all devices and systems furnished and installed detailed on the Drawings and in the Loop Diagrams, and as described in the related Sections of Division 40.
- C. Refer to Section 40 50 00.

1.02 RELATED WORK

- A. Refer to Section 40 50 00.

1.03 SUBMITTALS

- A. Refer to Section 40 50 00.

1.04 REFERENCE STANDARDS

- A. Refer to Section 40 50 00.

1.05 QUALITY ASSURANCE

- A. Refer to Section 40 50 00.

1.06 SYSTEM DESCRIPTION

- A. N/A

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 40 50 00.

1.08 PROJECT/SITE REQUIREMENTS

- A. Refer to Section 40 50 00.

1.09 MAINTENANCE

- A. Refer to Section 40 50 00.

1.10 WARRANTY

- A. Refer to Section 40 50 00.

1.11 NOMENCLATURE AND IDENTIFICATION

- A. Refer to Section 40 50 00.

1.12 *COORDINATION MEETINGS*

- A. Refer to Section 40 50 00.

PART 2 -PRODUCTS

2.01 *NOT USED*

PART 3 -EXECUTION

3.01 *TESTING - GENERAL*

- A. See execution requirements in Section 40 50 00.
- B. The PCSS shall test all equipment at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the PCSS shall be tested at the factory as a single fully integrated system.
- C. The PCSS shall test the system so that the Owner and Engineer can verify all the points in the existing control system. The PCSS shall coordinate testing of the ORT and FDT with the Owner.
- D. At a minimum, the testing shall include the following:
 - 1. Unwitnessed Factory Test (UFT).
 - 2. System Integration Test (SIT).
 - 3. Operational Readiness Test (ORT).
 - 4. Functional Demonstration Test (FDT).
 - 5. 30-day Site Acceptance Test (SAT).
- E. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.
- F. All tests shall be conducted in accordance with prior Engineer and/or Owner-approved procedures, forms, and all checklists as submitted by the PCSS under Specification 40 50 00 Part 1.03. Each test to be performed shall be described and a space provided after it for sign-off by the appropriate parties after its satisfactory completion. The PCSS shall include "punchlist" forms with the test procedures to document issues that arise during the testing. Punchlist forms, at a minimum, shall include a specification cross reference; an issues description field; a resolution description field; and a sign-off area for the PCSS, Owner, and Engineer.
- G. Copies of the signed-off test procedures, forms, and checklists will constitute the required testing documentation. The test result forms shall be submitted to the Engineer for approval within 10 days of completion of each test.
- H. The PCSS shall provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it

is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. These simulation techniques shall be defined in the test procedures.

- I. The PCSS shall coordinate all required testing with the Contractor, all affected Subcontractors, the Engineer, and the Owner.
- J. The PCSS shall furnish the services of field service engineers, all special calibration and test equipment, and labor to perform the field tests.
- K. The Engineer reserves the right to test or retest all specified functions, whether or not explicitly stated on the Test Procedures, as required to determine compliance with the functional requirements of the overall system. Such testing required to determine compliance with the specified requirements shall be performed at no additional cost to the Owner. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.
- L. No equipment shall be shipped until the Engineer and/or Owner has received all test results and approved the system is ready for shipment.
- M. Correction of Deficiencies
 - 1. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to the Owner.
 - 2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the Owner.

3.02 *FACTORY TESTING - UNWITNESSED FACTORY TEST (UFT)*

- A. Prior to shipment of the equipment, the entire system, except primary elements, final control elements, and field-mounted transmitters, shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.
- B. All panels, consoles, and assemblies shall be inspected and tested to verify their conformance with related submittals, Specifications, and Drawings.
- C. During the tests, all digital system hardware and software shall be operated for at least five days continuously without a failure to verify the system is capable of continuous operation.
- D. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in the Test Procedure submittal.
 - 1. All panels and enclosures being provided shall undergo a thorough inspection to verify the integrity of the cabinet enclosures, frame structures, paint work and

- finish, etc. Additionally, the PCSS shall review the panel drawings with the Owner and/or Engineer to ensure they accurately reflect the panel layout and wiring.
2. Panel wire pull tests shall be performed on all wiring to ensure all wiring has been connected to the appropriate torque to prevent wires from coming loose.
 3. For panels provided in new enclosures, heat loading tests shall be performed to ensure proper cooling/ventilation is being provided.
 4. UPSs shall be tested with all equipment connected to verify the UPSs have been sized correctly to maintain the specified run time.
 5. An I/O point checkout of at least 50 percent of each I/O module shall be performed to verify proper operation of the input/output points. To perform this test, the PCSS shall obtain copies of the PLC configuration files from the Application Engineering Services (AES) Supplier prior to proceeding with the UFT. The verification of the signals will be accomplished via the use of the PLC programming software. At a minimum, the I/O checkout shall consist of four steps.
 - a. Digital input signals shall be jumpered within the termination connections of the PLC panels and verification of proper alarming, statuses, etc., shall be performed utilizing the tools available in the PLC programming software.
 - b. Analog input signals shall be connected to a signal generator at the termination connections and signals shall be verified at zero percent, 25 percent, 50 percent, 75 percent, and 100 percent of full scale. The appropriate scaled value shall be verified utilizing the tools available in the PLC programming software.
 - c. Digital output signals shall be initiated by the user by writing to the signals utilizing the PLC programming software. Verification shall occur in the PLC panel by connecting a digital multimeter to measure the continuity at the terminations, thus verifying the command from the PLC has properly executed the contact closure.
 - d. Analog output signals shall be initiated by the user by writing to the signals utilizing the PLC programming software. Verification shall occur in the PLC panel by utilizing a digital multimeter to measure the current/voltage generated at the termination points.
- E. All control panels provided or modified under the requirements of the related technical specification sections of Division 40 shall be included in these tests.
- F. Upon successful completion of the UFT, the PCSS shall submit a record copy of the test results to the Owner and Engineer and coordinate the scheduling of the SIT with the AES Supplier.

3.03 *FACTORY TESTING - SYSTEM INTEGRATION TEST (SIT)*

- A. Before scheduling the SIT, the PCSS shall determine through his own UFT and through his internal quality assurance program that the equipment is ready for the SIT.
- B. The SIT shall be conducted a minimum of three weeks before the Witnessed Factory Test. The SIT shall be a joint test by the PCSS and the AES Supplier conducted at the PCSS's facility. As part of the requirements of Section 40 50 00-1.06, the PCSS's factory testing facility shall be within 200 miles of project site. The test will be an unwitnessed test, and the PCSS shall include time within the construction schedule for this test.
- C. The purpose of the SIT is to allow the PCSS and the AES Supplier to jointly verify the functionality, performance, and stability of the hardware and software as a complete integrated system. The AES Supplier will load the application software on the PLCs, SCADA servers, and historian. The entire system will then be tested. All process control strategies shall be simulated to ensure proper operation. The primary objective of the SIT is to allow the PCSS and the AES Supplier to perform a dry run of the WFT and thus verify the system's readiness to move forward with the WFT.
- D. The PCSS and AES Supplier shall utilize the approved WFT Procedures as the basis for the tests to be performed during the SIT.
- E. Minimum testing to be performed during the SIT shall include, but not be limited to, the following:
 1. Verification of proper scanning, communication, and complete data acquisition of the entire system.
 2. Verification of all redundant functionality of components.
 3. Verification of proper power failure recovery.
 4. Verification of proper indication for communication error issues.
 5. A complete I/O point checkout shall be performed to verify proper operation of each input/output point. The I/O checkout shall consist of four steps.
 - a. Digital input signals shall be jumpered within the termination connections of the PLC panels and verification of proper alarming, statuses, etc., shall be performed at the HMI.
 - b. Analog input signals shall be connected to a signal generator at the termination connections and signals shall be verified at zero percent, 25 percent, 50 percent, 75 percent, and 100 percent of full scale. The appropriate scaled value shall be verified at the HMI. Simultaneously, verification of alarming shall occur. The alarming verification shall, at a minimum, include HiHi, Hi, Lo, LoLo, Rate of Change, and Alarm Deadband.
 - c. Digital output signals shall be initiated by the user from the HMI system. Verification shall occur within the PLC panel by connecting a digital

multimeter to measure the continuity at the terminations, thus verifying the command from the PLC has properly executed the contact closure.

- d. Analog output signals shall be initiated by the user from the HMI system. Verification shall occur in the PLC panel by utilizing a digital multimeter to measure the current/voltage generated at the termination points.
6. Upon successful completion of the SIT, the PCSS shall submit a record copy of the test results to the Owner and Engineer and request the scheduling of the WFT as noted below.

3.04 *FIELD TESTING - OPERATIONAL READINESS TEST (ORT)*

- A. Following installation of the process control system components and prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, wired, calibrated, tested, etc., and documented) that it is installed and ready for the ORT as defined below.
- B. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and these Specifications.
- C. The Loop/Component Inspections and Tests shall be implemented using Engineer-approved forms and checklists. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and check-off items with spaces for sign-off by the system supplier:
 1. Project Name, Test Date, PCSS Name, and Lead PCSS Technician Name.
 2. Loop Number.
 3. Tag Number for each component.
 4. Check-offs/sign-offs for each component: Tag/identification; installation; termination (wiring and tubing); scale, range, and setpoint as applicable; and calibration/adjustment (four-point for analog, set point for switches) rising and falling.
 5. Check-offs/sign-offs for the loop: Panel interface terminations; I/O interface terminations; I/O signal operation; inputs/outputs operational (received/sent, processed, adjusted); total loop operation; process controller scaling and adjustment; and space for comments.
 6. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for sign-off by the PCSS.
 - a. Project Name.

- b. Loop Number.
 - c. Component Tag Number of I/O Module Number.
 - d. Component Code Number Analog System.
 - e. Manufacturer (for Analog system element).
 - f. Model Number/Serial Number (for Analog system).
 - g. Summary of functional requirements shall include, but not be limited to, scale and chart ranges of indicators, recorders, and transmitters/converters; functions of computing elements; and parameters of controllers (i.e., proportional, integral, derivative, reverse/forward acting, etc.).
 - h. Calibrations shall include testing of analog input and output signals at zero, 10, 50, and 100 percent of span. Where appropriate, discrete input signals shall include details regarding actual trip points and reset points.
 - i. Space for comments.
 - j. Space for sign-off by the PCSS.
- D. The PCSS shall maintain the Loop Status Reports sheets at the job site and make them available to the Engineer/Owner at any time.
- E. These inspections, calibrations, and tests do not require witnessing. However, the Engineer will review Loop Status Sheets and spot-check the PCSS test process periodically. Any deficiencies found shall be corrected by the PCSS prior to commencement of the Functional Acceptance Test.
- F. Prior to checkout of the I/O to the HMI, the PCSS shall thoroughly test all I/O from the field device to the PLC terminals, and verify the PLC is powered up and the PLC is communicating to the SCADA servers. After the PCSS has successfully tested all I/O from the field devices to the PLC terminals, the PCSS and AES Supplier shall jointly test all I/O from the HMI to the field device. Should this test prove to be unsuccessful, the PCSS and AES Supplier shall test from the HMI to the terminations located in the Owner's termination cabinet, and the PCSS shall inform the Owner in writing of the discrepancy with the existing field wire.
- G. Computer-Manual (i.e., Remote-Manual) start/stop, open/close commands of all devices controlled by the SCADA system shall be verified jointly by the PCSS and AES Supplier during the ORT. Subsequent to verification of Computer-Manual control, the PCSS may request from the Owner and Engineer permission to begin replacement of the next PLC. Simultaneously, the AES Supplier may continue with Computer-Automatic testing to confirm the control strategies were implemented as specified.
- H. For all panels with enclosures (new and existing) modified by this contract, heat load tests shall be performed to ensure proper cooling/ventilation is being provided.

- I. Upon successful completion of the ORT, the PCSS shall submit a record copy of the test results to the Owner and Engineer and request the scheduling of the FDT as noted in the following section.

3.05 *FIELD TESTING - FUNCTIONAL DEMONSTRATION TEST (FDT)*

- A. Prior to startup and the 30-day Site Acceptance Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the ORT. The FDT will be a joint test by the PCSS and the AES Supplier.
- B. Once a process area has been started up and is operating, a witnessed FDT shall be performed on that system to demonstrate that it is operating and is in compliance with these Specifications. A witnessed FDT shall be performed on each process area. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
- C. Loop-specific and non-loop-specific tests shall be the same as specified under WFT, except that the entire installed system shall be tested and all functions demonstrated using live field-based data to the greatest extent possible.
- D. Updated versions of the documentation specified to be provided for during the factory tests shall be made available to the Engineer at the job site both before and during the tests. In addition, one copy of all O & M Manuals shall be available for reference at the job site, both before and during testing.
- E. The daily schedule specified to be followed during the factory tests shall also be followed during the FDT.
- F. During the FDT, a demonstration of communication failure and recovery shall be accomplished. This test shall be scheduled and coordinated with Owner's personnel to minimize the impact on plant operations.
- G. Following initial startup, the entire process control system shall operate for a continuous 100 hours without failure before this test will be started.
- H. Punchlist items and resolutions noted during the test shall be documented on the Punchlist/Resolution form. In the event of rejection of any part or function test procedure, the PCSS shall perform repairs, replacement, and/or retest within 10 days.
- I. Upon successful completion of the FDT, the PCSS shall submit a record copy of the test results to the Owner and Engineer and request the scheduling of the SAT as noted in the following section.

3.06 *FIELD TESTING - 30-DAY SITE ACCEPTANCE TEST (SAT)*

- A. After completion of the Operational Readiness and Functional Demonstration Tests, the system shall undergo a 30-day Site Acceptance Test (SAT), under conditions of full plant process operation, without a single non-field-repairable malfunction. The SAT will be a joint test by the PCSS and the AES Supplier.

- B. During this test plant operations, PCSS personnel and AES Supplier personnel shall be present as required to address any potential issues that would impact the overall system operation. The PCSS is expected to provide personnel for this test who have an intimate knowledge of the hardware, software, field wiring and network configuration of the system. The AES Supplier is expected to provide personnel for this test who have an intimate knowledge of the software programming of the system. When PCSS personnel are not on-site, the PCSS shall provide cell phone/pager numbers that Owner personnel can use to ensure that support staff are available by phone and/or on-site within four hours of a request by operations staff.
- C. While this test is proceeding, the Engineer and Owner's Agent shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain the responsibility of Owner and the decision of plant operators regarding plant operations shall be final.
- D. Any malfunction during the tests shall be analyzed and corrections made by the AES Supplier for software programming issues, and the PCSS for hardware, software, field wiring and network configuration issues. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- E. Any malfunction during this 30 consecutive day test period which cannot be corrected by the PCSS's personnel within 24 hours of occurrence, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction. Upon completion of repairs by the PCSS, the SAT will be re-started from the date which the PCSS successfully corrected the malfunction(s) and the Owner and Engineer have accepted and signed off on the repairs.
- F. The PCSS shall perform repairs or replacement within 10 days in the event of rejection of any part or function of the hardware, software, field wiring and network configuration systems.
- G. All data base, process controller logic, and graphical interface system errors must be functioning as required per the specifications prior to the start of each test period. The 30-day test will not be considered successful until all data base points and logic functions are tested and verified to be correct.
- H. The total availability of the system shall be greater than 99.5 percent during this test period. Availability shall be defined as: $\text{Availability in percent} = 100 * (\text{Total Testing Time} - \text{Down Time}) / \text{Total Testing Time}$
- I. Down times due to power outages or other factors outside the normal protection devices or backup power supplies provided shall not contribute to the availability test times above.
- J. Throughout the duration of the 30-day SAT, no software or hardware modifications shall be made to the system without prior approval from the Owner and Engineer.
- K. Upon successful completion of the 30-day operation test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the warranty period shall commence.

- L. Certification of Installation: Following successful completion of the 30-day test, the PCSS shall issue a Certification of Installation. Certification shall be on PCSS corporate letterhead and signed by an officer of the firm. Certification shall state that the process control system has been completed in conformance with plans and specifications. Certification shall be submitted to the Engineer as specified herein.

END OF SECTION

SECTION 40 50 30

WATER QUALITY ANALYZERS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes requirements for materials, testing, and installation of chlorine residual analyzer and pH/temperature analyzers.

1.2 RELATED WORK

- A. Section 26 05 00– Basic Electrical Materials and Methods
- B. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- C. Section 26 05 53 – Electrical Identification
- D. Section 40 50 00 – Instrumentation and Controls General Provisions
- E. Section 40 50 01 – I&C Testing

1.3 REFERENCES

- A. International Society of Automation (ISA)

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00.
- B. Submit manufacturer's catalog data and detail drawings showing dimensions, materials of construction, measurement range, electrical interfaces and protocols, and mounting requirements.
- C. Submit list of accessories and instrument options.

1.5 MATERIALS

- A. All materials in contact with potable water shall be certified to ANSI/NSF Standard 61.

PART 2 PRODUCTS

2.1 GENERAL

- A. Wherever possible and feasible, components shall be of electronic solid-state design and systems shall utilize the same signal characteristics throughout each and all of the several systems; transmission signals shall be 4 mA to 20 mA. The combined power supply and transmitter loops shall, when tested with appropriate precision resistors, present a voltage signal of 1- to 5-volt DC.

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- B. Signal isolators shall be provided where required.
- C. All products shall be UL listed.

2.2 PH ANALYZERS

- A. Provide pH sensor with a combination pH/reference electrode with temperature compensation. The sensor shall be flow-through type. The sensor shall consist of a sensor housing with 3/4-inch NPT male connection, electrodes, reference junction, and 10 feet of interconnecting cable.
- B. Provide LCD indicating analyzer transmitter including integral preamplifier with solid-state electronics for continuous pH and temperature measurement of an aqueous solution over the range of 2 to 12. All readings shall be automatically compensated for temperature variations between 32°F and 212°F with an accuracy of ± 0.01 pH units. Provide output signal of 4- to 20-mA d-c for remote indication or control. The analyzer shall utilize a four-wire transmitter. Housing shall be NEMA 4X suitable for wall, panel, or 2-inch pipe stand mounting.
- C. The pH sensor shall be that manufactured by Rosemount Model 3900pH with indicating analyzer transmitter Model 1056 pH or equal.
- D. Furnish mounting hardware as shown in drawings. Otherwise provide mounting hardware as recommended by manufacturer. Materials shall be 304 stainless steel or fusion bonded epoxy carbon steel unless otherwise noted in drawings. Anchors and fasteners shall be 316 stainless steel.

2.3 AMPEROMETRIC FREE CHLORINE ANALYZER

- A. The chlorine residual analyzer and controller shall be the following manufacturer's with no equal.
 - 1. Hach CLF10sc with sc200 controller and pH sensor
- B. The analyzer shall provide continuous measurement of the free chlorine residual via amperometric measurement technology.
- C. The free chlorine analyzer shall use a bare electrode type cell with a flow cell assembly and internal flow regulator. The analyzer shall also have a pH sensor in the flow cell to provide a pH compensated free chlorine measurement without the use of a buffer.
- D. The analyzer shall be housed in a NEMA 4X enclosure.
- E. The analyzer shall be microprocessor-based with solid state circuitry and shall output a proportional 4 to 20 mA signal linear to free chlorine residual.
- F. The analyzer shall include a built-in simulator to verify calibration, analog to digital signal conversion, processing, outputs, and alarms.

- G. The analyzer shall include built in self-diagnostics to display error messages including questionable calculation results, insufficient data, excessive input noise, input measurement, or calculated results out of range.
- H. The analyzer shall include a minimum of three standard optically isolated 4 to 20 mA analog outputs, field programmable over any portion of the analyzer range.
- I. The analyzer shall incorporate two standard SPDT relay alarms, with contacts rated for 5 amp resistive loads at 115V AC power. Alarm options shall include concentration set point, analyzer system warning, and analyzer system shut down.
- J. The analyzer shall provide automatic compensation for the samples temperature.
- K. Performance requirements:
 - 1. Measurement range: Selectable but not less than 0 to 5 mg/L free or total residual chlorine.
 - 2. Accuracy: $\pm 2\%$ of full scale ± 0.01 mg/L, whichever is greater.
 - 3. Precision: 5% of reading or 0.01 mg/L, whichever is greater
 - 4. Sensitivity: 0.01 mg/L or 1 % of full scale, whichever is greater.
 - 5. Repeatability: 0.01 mg/L or 2 % of full scale, whichever is greater.
 - 6. Stability: 2% percent of full scale for 1 month.
 - 7. Response Time:
 - a. Free Chlorine: 90% of change within 20 seconds after sample entry
 - 8. Sampling rate: Continuous.
 - 9. Sampling flow:
 - a. Free Chlorine: 33 ± 5 lph
 - 10. Inlet pressure: 2 to 60 psi.
 - 11. Inlet sample temperature:
 - a. Free Chlorine: 32 to 122 degrees F

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide Manufacturer's services at the jobsite for one day to advise during start-up, testing, and adjustment of the equipment; and to instruct the Owner in the proper operation of the equipment.

3.2 *FIELD OR SITE QUALITY CONTROL*

- A. Operate each analyzer using the built-in simulator for two hours to simulate the full range of operating conditions and test alarm responses.

3.3 *INSTALLATION*

- A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents.
- B. All items shall be mounted and anchored using Type 316 stainless steel hardware unless otherwise noted.
- C. All instruments shall be rigidly secured to walls or a backboard as shown on the drawings.

END SECTION

SECTION 40 51 50

CONTROL PANELS AND PANEL MOUNTED EQUIPMENT

PART 1 — GENERAL

1.01 SCOPE OF WORK

- A. Refer to Section 40 50 00.
- B. Furnish and install control panels and panel mounted equipment as specified herein and shown on the Drawings.
- C. All new panels and panel components shall match existing equipment makes and models wherever possible, so that system additions can be most easily integrated with respect to operation and maintenance training, spare parts inventory, and service contracts. Even when exact matches are not possible, equipment furnished must be fully compatible with the existing system. Color, size, and material of new panels should conform to that of existing panels.
- D. Furnish the following panels and consoles. Each panel shall be supplied with full sub-panels and side panels as required.

1.02 RELATED WORK

- A. Refer to Section 40 50 00.

1.03 SUBMITTALS

- A. Refer to Section 40 50 00.

1.04 COORDINATION MEETINGS

- A. Refer to Section 40 50 00.

1.05 REFERENCE STANDARDS

- A. Refer to Section 40 50 00.

1.06 QUALITY ASSURANCE

- A. Refer to Section 40 50 00.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 40 50 00.

1.08 NOMENCLATURE AND IDENTIFICATION

- A. Refer to Section 40 50 00.

1.09 MAINTENANCE

- A. Refer to Section 40 50 00.

1.10 SPARE PARTS AND TEST EQUIPMENT:

- A. Refer to Section 40 50 00.

1.11 *WARRANTY*

- A. Refer to Section 40 50 00.

PART 2 - PRODUCTS

2.01 *GENERAL*

- A. Refer to Section 40 50 00.

2.02 *LIGHTNING/SURGE PROTECTION*

- A. Refer to Section 40 50 00.

2.03 *CONTROL PANEL GENERAL REQUIREMENTS*

- A. The dimensions within this Section and on the Contract Drawings are for general reference only. Ensure that final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as specified herein and in the Contract Documents.
- B. Each control panel and terminal cabinet shall bear the UL label. The UL label shall apply to the enclosure, the specific equipment supplied with the enclosure, and the installation and wiring of the equipment within and on the enclosure. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and any other equipment necessary to achieve compliance with UL 508 requirement. The Drawings do not detail all UL 508 requirements.
- C. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.
- D. The devices designated for rear-of-panel mounting shall be arranged within the panel according to respective panel drawings and in a manner to allow for ease of maintenance and adjustment. Heat generating devices such as power supplies shall be located at or near the top of the panel.
- E. The panels shall be completely fabricated, instruments and devices installed and wired at the PCSS's facility.
- F. All components shall be mounted in a manner that shall permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with manufacturer's recommendations. The internal components shall be identified with suitable plastic or metal engraved nametags mounted adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and PCSS's data.
- G. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.

H. Nameplates

1. All panels and panel devices shall be supplied with suitable nameplates, which identify the panel and individual devices as required. Unless otherwise indicated, each device nameplate shall include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).
2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, nameplates shall be 3/32-inch thick, black and white, Lamicoid with engraved inscriptions. The letters shall be Black [White] against a White [Black] background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.
3. Nameplate fasteners and mounting shall be epoxy adhesive or stainless steel screws for cabinet mounted nameplates
4. For every panel, provide a panel nameplate with a minimum of 1" high letters. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights, and meters.
5. Single lamicoid nameplates with multiple legends shall be used for grouping of devices such as selector switches and pilot lights that relate to one function.

I. Mounting Elevations

1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.
2. Centerline of indicators and controllers shall be located no lower than 48-inches or higher than 66-inches above the floor on a panel face.
3. Centerline of lights, selector switches, and pushbuttons shall be located no lower than 32-inches or higher than 70-inches above the floor on a panel face.
4. Tops of annunciators shall be located no higher than 86-inches above the floor on a panel face.
5. Installation of panel components shall conform to component manufacturers' guidelines.

2.04 PANEL MATERIALS AND CONSTRUCTION

A. Structure and Enclosure

1. Panels shall be of continuous welded-steel or FRP construction as shown on the Panel Schedule. Provide angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting

without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation.

2. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with a three-point stainless steel latch and heavy duty stainless steel locking handle. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments.
3. The panels, including component parts, shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.
4. The panel shall be suitable for top and bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry, the panel top shall be provided with nominal one-foot square removable access plates, which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, and other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.
5. All panels in indoor, dry, non-corrosive environments shall be NEMA 12 unless otherwise noted. All panels in outdoor, wet, and non-chemically corrosive environments shall be NEMA 4 unless otherwise noted. Panels in chemically corrosive environments shall be NEMA 4X unless otherwise noted. All panels located in a hazardous location shall be rated for the type of hazard (e.g., NEMA 7 for Class 1, Division 1).

B. Freestanding and Floor-Mounted Vertical Panels

1. Freestanding and floor-mounted vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of sheet steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated panels shall be constructed of 316 stainless steel. Front panels or panels containing instruments shall be not less than 10 gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.

C. Wall and Unistrut Mounted Panels

1. All wall and Unistrut mounted panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of not strength. All NEMA 4X rated wall mounted panels shall be constructed of 316 stainless steel.

D. Finish Requirements

1. All sections shall be descaled, degreased, filled, ground and finished. The enclosure when fabricated of steel shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish

which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels will not require a paint finish.

2. The panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.
 3. Immediately after cleaning, one coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and top coat of a two-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.
 4. Apply a minimum of two coats of flat white lacquer on the panel interior after priming.
 5. Unless otherwise noted, the finish exterior colors shall be ANSI 61 gray with a textured finish.
- E. Print storage pockets shall be provided on the inside of each panel. The storage pockets shall be steel, welded on to the door, and finished to match the interior panel color. The storage pocket shall be sufficient to hold all of the prints required to service the equipment, and to accommodate 8.5 inch by 11 inch documents without folding.
- F. Where specified on the Panel Schedule, a folding shelf shall be provided on the inside of the door on all free-standing and floor-mounted panels. The shelf shall be suitable for a laptop computer and shall be placed such that an open laptop computer does not interfere with any door-mounted devices. The folded shelf shall not interfere with any internal panel components when the door is closed. The folding shelf shall automatically lock in the horizontal position when raised. The folding shelf shall be approximately 18 inches wide by 12 inches deep and shall have a minimum distributed load rating of 100 pounds. All parts shall be made of heavy gauge steel and shall be painted white or finished to match the interior panel color.

2.05 ENVIRONMENTAL CONTROL

- A. All panels shall be provided with louvers, sun shields, heat sinks, forced air ventilation, or air conditioning units as required to prevent temperature buildup inside of panel. The internal temperature of all panels shall be regulated to a range of 45 Deg F to 104 Deg F under all conditions. Under no circumstances shall the panel cooling or heating equipment compromise the NEMA rating of the panel.
- B. PCSS shall submit heat dissipation calculations for every control panel.
- C. Except for panels mounted with their backs directly adjacent to a wall, louvers shall be in the rear of the panels, top and bottom, and shall be stamped sheet metal construction.
- D. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides.

- E. Forced air ventilation fans, where used, shall provide a positive internal pressure within the panel, and shall be provided with washable or replaceable filters. Fan motors shall operate on 120-volt, 60-Hz power.
- F. For panels with internal heat that cannot be adequately dissipated with natural convection and heat sinks, or forced air ventilation, an air conditioner shall be provided.
- G. Provide custom fabricated sun shields for all outdoor panels in accordance with the following requirements:
 - 1. Sun shields shall be fabricated from minimum 12 gauge aluminum. Units shall be designed, fabricated, installed, and supported to fully cover and shade the top, sides and back of the enclosure, and to partially shade the front panel of the enclosure, from direct exposure to sunlight from sunrise to sunset.
 - 2. Depending on overall size, sun shields may be fabricated in single or multiple segments for attachment to the enclosure support framing or to separate free standing framing around the enclosure.
 - 3. Sun shields shall not be attached directly to the enclosure by drilling holes through, or welding studs to, the enclosure surfaces, and shall be designed and mounted to provide a minimum 3-inch air gap all around the enclosure for air circulation and heat dissipation.
 - 4. The top section of all sun shields shall be sloped at a minimum angle of 5 degrees from horizontal. For wall mounted enclosures, the top section shall slope downward away from the wall and towards the front of the enclosure. For free standing, floor mounted and frame mounted enclosures the top section shall slope downward towards the back side of the enclosure.
 - 5. The front edge of the top section of all sun shields shall incorporate a narrow and more steeply sloped drip shield segment which sheds water away from the front of the enclosure and prevents it from dripping or running directly onto the front panel of the enclosure.
 - 6. All seam welds used in sun shield fabrication shall be continuous and shall be ground smooth.
 - 7. All exposed corners, edges and projections shall be smooth rounded or chamfered to prevent injury.
- H. All outdoor enclosures and enclosures located in unheated areas indoors or in areas subject to humidity and moisture shall be provided with an integral heater, fan, and adjustable thermostat to reduce condensation and maintain the minimum internal panel temperature. Mount the unit near the bottom of the enclosure with discharge away from heat-sensitive equipment. Heater shall be Hoffman DAH [100] [200] [400] [800] Watts, [115] [230] Volt, 50/60 HZ or equal.

2.06 CONTROL PANEL - INTERNAL CONSTRUCTION

A. Internal Electrical Wiring

1. All interconnecting wiring shall be stranded, type MTW, and shall have 600 volt insulation and be rated for not less than 90 degrees Celsius. Wiring for systems operating at voltages in excess of 120 VAC shall be segregated from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Panel layout shall be developed such that technicians shall have complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.
2. Power distribution wiring on the line side of fuses or breakers shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 16 AWG minimum. Electronic analog circuits shall utilize 18 AWG shielded, twisted pair, cable insulated for not less than 600 volts.
3. Power and low voltage DC wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 6-inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.
4. Terminations
 - a. All wiring shall terminate onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable.
 - b. Multi-level terminal blocks or strips are not acceptable.
 - c. Terminal blocks shall be arranged in vertical rows and separated into groups (power, AC control, DC signal). Each group of terminal blocks shall have a minimum of 25 percent spares.
 - d. Terminal blocks shall be the compression type, fused, unfused, or switched as shown on the Contract Drawings or specified elsewhere in Division 40.
 - e. Discrete inputs and outputs (DI and DO) shall have two terminals per point with adjacent terminal assignments. All active and spare PLC and controller points shall be wired to terminal blocks.
 - f. Analog inputs and outputs (AI and AO) shall have three terminals per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. All active and spare PLC and controller points shall be wired to terminal blocks.
 - g. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers.

- h. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.
 - i. Circuit power from the SCADA cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards shall be isolated with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. Isolation switch block shall be an Allen Bradley Model 1492-H7 or equal. One isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.
 - j. All PLC discrete outputs to the field shall be isolated with an isolating fuse switch terminal block with a flip cover and a neon blown fuse indicator. The single circuit fusible terminal block shall be an Allen Bradley 1492-H4 or equal.
5. All wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection, shall be clearly identified as such.
6. All wiring shall be clearly tagged and color coded. All tag numbers and color coding shall correspond to the panel wiring diagrams and loop drawings prepared by the PCSS. All power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. The color coding scheme shall be:
- a. Incoming 120 VAC Hot - Black
 - b. 120 VAC Hot wiring downstream of panel circuit breaker – Red
 - c. 120 VAC Hot wiring derived from a UPS system – Red with Black stripe
 - d. Three phase power – Brown, Orange, Yellow, and Green ground or as specified in Division 26.
 - e. 120 VAC neutral - White
 - f. Ground - Green
 - g. DC power or control wiring – Blue
 - h. DC analog signal wiring – Black (+), White (-)
 - i. Foreign voltage – Yellow
7. Provide surge protectors on all incoming power supply lines at each panel per the requirements of Section 40 50 00.
8. Each field instrument furnished under Division 40 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power

distribution circuit with a circuit breaker or fuse and blown fuse indication. All instruments requiring 120VAC power shall be powered from the UPS source in the panel where the instrument signals lands.

9. Provide 24VDC power supplies to power field instruments and panel devices. 24VDC power supplies shall be as specified in this Section.
10. Use of adhesive backed cable tie mounts is not acceptable. Cable ties shall be permanently fixed to the panel structure, as needed for controlling cable routing within the panel.
11. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.
12. Each panel shall have a single tube, fluorescent light fixture, 20 Watt in size, mounted internally to the ceiling of the panel. Light fixture shall be switched and shall be complete with the lamp.
13. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate cover. Convenience receptacle shall not be powered from a UPS and shall be protected by a dedicated fuse or circuit breaker.
14. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.
15. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
16. Each panel shall have control, signal, and communication line surge suppression in accordance with Section 40 50 00.
17. All microprocessor-based electronic devices in the panel that are powered by 120VAC shall be powered by the UPS (refer to appropriate Section in Division 40).
18. Each panel shall be provided with a circuit breaker to interrupt incoming power. Provide a minimum of two (2) spare 20-amp breakers.
19. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 26.

B. Pneumatic Tubing

1. Refer to Section 40 50 00.

2. Pneumatic tubing shall be a minimum of 1/4-inch O.D. 316 stainless steel with compression fittings. All tubing shall be rigidly supported and run in horizontal or vertical planes.
 3. All pneumatic equipment shall be provided with separate shut-off valves. Flexible polyethylene tubing shall be used on all devices mounted on hinged doors, etc.
 4. A screened vent shall be provided on all enclosures using pneumatic instruments.
 5. All pneumatic tubing shall be routed in separate bundles or wireways, and shall be separated from all electrical wiring by a minimum of 3-inches.
- C. Relays not provided under Division 26 and required for properly completing the control function specified in Division 40, Division 26, or shown on the Drawings shall be provided under this Section.
- D. The orientation of all devices including PLC and I/O when installed shall be per the manufacturer's recommendations. No vertical orientation of PLC racks shall be allowed unless specifically indicated by the manufacturer as an acceptable mounting alternative and also approved by the engineer.
- E. Purge system for enclosures located in hazardous areas.

2.07 *ELECTRICAL COMPONENTS*

- A. Refer to Division 26.
- B. The control panel shall be provided with a main power circuit breaker and individual fuses for each 120VAC and 24VDC logical circuit.
- C. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Contract Drawings.
- D. The control panel shall be provided with a lightning and surge protection unit on the line side of the main circuit breaker. Unit shall be 600 Volt, 3 Phase, General Electric "Tranquell" Series, or equal.

2.08 *GENERAL PURPOSE RELAYS AND TIME DELAYS*

- A. Type:
1. General purpose plug-in type.
- B. Functional:
1. Contact arrangement/function shall be as required to meet the specified control function; mechanical life expectancy shall be in excess of 10 million.
 2. Duty cycle shall be rated for continuous operation; Units shall be provided with integral indicating light to indicate if relay is energized.

3. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
4. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.

C. Physical:

1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide contacts rated 5 amps at 28 VDC, for electronic (milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service; relays shall be provided with dust and moisture resistant covers.

D. Options/Accessories Required:

1. Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
2. Provide mounting rails/holders as required.

E. Manufacturer(s):

1. IDEC.
2. Allen Bradley.
3. Potter & Brumfield.
4. Equal.

2.09 *SIGNAL RELAY SWITCHES (CURRENT TRIPS)*

A. Type:

1. Solid state, ASIC technology, electronic type.

B. Functional:

1. Input: 4-20 mA.
2. Output: Isolated contact output, double pole double throw, rated 5 amps at 120 VAC.
3. Accuracy: 0.1 percent.
4. Protection: Provide RFI protection.
5. Deadband: Adjustable between 0.1 and 5.0 percent of span.

6. Set point Adjustment: Single Point alarms shall be adjustable to trip on rising or falling input signal, dual point alarms shall be adjustable to trip on rising and falling input signals.
7. Repeatability: Trip point repeatability shall be at least 0.1 percent of span.

C. Physical:

1. Mounting: DIN rail.

D. D. Manufacturer(s):

1. Action Instruments Slim Pak.
2. Acromag.
3. Equal.

2.10 *SIGNAL ISOLATORS/BOOSTERS/CONVERTERS*

A. Type:

1. Solid state, ASIC technology; electronic type.

B. Functional:

1. Accuracy: 0.15 percent.
2. Inputs: Current, voltage, frequency, temperature, or resistance as required.
3. Outputs: Current or voltage as required.
4. Isolation: There shall be complete isolation between input circuitry, output circuitry, and the power supply.
5. Adjustments: Zero and span adjustment shall be provided.
6. Protection: Provide RFI protection.

C. Physical:

1. Mounting: DIN rail.

D. Manufacturer(s):

1. Action Instruments Slim Pak.
2. Acromag.
3. Equal.

2.11 *SIGNAL SELECTORS, COMPUTATION, AND CONDITIONING RELAYS*

A. Type:

1. Solid state, ASIC technology, electronic type.

B. Functional:

1. Inputs: 4-20 mA.
2. Outputs: 4-20 mA.
3. Protection: Provide RFI protection.
4. Operation: The relay shall multiply, add, subtract, select, extract the square root, or perform the specified conditioning/ computation function required. All inputs shall be able to be individually rescaled and biased as Required.
5. Isolation: All inputs, outputs, and power supplies shall be completely isolated.
6. Accuracy: 0.35 percent of span.
7. Adjustments: Multi turn potentiometer for zero, span, scaling, and biasing.

C. Physical:

1. Mounting: DIN rail.

D. Manufacturer(s):

1. Action Instruments Slim Pak.
2. Acromag.
3. Equal.

2.12 *INTRINSICALLY SAFE RELAYS*

A. Type:

1. Relays shall be of the solid state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe usage in hazardous areas.

B. Options Required:

1. Relays shall match power supply provided.
2. Relays shall be located in non-hazardous areas.

C. Manufacturer(s):

1. Consolidated Electric.

2. Gems Safe-Pak.
3. Warrick Controls.
4. R. Stahl, Inc.
5. Equal.

2.13 INTRINSIC SAFETY BARRIERS (FOR 2-WIRE TRANSMITTER SYSTEMS)

- A. Intrinsic safety barriers shall be passive devices requiring no external voltage supply and supplied with series resistors, series fuse and shunt zener diodes to limit the transfer of energy to levels required by intrinsically safe protection between safe and hazardous locations.
- B. Unit shall be Factory Mutual approved and certified for use in accordance with National Fire Protection Association (NFPA 493).
- C. Manufacturer(s):
 1. P&F.
 2. Gems.
 3. Unitech.
 4. Equal.

2.14 24 VDC POWER SUPPLIES

- A. Provide a 24 VDC power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.
- B. The 24 VDC power supply shall meet the following requirements:
 1. Input power: 115 VAC, plus or minus 10 percent, 60 Hz.
 2. Output voltage: 24 VDC.
 3. Output voltage adjustment: 5 percent.
 4. Line regulation: 0.05 percent for 10 volt line change.
 5. Load regulation: 0.15 percent no load to full load.
 6. Ripple: 3 mV RMS.
 7. Operating temperature: 32 to 140 degrees Fahrenheit.
- C. Size the 24 VDC power supply to accommodate the design load plus a minimum 25 percent spare capacity.

- D. If power supply on/off status signal is shown, provide a relay contact (internal to the power supply or external if the power supply is not so equipped) to indicate on/off status of the power supply.
- E. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.
- F. Mount the 24 VDC power supply such that dissipated heat does not adversely affect other panel components.

- G. Manufacturer(s):
 - 1. Phoenix Contact – Quint Series
 - 2. PULS.
 - 3. Lambda.
 - 4. Equal.

PART 3 -EXECUTION

3.01 INSTALLATION

- A. The panels shall be installed at locations as shown on the Contract Drawings.
- B. Refer to Section 40 50 00.

3.02 TESTS

- A. Refer to Section 40 50 00.

END OF SECTION

SECTION 40 64 01

CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Programmable logic controller (PLC) based control systems hardware.
 - 2. Development software to be used with the specified PLC hardware.

1.02 REFERENCES

- A. Institute of Electrical and Electronics Engineers (IEEE).
- B. National Electrical Manufacturers Association (NEMA).

1.03 DEFINITIONS

- A. Specific definitions:
 - 1. CPU: Central processing unit.
 - 2. HART: Highway addressable remote transducer. A protocol that allows multiple layers of transmitter process variables and data to be transmitted to the controller.
 - 3. HMI: Human Machine Interface: typically a visual monitor that displays the status and values of the process and equipment.
 - 4. I/O: Input/Output.
 - 5. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
 - 6. PID: Portional-Integral-Derivative, software based loop controller
 - 7. PC: Personal computer.
 - 8. PLC: Programmable Logic Controller
- B. Specific definitions:

1. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.
2. Application software: The software that is programmed specifically for the Project.

1.04 SYSTEM DESCRIPTION

- A. Provide all PLC hardware as indicated on the Drawings and as specified in this Section.

1.05 SUBMITTALS

- A. Product data:
 1. CPU:
 - a. Processor type.
 - b. Processor speed.
 - c. Memory.
 - d. Internal processor battery backup time.
 2. I/O modules:
 - a. Type.
 - b. Standard wiring diagram.
- B. Calculations:
 1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.
 2. Submit calculations to verify that spare I/O requirements of this Section are met.
 3. Submit calculations to verify that PLC power supply requirements of this Section are met.
- C. Control logic:
 1. Fully annotated copy of programmed PLC logic.
 2. Cross-referenced index of all PLC registers or points.
- D. Provide application software for the specific Project process requirements.

1. Fully annotated copy of programmed PLC logic in its native format.
2. Cross-referenced index of all PLC registers or points.

1.06 QUALITY ASSURANCE

A. Additional requirements:

1. Provide PLC system components by a single manufacturer:
 - a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
2. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE

A. Furnish the following:

1. CPU: 1 spare for each type of CPU in the system.
2. I/O cards: 3 spares for each type of I/O card in the system.
3. Power supplies: 2 spares for every power supply in the system.
4. Network/communications cards: 1 spare for every network or communications card in the system.

5. Chassis: 1 spare for each chassis size in the system.
 6. Communication cable: 1 spare for each type of cable used in the system.
- B. Installed spare requirements:
1. I/O points:
 - a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC.
 - b. Wire all spare I/O points to field terminal blocks in the same enclosure the PLC resides in.
 2. PLC backplane capacity:
 - a. Provide 25-percent or 3 spare backplane slots, whichever is greater, in all racks containing I/O.
 3. PLC memory:
 - a. Provide 50-percent spare program volatile memory.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. The following, no equal:
1. Rockwell Automation:
 - a. CompactLogix Model number 5380, Cat No.5069-L320ER.
 - b. No equal.
- B. The PLC programming software system shall be manufactured by PLC hardware manufacturer:
1. Rockwell Software:
 - a. RSLogix 5000. Version is to be Determined by client.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Programmable logic controller:

1. General:

a. Design the PLC system to function as a standalone unit that performs all of the control functions described in this Section completely independent from the functions of the HMI system PC-based operator interfaces:

1) Failure of the HMI system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.

2. CPU:

a. Configure each CPU so that it contains all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.

b. Capable of interfacing with all discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.

c. Capable of supporting and implementing closed-loop floating-point math and PID control that is directly integrated into the CPU control program.

3. Memory:

a. Non-volatile memory: On-board complementary metal-oxide-semiconductor (CMOS), electrically erasable programmable read-only memory (EEPROM), PCMCIA, compact flash card, or SD card.

b. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:

1) Reserve capacity:

a) Totally free from any system use.

2) Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.

4. Programming:

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- a. Provide a system where processors are programmed by:
 - 1) Portable laptop computer both locally and via the PLC control network.
5. PLC power supply:
 - a. Input: 120 VAC.
 - b. Mounted in the PLC housing or as indicated on the Drawings.
 - c. Sized to power all modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.
6. PLC input/output, I/O modules:
 - a. General:
 - 1) Compatible with all of the PLCs being furnished under the contract and by the same manufacturer as the PLCs.
 - 2) Provide I/O modules that:
 - a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
 - b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
 - c) Accept dual-ended inputs.
 - 3) The use of common grounds between I/O points is not acceptable.
 - 4) Provide at each PLC the I/O modules for the following:
 - a) Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
 - b) Wire all spares provided to the field terminal strip.
 - 5) Condition, filter, and check input signals for instrument limit conditions.
 - 6) Filter, scale, and linearize the raw signal into an engineering-units-based measurement.
 - 7) Alarm measurements for high, low, rate-of-change limits, and alarm trends.

- 8) Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.
 - 9) When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.
- b. Discrete input modules:
- 1) Defined as contact closure inputs from devices external to the input module.
 - 2) Provide inputs that are optically isolated from low-energy common-mode transients to 1,500 volts peak from users wiring or other I/O modules.
 - 3) Individually isolated inputs.
 - 4) With LEDs to indicate status of each discrete input.
 - 1) Input voltage: 120VAC.
 - 5) Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:
 - a) Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.
- c. Discrete output modules:
- 1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
 - a) Triac outputs may be used, with the permission of the Engineer. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
 - 2) Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.
 - 3) LEDs to indicate status of each output point.
 - 4) Output voltage: 24VDC.
 - 5) Individually isolated outputs.

- d. Analog input modules:
 - 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
 - 3) The analog-to-digital conversion updated with each scan of the processor.
 - 4) Individually isolated each input.
 - 5) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.

- e. Analog output modules:
 - 1) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
 - 2) Individual isolated output points each rated for loads of up to 1,000 ohms.
 - 3) HART analog input module:
 - a) Channels per module: 4 minimum.
 - b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
 - c) Each channel can individually have HART enabled or disabled.
 - d) Flash-upgradeable firmware.
 - e) Mounts in slot in PLC backplane.
 - f) Modules shall be configured using the specified PLC programming software.
 - 4) HART analog output module:
 - a) Channels per module: 4 minimum.
 - b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
 - c) Each channel can individually have HART enabled or disabled.

- d) Flash-upgradeable firmware.
- e) Mounts in slot in PLC backplane.
- f) Modules shall be configured using the specified PLC programming software.

7. Communications modules:

a. Network and Radiocommunications modules:

1) General:

- a) Install communications modules in the PLC backplane.

2) Ethernet:

- a) Ports: 1 RJ-45.
- b) Communication rate: 10 Mbit/s.
- c) Rockwell ControlLogix - 1756-EN2T.

- 3) Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.

B. PLC programming software:

Manufacturer: Rockwell Studio 5000

- 1. Licensed to the Owner.
- 2. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
 - a. Monitor devices at each drop on the PLC data network for proper communications.
- 3. Generate a PLC program printout, which is fully documented, through the PLC programming software:
 - a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.
 - b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.

- c. Use a mnemonic associated with each contact, coil, etc. that describes its function.
 - d. Utilize the tag and loop identification as contained in the P&IDs:
 - 1) If additional internal coils, timers, etc. are used for a loop, they shall contain the loop number.
 - e. Provide a cross-reference report of program addresses.
4. Software functions automatically without operator intervention, except as required to establish file names and similar information:
- a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:
 - 1) Respond to demands from a program request.
 - 2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
 - 3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.
 - 4) Queuing of requests in order of priority if one or more requested resources are unavailable.
 - 5) Resolution of contending requests for the same resource in accordance with priority.
 - 6) Service requests for execution of one program by another.
 - 7) Transfer data between programs as requested.
 - 8) Management of all information transfers to and from peripheral devices.
 - 9) Control and recovery from all program fault conditions.
 - 10) Diagnose and report real-time hardware device errors.
5. Program execution:
- a. Application software - program execution scheduled on a priority basis:
 - 1) A multilevel priority interrupt structure is required.
 - 2) Enter into a list of pending programs a program interrupted by a higher priority program:

- a) Resume its execution once it becomes the currently highest priority program.
 - 3) Schedule periodic programs.
 - 4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.
6. Start-up and restart:
- a. Provide software that initializes and brings a PLC or any microprocessor-based hardware unit from an inactive condition to a state of operational readiness.
 - b. Initialization:
 - 1) Determination of system status before start-up of initializing operating system software and initializing application software.
 - 2) Loading of all memory-resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.
7. Shutdown:
- a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.
 - b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
 - c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
 - d. Alarm PLC failure at the operator interface level.
8. Diagnostics:
- a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
 - b. Use the manufacturer's standard diagnostic routines as much as possible.
 - c. Furnish diagnostic software and test programs for each significant component in the control system.
 - d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.

9. Calendar/time program:
 - a. The calendar/time program to update the second, minute, hour, day, month, and year and transfer accurate time and date information to all system-level and application software.
 - b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
 - c. The operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
10. Algorithms:
 - a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
 - b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
 - c. Algorithms must include alarm checks where appropriate.
 - d. Provide, as a minimum, the following types of algorithms:
 - 1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
 - 2) A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.
 - 3) A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supports both direct and reverse-acting modes.
 - 4) Lead, lag, dead time, and ratio compensators.
 - 5) Integration and totalization of analog process variables.
11. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
 - a. In addition, provide spare database points for future expansion.
12. One integrated database can be utilized for all types of analog points or separate databases for each type; in either case, the database for each point must include all specified aspects.
13. All portions of the database must be available for use by the display, report, and other specified software modules.

14. All of the data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all of the features and functions defined below. The analog database software must support the following functions and attributes:
 - a. Analog input signal types:
 - 1) Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
 - b. Input accuracy:
 - 1) Inputs must be read with an accuracy of within 0.05-percent full-scale or better.
 - 2) Data conversion errors must be less than 0.05-percent full-scale.
 - 3) Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once per minute.
 - 4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.
 - c. Blocking:
 - 1) Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.
 - 2) For any input so blocked, the operator may manually enter a value to be used as the input value.
 - d. Filtering:
 - 1) For each analog input, provide a first order lag digital filter with an adjustable filter factor.
 - e. Linearizing:
 - 1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.
 - f. Calculated values:

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- 1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated values, constants, etc.
 - 2) These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.
- g. Scaling and zero suppression:
- 1) Provide a conversion program to convert input values into engineering units in a floating-point format.
- h. Alarms:
- 1) Provide an alarm program to check all analog variables against high-high, high, low, and low-low alarm limits.
 - 2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.
 - 3) Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.
 - 4) Must be possible to inhibit alarms based on external events, e.g., lock-out low pump flow alarm when the pump is off.
- i. Averages:
- 1) Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.
 - 2) Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.
 - 3) Update hourly averages each minute or at the polling interval for the selected variable.
 - 4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
 - 5) Update monthly averages at least once each day and calculate using the results of the daily averages.
 - 6) At the end of each averaging period, store the average values for the period on the hard disk for historical record-keeping and reset the present period average register to the present value of the variable.
 - 7) The active database must include the present period average and previous period average for each variable and averaging period.

j. Totals:

- 1) Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.
- 2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
- 3) Assign a separate factor for each totalizing interval.
- 4) Variables for which totalization is inappropriate must have scaling factors of zero.
- 5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record-keeping and reset the present period totalization register to zero.
- 6) The active database must include the present period total and previous period total for each variable and totalizing period.

k. Engineering units:

- 1) Provide software to allow the system and the operator to convert all the measured analog variables to any desired engineering units.
- 2) The operator must be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in gpm, mgd, cfs, and acre-feet per day.
- 3) Pre-program the conversion of the engineering units, and, if not pre-programmed, the operator must be able to program new engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.
- 4) The programming method must be at a level and compatible with the specified training of the operator and the Owner's personnel.
- 5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.

l. Control modules:

- 1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
- 2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.

- 3) Provide control algorithms for manual control with output values adjustable by the operator.
 - m. Analog outputs:
 - 1) Analog outputs must be maintained as part of the database.
 - 2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.
 15. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.
- C. General control functions:
1. Analog control functions:
 - a. PID, lead/lag, signal select, alarm, limit, delay, and time base.
 - b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.
 - c. All math utilities must be linkable to process data points or manual inputs via control block configuration.
 - d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.
 2. Discrete control functions:
 - a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.
 3. Software support:
 - a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.
 - b. Call each function as required by the configured controls to perform the intended function.
 4. Control and status discrepancies:
 - a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.

- 1) For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator-programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.
 - b. Involuntary change in the device's status must also generate an alarm:
 - 1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
 - c. Each command, status, and alarm must cause the color of the symbol to change.
 - d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:
 - 1) Delay periods for each final control element must be adjustable at the operator interface.
 - 2) List all time delays in the final documentation.
 5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.
- D. Control configuration:
1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.
 2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, setpoints, tuning constants, etc.
 3. Provide a mechanism to link separate control functions together into an integrated control strategy.
 4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.
 5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU, and to upload them to the operator interface for operational record-keeping.
 6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. As specified in Section 40 61 00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. ~~(NOT APPLICABLE) As specified in Section 40 61 00 - Common Work Results for Process Control and Instrumentation Systems.~~
- B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
 - 1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.
- C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.
- D. General:
 - 1. The control system logic program shall reside at the PLC level.
- E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.
- F. Program the PLC logic using the following language(s):
 - 1. Ladder Diagram.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

- A. Provide a minimum of 4 CD/DVD/USB copies of the following:
 - 1. Application software:
 - a. Finalized fully annotated copy of programmed PLC logic in its native format.
 - b. Cross-referenced index of all PLC registers or points.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

- A. Tailor training specifically for this Project that reflects the entire control system installation and configuration.
- B. Perform training by pre-approved and qualified representatives of the ICSC and/or manufacturer of the PLC hardware and programming software:
 - 1. A representative of the ICSC may perform the PLC hardware training only if the representative has completed the manufacturer's training course for the PLC hardware.
 - 2. A representative of the ICSC may perform the PLC programming software training only if the representative has completed the manufacturer's training course for the PLC programming software.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

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SECTION 40 66 70

CONTROL SYSTEMS: WIRELESS COMMUNICATIONS - RADIO

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PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Radio and antenna product data and submittal requirements.

1.02 REFERENCES

A. American Concrete Institute (ACI):

1. 318 - Building Code Requirements for Structural Concrete.

B. ASTM International (ASTM):

1. A475 - Standard Specification for Zinc-Coated Steel Wire Strand.
2. A586 – Standard Specification for Metallic-Coated Parallel and Helical Steel Wire Structural Strand.

C. Code of Federal Regulations (CFR):

1. Title 47 – Telecommunication.

D. Institute of Electrical and Electronics Engineers (IEEE):

1. 802.11 – Wireless LAN Standards.

E. International Electrotechnical Commission (IEC).

F. International Society of Automation (ISA).

G. National Electrical Code, (NEC).

H. National Electrical Manufacturer's Association Standards, (NEMA).

I. National Fire Protection Association (NFPA):

1. 79 – Electrical Standard for Industrial Machinery.

J. Telecommunications Industry Association (TIA):

1. 222 - Structural Standard for Antenna Supporting Structures and Antennas and Small Wind Turbine Support Structures.
2. 1019 – Installation, Alteration, and Maintenance of Antenna Supporting Structures and Antennas.

1.03 DEFINITIONS

- A. Specific definitions:
1. AGL: Above ground level.
 2. ASL: Above sea level.
 3. Antenna CL: Antenna center line mounting height.
 4. BER: Bit error rate, a unitless measure of the number of bit errors that occur in a given number of bit transmissions.
 5. CPM: Critical path method.
 6. dB: Decibel, a relative expression representing a change in radio frequency power.
 7. dBi: A decibel referenced against an isotropic radiator.
 8. dBd: A decibel referenced to a dipole antenna.
 9. dBm: A decibel referenced to 1 milliwatt (mW).
 10. Direct Sequence Spread Spectrum (DSSS): A spread-spectrum technology used in IEEE 802.11 and IEEE 802.11b/g used to achieve data rates up to 2 Mbps.
 11. EIRP: Effective isotropic radiated power.
 12. Fade margin: The amount of margin left to allow for the natural variations in radio performance, which will occur due to weather, air density, etc.
 13. Fade margin: The difference between the received signal level at the input to the receiver and the sensitivity of the receiver.
 14. FCC: Federal Communications Commission.
 15. Fresnel zone: The area around the line-of-sight that radio waves spread out into after being transmitted by the antenna.
 16. FRN: FCC Registration Number.
 17. ITS: Institute for Telecommunications Science.
 18. LOS: Line of Sight.
 19. Radio Path Survey: In-field wireless communication site survey performed by the radio sub-contractor during the preliminary construction phase of the project.

20. Receiver Sensitivity: The minimum signal power level with an acceptable Bit Error Rate (in dBm or mW) that is necessary for the receiver to accurately decode a given signal.
21. RF: Radio frequency.
22. RSSI: Receive signal strength intensity.
23. SIM: Subscriber identity module.
24. WLAN: Wireless local area network.

1.04 SYSTEM DESCRIPTION

- A. System must be in accordance with the following:
 1. Code of Federal Regulations:
 - a. CFR Title 47:
 - 1) Part 15 - Unlicensed Spread Spectrum.
 - 2) Part 90 - UHF Radio Systems – Subpart C and J.
 - 3) Part 101 - Fixed Microwave Services.
 - a) Subpart H – Private Operational Fixed Point-to—Point Microwave Service.
 - b) Subpart O – Multiple Address Systems.
 2. NFPA 79, Annex “D” Standards.
 3. NEC.
 4. NEMA.
 5. ISA.
 6. IEC.
 7. State and Local code requirements.
 8. TIA 1019.
- B. Owner will provide a list of aggregation sites and remote sites during construction. For bidding purposes, assume 10 aggregation sites and 80 remote sites.
- C. Provide new radios, antenna, antenna cable and mounting hardware and accessories, surge protection, and any additional components to provide a complete and functioning radio link.

1. Owner will provide the services of a radio consulting firm for installation signal strength testing.

1.05 SUBMITTALS

- A. Submit product data for all components of the radio communication system:
 1. Radio.
 2. SIM card(s).
 3. Antenna.
 4. Cables between radio and antenna.
 5. All other related accessories.
 6. Communication port type and quantity.
 7. Installation details for each component indicated above.
 8. For each type of radio/antenna:
 - a. Provide operating mode setup, encryption, and polling configuration information.
 9. Block diagram showing the location of each component of the radio communication system.
 10. Radio link map associated with each site.
- B. Submit structural calculations demonstrating that the system complies with the design criteria as indicated on the Drawings:
 1. Antenna mounting structure.
 2. Anchorage of support structure to foundation.
 3. Foundation.
 4. Antenna mounting structure height.
 5. Wind/Seismic requirements.

1.02 QUALITY ASSURANCE (NOT USED)

1.03 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.04 PROJECT OR SITE CONDITIONS (NOT USED)

1.05 SEQUENCING (NOT USED)

1.06 SCHEDULING (NOT USED)

1.07 WARRANTY

- A. Provide a minimum of 1 year of warranty from substantial completion date for all wireless communication equipment.

1.08 SYSTEM START-UP (NOT USED)

1.09 OWNER'S INSTRUCTIONS (NOT USED)

1.10 COMMISSIONING (NOT USED)

1.11 MAINTENANCE

- A. Furnish all parts, materials and additional components necessary for maintenance and calibration purposes for 1 year:
 - 1. Deliver all supplies before Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Radio:
 - 1. Licensed radio:
 - a. Provide the following, no equal:
 - 1) General Electric, Orbit LN4 Series.
 - a) MCR for aggregation sites
 - b) ECR for remote sites
- B. Transmission cables:
 - a. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact.
 - 2) Teledesign Systems.

- 3) FreeWave.
- 4) Telewave, Inc., ANT Series.
- 5) CommScope:
 - a) HELIAX Cable Products.
- 6) Times Microwave Systems.

C. Surge protectors:

1. Manufacturers: One of the following or equal:
 - a. CommScope:
 - 1) T Series Surge Arrestors.
 - 2) Gas Tube Surge Arrestors.
 - b. Phoenix Contact, Trabtech Series.
2. As specified in Section 40_67_01 - Control Systems: Panels, Enclosures, and Panel Components.

D. Antennas:

1. Radio antennas:
 - a. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact.
 - 2) Teledesign Systems.
 - 3) Telewave, Inc., ANT Series.
 - 4) Kathrein Scala.
 - 5) CommScope.
 - 6) Microwave Data Systems, Clearwave Series.

2.02 MANUFACTURED UNITS

A. Licensed radio system:

1. General:
 - a. The radio system comprises the following:

- 1) Wireless radio(s).
 - 2) Antennas.
 - 3) Surge protectors.
 - 4) Transmission cables.
 - 5) Software and other accessories as specified in the Components article.
 - 6) Protocol conversion modules as indicated on the Drawings.
2. Performance requirements:
- a. Frequency: 400 MHz band
 - b. Ambient temperature range: -20 to 60 degrees Celsius.
 - c. Enclosure protection class:
 - 1) IEC IP20.
3. Bi-directional (2-way) system:
- a. Transceiver:
 - 1) Carrier power: 0.1 to 5 W, programmable.
 - 2) Power supply: 10.5 - 24 VDC.
- B. Transmission cables characteristics:
1. 1/2-inch, nominal diameter.
 2. Continuous section without splices or connectors other than at the radio and antenna.
 3. Cable length: As indicated on the Drawings, path study report, or as required to reuse existing conduit path.
 4. Cable characteristics:
 - a. Attenuation: Less than 2.2 dB at 960 MHz per 100 feet.
 - b. Characteristic impedance: 50 ohms.
 - c. Coaxial shield.
 - d. Dielectric: Foam.

C. Antennas:

1. Radio antenna characteristics:

a. Yagi antenna:

- 1) Frequency range: 440-470 MHz.
- 2) Nominal impedance: 50 ohm.
- 3) Connector: N-Type.
- 4) Gain: 9 dB
- 5) Construction material: All welded aluminum.
- 6) Operating temperature:
 - a) Stationary: -40 to 85 degrees Celsius.
 - b) Cyclic: -40 to 55 degrees Celsius.

b. Omni-directional antenna characteristics:

- 1) Frequency range: 440-470 MHz.
- 2) Nominal impedance: 50 ohm.
- 3) Connection: N-type.
- 4) Gain: 6 dB.
- 5) Construction material: All welded aluminum.
- 6) Operating temperature: -40 to 75 degrees Celsius.

2.03 EXISTING PRODUCTS

- A. Mount all new antennas to existing antenna mounting structures.

2.04 MATERIALS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Antenna accessories:

1. Provide all required mounting accessories required for installation, such as clamps, brackets adapters, and related hardware for a complete installation.

- a. Mounting guidelines shall be provided in the installation details indicated in the Drawings and as recommended by the manufacturer.
2. Provide mounting hardware to meet the wind and seismic requirements at the Project Site.
- B. Provide lightning surge arrestors and data line surge protection for radios or antennas located outdoors.
- C. Provide antenna cables, connectors and related hardware for a complete installation.
- D. Provide din-rail mounting adapters required for installation of radios in control panels/communication cabinets, as needed for each application.
- E. Software:
 1. Provide software package for radio diagnostic testing.
 2. Provide radio configuration via a secured wireless or wired ethernet network.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Tag and label terminal blocks, radio system components and associated wiring as indicated in the Drawings.

3.04 ERECTION, APPLICATION, AND CONSTRUCTION

- A. Install new antennas, mounting hardware and accessories on existing antenna support structures or as indicated in the Drawings.

- 3.05 REPAIR/RESTORATION (NOT USED)**
- 3.06 RE-INSTALLATION (NOT USED)**
- 3.07 COMMISSIONING (NOT USED)**
- 3.08 FIELD QUALITY CONTROL (NOT USED)**
- 3.09 ADJUSTING (NOT USED)**
- 3.10 CLEANING (NOT USED)**
- 3.11 DEMONSTRATION AND TRAINING (NOT USED)**
- 3.12 PROTECTION (NOT USED)**
- 3.13 SCHEDULES (NOT USED)**

END OF SECTION

SECTION 40 67 01

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

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PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
 - a. Custom built instrumentation and control panels, including all enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
 - b. Control components.
 - c. Control panel installation.
- B. Provide all control panels identified in Contract Documents.

1.02 REFERENCES

- A. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
 - 2. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
 - 3. 802.3at - Standard for Information Technology -- Local and Metropolitan area networks -- Specific requirements -- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements.
- B. International Electrotechnical Commission (IEC):
 - 1. 61643-11 - Low-Voltage Surge Protective Devices - Part 11: Surge Protective Devices Connected to Low-Voltage Power Systems - Requirements and test methods.
 - 2. 61643-21 - Low-Voltage Surge Protective Devices - Part 21: Surge Protective Devices Connected to Telecommunications and Signaling Networks - Performance Requirements and Testing Methods.
- C. Underwriters Laboratories Inc. (UL):
 - 1. 248-14 - Low-Voltage Fuses - Part 14: Supplemental Fuses.

2. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
3. 508 - Standard for Industrial Control Equipment.
4. 508A - Standard for Industrial Control Panel.
5. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
6. 913 - Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.
7. 1077 - Standard for Supplementary Protectors for Use in Electrical Equipment.
8. 1283 - Standard for Electromagnetic Interference Filters.
9. 1449 - Standard for Surge Protective Devices.

1.03 DEFINITIONS

A. Specific definitions:

1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.04 SUBMITTALS

A. Provide a control panel hardware submittal for each control panel and enclosure being provided on this project, including but not limited to:

1. Product data:
 - a. Enclosure construction details and NEMA type.
 - b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
2. Shop drawings:
 - a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
 - 1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
 - b. Complete nameplate engraving schedule.
 - c. Structural details of fabricated panels.
3. Calculations:
 - a. Provide installation details based on calculated shear and tension forces:

- 1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
- b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
 - 1) Weight including panel internal components.
 - 2) Seismic forces and overturning moments.
 - 3) Shear and tension forces in connections.
- c. Cooling calculations, including but not limited to:
 - 1) Highest expected ambient temperature for the enclosure's location.
 - 2) Internal heat load.
 - 3) Exposure to direct sunlight.
 - 4) Dimensions of the enclosure in inches.
 - 5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

B. Seismic design:

1. Seismic panel construction:
 - a. Seismic anchorage: Provide seismic design calculations and installation details for anchorage of all panels, enclosures, consoles, etc. to meet seismic requirements in Section 01_81_02 - Seismic Design Criteria:
 - 1) Stamped by a Professional Engineer registered in the state where the project is being constructed.
 - b. For floor-mounted freestanding panels weighing 200 pounds or more (assembled, including contents), submit calculations, data sheets, and other information to substantiate that panel, base, and framing meet minimum design strength requirements and seismic requirements as specified in Section 01_81_02 - Seismic Design Criteria. Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

1.05 QUALITY ASSURANCE

- A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
 1. Provide all components and equipment with UL 508 listing.

2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling:
3. Provide fuses for all equipment that is not UL or UR listed.
4. Install all intrinsically safe circuits and equipment in accordance with UL698A.

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS (NOT USED)

1.08 SEQUENCING (NOT USED)

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY (NOT USED)

1.11 SYSTEM START-UP (NOT USED)

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 COMMISSIONING (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. As listed below in the individual component paragraphs.
- B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.02 SYSTEM DESCRIPTION

- A. Panel dimensions:
 1. Minimum dimensions are scalable from or as **indicated on the Drawings** and are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or manufacturer to design and size all panels:
 - a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
 - b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes **indicated on the Drawings** must be approved by the Engineer.

- c. Maximum panel depth: 30 inches, unless otherwise indicated.

2.03 EXISTING PRODUCTS

- A. Provide labor and materials for complete modifications to existing panels as required.
- B. Field cut and refinish existing panel faces to original condition to accommodate installation of new instruments, removal of existing instruments, and fitting of blanks to suit new layouts. New instrument supports shall be provided as required for complete installation.

2.04 MATERIALS

- A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
 - 1. Enclosures shall have the following properties:
 - a. NEMA Type 1: Steel.
 - b. NEMA Type 4: Steel with gasketed door, raintight.
 - c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is **indicated on the Drawings**).
 - d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.
 - e. NEMA Type 12: Steel with gasketed door, dusttight.
 - f. NEMA Type 7: Cast aluminum.
 - B. Bolting material:
 - 1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
 - 2. Carriage bolts for attaching end plates.
 - 3. All other bolted joints shall have S.A.E. standard lock washers.

2.05 MANUFACTURED UNITS

- A. Panels/enclosures:
 - 1. Manufacturers: One of the following or equal:
 - a. Rittal.
 - b. nVent/Hoffman.

- c. Saginaw Control & Engineering.
- d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.
- e. Door construction:
 - 1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
 - 2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
 - 3) Heavy-gauge stainless steel hinges.
 - 4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
 - 5) Gasket installed to seal against roll lip on the enclosure opening.
- f. Latches:
 - 1) For panels, provide each door with a 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
 - a) Provide padlock for each enclosure with padlock provisions.
 - 2) Include an oiltight key-locking, 3-point latching mechanism on each door:
 - a) Provide 2 keys per panel.
 - b) All locks keyed alike.
 - 3) For cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.
- g. Panel cut-outs:
 - 1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
 - 2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.
 - 3) Reinforce around cut-outs with steel angles or flat bars for the following:

- a) Large panel cutouts; for example, openings for local operator interfaces.
 - b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.
 2. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
 - a. Minimum 14-gauge, Type 304 stainless steel.
 - b. Captive stainless steel cover screws threaded into sealed wells.
 - c. Inside finish: White polyester powder coating.
 - d. Specifically designed for use with flange-mounted disconnect handles where required or as **indicated on the Drawings**.
 - e. NEMA Type 4X powder-coated stainless steel enclosures are not an acceptable substitute for stainless steel unless **indicated on the Drawings**.
 3. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
 - a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
 - b. Door hardware: Stainless steel.
 - c. Provide factory installed rain canopy and sun shield for all enclosures with operator interface panels.
 - d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.
- B. Arrangement of components:
1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
 2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as **indicated on the Drawings**.
 3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
 4. All control panel mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:

1. Main overcurrent device:

a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:

- 1) Door-mounted disconnect handles are not acceptable.
- 2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
- 3) Provide means to defeat the interlock.
- 4) Lockable in the off position.

b. Control panels supplied with 120 VAC:

- 1) Provide an internal breaker with the line side terminals covered by a barrier.
- 2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
- 3) Provide a nameplate prominently positioned on the control panel stating "CAUTION Risk of Electric Shock – UPS equipment outputs remain energized with main disconnect in off position" for any panel containing a UPS.

2. Molded Case Circuit Breakers:.

3. Selection and ratings of protective devices:

- a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
- b. Voltage rating: Not less than the voltage of the application.
- c. Select current rating and trip characteristics to be suitable for:
 - 1) Maximum normal operating current.
 - 2) Inrush characteristics.
 - 3) Coordination of the protective devices to each other and to the source breaker feeding the panel.

- d. Circuit breakers, fuses, and motor overcurrent protection devices used for branch circuit protection must be UL 508A compliant.
 - 1) Circuit breakers listed under UL 1077 Standard for Supplementary Protectors that do not comply with UL 508A requirements are not acceptable.
 - 2) Miscellaneous, miniature, and micro fuses listed under UL 248 Part 14 that do not comply with UL 508A requirements are not acceptable.
 - 3) Manual motor controllers provided with an instantaneous-trip overcurrent mechanism listed under UL 508 that do not comply with UL 508A requirements are not acceptable.
- 4. Provide a separate protective device for each powered electrical device:
 - a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
 - b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
 - 1) Size external fuse to open before any I/O-card-mounted fuses.
 - c. Individual discrete inputs shall use a 1/2-ampere fuse.
 - d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
- 5. Fuses for 4 to 20 milliamperes signals:
 - a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
 - 1) Label shall not cover or interfere with equipment manufacturer's instructions.
 - b. An individual 1/2-ampere fuse for each 4-to-20 milliamperes analog loop powered from the control panel.
 - c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
 - d. Manufacturers: One of the following or equal:
 - 1) Ferraz Shawmut.
 - 2) Littelfuse.
 - 3) Bussmann.
- 6. Fuse holders:

- a. Modular type:
 - 1) DIN rail mounting on 35-millimeter rail.
 - 2) Touch-safe design: All connection terminals to be protected against accidental touch.
 - 3) Incorporates blown-fuse indicator.
 - 4) Plug-in style fuse terminals and fuse plugs are not acceptable.
 - b. Provide nameplate identifying each fuse:
 - c. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, UT4-HESI Series.
 - 2) Allen-Bradley, 1492-FB Series B.
7. Control circuit breakers:
- a. DIN rail mounting on 35-millimeter rail.
 - b. Manual OPEN-CLOSE toggle switch.
 - c. Rated for 250 VAC.
 - d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
 - e. Current ratings: As required for the application.
 - f. Provide nameplate identifying each circuit breaker:
 - g. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, TMC Series.
 - 2) ABB.
 - 3) Allen-Bradley.
 - 4) Square D.
8. Electronic circuit protectors:
- a. Used where a NEC Class 2 power circuit is required to protect devices with NEC Class 2 power supplies.

- b. DIN rail mounting on 35-millimeter rail.
- c. Rated for 24 VDC.
- d. 4 channels to feed 4 independent power feeds to separate devices.
- e. Output current ratings: As required for the application.
- f. LED input status indication.
- g. LED failure status of each channel indication.
- h. Fail contacts.
- i. Provide nameplate identifying each circuit electronic circuit protector module:
- j. Manufacturers: One of the following or equal:
 - 1) Rockwell Automation 1692-TD014.
 - 2) Puls PISA11 series.

D. Conductors and cables:

- 1. Power and control wiring:
 - a. Materials: Stranded, soft annealed copper.
 - b. Insulation: 600 volts type MTW.
 - c. Minimum sizes:
 - 1) Primary power distribution: 12 AWG.
 - 2) Secondary power distribution: 14 AWG.
 - 3) Control: 16 AWG.
 - d. Color:
 - 1) AC power (line and load): Black.
 - 2) AC power (neutral): White.
 - 3) AC control: Red.
 - 4) AC control: Orange for foreign voltages.
 - 5) DC power and control (ungrounded): Blue.
 - 6) DC power and control (grounded): White with Blue stripe.

7) Ground: Green.

2. Signal cables:

- a. Materials: Stranded, soft annealed copper.
- b. Insulation: 600 volts, PVC outer jacket.
- c. Minimum size: 18 AWG paired triad.
- d. Overall aluminum shield (tape).
- e. Copper drain wire.
- f. Color:

1) 2-Conductor:

- a) Positive (+): Black.
- b) Negative (-): White and red.

2) 3-Conductor:

- a) Positive (+): Black.
- b) Negative (-): Red.
- c) Signal: White.

- g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:

- 1. Identify each conductor and cable with unique wire numbers
- 2. Readily identified without twisting the conductor.

F. General wiring requirements:

- 1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
- 2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
- 3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.

4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
5. Provide power surge protection for all control panels.
6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
7. Provide non-metallic ducts for routing and organization of conductors and cables:
 - a. Provide wiring separation plan.
 - b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
 - c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
 - 1) 120 VAC: Grey colored ducts.
 - 2) 24 VDC: White colored ducts.
8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
 - a. Screw-on cable tie mounts.
 - b. Hammer-on cable-tie mounting clips.
 - c. Fingers of the nonmetallic duct.
9. Wire ties:
 - a. No wire ties inside wire duct.
 - b. Use Panduit Cable tie installation tool, with tension control/cutoff.
 - c. Verify cut ends are cut flush filed smooth after installed.
10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
11. Support panel conductors where necessary to keep them in place.
12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:

- a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
- a. Solenoid valves.
 - b. Instruments both mounted in the control panel and remotely connected to the control panel.
- G. Provide power circuits for all Contractor and Vendor-furnished PLC cabinets in accordance with the PLC and Instrument Power wiring diagrams **Indicated on the Drawings** or as specified.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

- A. Thermal management:
1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range of the most temperature and humidity sensitive component.
 2. Air conditioner:
 - a. Provide solid-state cabinet coolers or air conditioning units on all outdoor panels containing electronic components such as local operator interfaces, panel instruments, programmable logic controllers, or remote I/O.
 - b. Provide filters on intake and exhaust openings.
 - c. Increase panel sizes as needed to accommodate cooling units.
 - d. Enclosure rating: NEMA Type 4X.
 - e. Power supply: 120 VAC.
 - f. Manufacturers: The following or equal:
 - 1) Kooltronic, Guardian DP Series.
 - 2) ICEcube, Blade series or IECEx/ATEX for Zone 1 & 2.
 3. Heating:
 - a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:

- 1) The panel is not supplied with 120 VAC power.
 - 2) There are no electronics or moisture-sensitive devices in the enclosure.
 - 3) The panel is smaller than 38 inches high.
4. Heat exchanger:
- a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
 - b. Filterless design to facilitate easy cleaning of the core.
 - c. Mounting: As **indicated on the Drawings**.
 - d. Manufacturers: The following or equal:
 - 1) Noren, CC Series.
 - 2) ICEcube, Blade series.
5. Enclosure temperature sensor as indicated on the Drawings:
- a. Provide wall-mounted RTD transmitter (to measure internal cabinet temperature) in all enclosures containing electrical components such as PLCs, RTUs, RIO, and VFDs.
 - b. Platinum RTD.
 - c. 4-20 mA DC output.
 - d. Sensor and electronic enclosure.
 - e. Accuracy: Within 2 degrees Fahrenheit.
 - f. Manufacturers: One of the following or equal:
 - 1) Omega, EWS Series.
 - 2) TCS Basys Controls, TS Series as indicated on the Drawings.
6. Enclosure temperature switch:
- a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
 - b. Sensor and electronic enclosure.
 - c. Accuracy: Within 2 degrees Fahrenheit.

- d. Single contact:
 - 1) Manufacturers: One of the following or equal:
 - a) nVent/Hoffman ATEMNC.
 - b) Pfannenberg FLZ.
- e. Dual contact:
 - 1) Manufacturers: The following or equal:
 - a) nVent/Hoffman ADLTEMP.
- 7. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
 - a. Provide as **indicated on the Drawings** or as specified.
- 8. Fan ventilation:
 - a. Provide nVent/Hoffman fan speed control:
 - 1) Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
 - 2) Provide finger-guard kit.
 - 3) Filter kit with 2 spare filters for each intake fan.
 - 4) Provide bezel and gasket kit.
 - 5) Provide fan shroud.
 - 6) Automatically adjust fan speed depending on remote temperature sensor input.
 - 7) 120 VAC, 60 hertz.
 - 8) NEMA Type 5-15R cord connections.

B. Panel meters:

- 1. Pointer type:
 - a. Suitable for panel mounting.
 - b. Minimum scale length: 3 inches.
 - c. Calibrated in engineering units.
 - d. Accuracy: Within 2 percent of span.

- e. NEMA Type 4/IP65 sealed front metal bezel.
 - f. Manufacturers: One of the following or equal:
 - 1) Yokogawa.
 - 2) Red Lion.
2. Digital process indicators:
- a. General:
 - 1) Integral provisions for scaling.
 - 2) Scale to process engineering units.
 - 3) Switch-programmable decimal points.
 - 4) NEMA Type 4/IP65 sealed front bezel.
 - b. Current and voltage indicators:
 - 1) 3-1/2-digit minimum.
 - 2) Minimum character height: 0.5 inches.
 - 3) Accuracy:
 - a) AC/DC volts: Within 0.1 percent of reading plus 2 digits.
 - b) DC current: 4-to-20 milliamperes; within 0.1 percent of reading plus 1 digit.
 - c) DC voltage: 0 to 10 volts; within 0.1 percent of reading plus 1 digit.
 - c. Operating voltage: 120 VAC.
 - d. Operating temperature: 32 degrees to 140 degrees Fahrenheit.
 - 1) Manufacturers: One of the following or equal:
 - a) Red Lion, PAX
 - b) Action Instruments, Visipak.
- C. Pilot devices:
- 1. General:
 - a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.

- b. Size:
 - 1) 30.5 millimeters.
- c. Heavy duty.
- d. Pushbuttons:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
- e. Selector switches:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - b) Knob type.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
 - 3) Provisions for locking in the OFF position where lockout provisions are **indicated on the Drawings.**
- f. Pilot lights:
 - 1) Type:
 - a) LED for interior installations.
 - 2) Push to test.
 - 3) Lamp color:
 - a) On/Running/Start: Red.
 - b) Off/Stop: Green.
 - c) Power: White.
 - d) Alarm: Amber.
 - e) Status or normal condition: White.
 - f) Opened: Red.
 - g) Closed: Green.

- h) Failure: Red.
2. Indoor and outdoor areas:
 - a. NEMA Type 4/13.
 - b. Manufacturers: One of the following or equal:
 - 1) Allen-Bradley, Type 800T.
 - 2) Schneider Electric, Class 9001, Type K.
 - 3) General Electric, Type CR104P.
 - 4) IDEC, TWTD Series.
 3. Corrosive areas:
 - a. NEMA Type 4X.
 - b. Corrosion resistant.
 - c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.
 - d. Manufacturers: One of the following or equal:
 - 1) Cutler Hammer, Type E34.
 - 2) Schneider Electric, Class 9001, Type SK.
 - 3) Allen-Bradley Type 800H.
 - 4) IDEC, TWTD Series.
 4. Hazardous (Classified) Areas/Class I Division 2:
 - a. NEMA Type 4X.
 - b. Corrosion resistant.
 - c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:
 - 1) All contacts contained within a hermetically sealed chamber:
 - a) Pushbuttons.
 - b) Selector switches.
 - c) Push-to-test contacts on pilot lights.

- 2) UL listed and labeled for Class I Division 2 areas.
- d. Manufacturers: One of the following or equal:
 - 1) Cutler Hammer, Type E34.
 - 2) Allen-Bradley, Type 800H.
- D. Potentiometer and slidewire transmitters:
 - 1. Provide a DC output in proportion to a potentiometer input.
 - 2. Potentiometer input:
 - a. 100 ohms to 100 K ohms.
 - b. Impedance Greater or equal to 1 M ohms.
 - c. Zero turn-up: 80 percent of full-scale input.
 - d. Span turn-down: 80 percent of full-scale input.
 - 3. Field-configurable output:
 - a. Voltage and current: All conventional current loops and voltage control signals.
 - 4. Accuracy including linearity and hysteresis within 0.1 percent maximum at 77 degrees Fahrenheit.
 - 5. Operating temperature: 32 degrees to 131 degrees Fahrenheit.
 - 6. Supply power: 9 to 30 VDC.
 - 7. Manufacturers: The following or equal:
 - a. Phoenix Contact, Mini Analog Pro.
- E. Signal isolators and converters:
 - 1. Furnish signal isolators that provide complete isolation of input, output, and power input:
 - a. Minimum isolation level: 1.0 kilovolts AC/50 hertz for at least 1 minute.
 - b. Adjustable span and zero.
 - c. Accuracy: Within 1.0 percent of span.
 - d. Ambient temperature range: -4 degrees to 149 degrees Fahrenheit.

2. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, Mini Analog Pro.
 - b. Acromag, 1500, 600T, 800T, Flat Pack, or ACR Series.
 - c. Action Instruments, Q500 Series or Ultra SlimPakII.
 - d. AGM Electronics, Model TA-4000.
 - e. Moore Industries, MIT 4-Channel.

F. Relays:

1. General:
 - a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
 - b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
 - c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.
2. General purpose:
 - a. Magnetic control relays.
 - b. NEMA ratings:
 - 1) 300 volts.
 - 2) 10 Amps thermal continuous test current.
 - 3) 60 Amps make.
 - 4) 6 Amps break.
 - c. Plug-in type.
 - d. LED indication for energization status.
 - e. Coil voltages: As required for the application.
 - f. Minimum poles: DPDT.

- g. Touch-safe design: All connection terminals to be protected against accidental touch.
 - h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
 - i. Quantity and type of contact shall be as **indicated on the Drawings** or as needed for system compatibility.
 - j. Relays with screw-type socket terminals.
 - k. Provide additional (slave/interposing) relays when the following occurs:
 - 1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
 - 2) Higher contact rating is required in order to interface with starter circuits or other equipment.
 - l. DIN rail mounting on 35-millimeter rail.
 - m. Ice-cube-type relays with retainer clips to secure relay in socket.
 - n. Integrated label holder for device labeling.
 - o. Manufacturers: One of the following or equal:
 - 1) Potter and Brumfield: Type KRP or KUP.
 - 2) IDEC: R* Series (* = H, J, R, S, U).
 - 3) Allen-Bradley: Type 700 HC.
 - 4) Square D: Type K.
3. Terminal block relays:
- a. Magnetic control relays.
 - b. For use as an interposing relay for PLC based discrete I/O signals.
 - c. NEMA ratings:
 - 1) 250 volts.
 - 2) 6 Amps continuous.
 - 3) 1,500 volt-amperes make.
 - d. Plug-in type.
 - e. LED indication for energization status.

- f. Coil voltages: As required for the application.
 - g. Minimum poles: SPDT.
 - h. Touch-safe design: All connection terminals to be protected against accidental touch.
 - i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
 - j. Relays with screw-type socket terminals.
 - k. DIN rail mounting on 35-millimeter rail.
 - l. Integrated label holder for device labeling.
 - m. Manufacturer: One of the following or equal:
 - 1) Phoenix Contact PLC Series.
 - 2) Eaton XR TBR Series.
 - 3) IDEC RV8H Series.
 - 4) Allen-Bradley Type 700 HL TBR Series.
4. Latching:
- a. Magnetic-latching control relays.
 - b. NEMA ratings:
 - 1) 300 volts.
 - 2) 5 Amps continuous.
 - 3) 360 volt-amperes make.
 - 4) 320 volt-amperes break.
 - c. Plug-in type.
 - d. DIN rail mounting on 35-millimeter rail.
 - e. Coil voltage: As required for the application.
 - f. Minimum poles: 2 PDT; as required for the application. Plus 1 spare pole.
 - g. Touch-safe design: All connection terminals to be protected against accidental touch.
 - h. Clear cover for visual inspection.

- i. Provide retainer clip to secure relay in socket.
 - j. Manufacturers: One of the following or equal:
 - 1) Square D, 8501, Type K.
 - 2) IDEC, RR2KP Series.
5. Time delay:
- a. Provide time-delay relays to control contact transition time.
 - b. Contact rating:
 - 1) 240 volts.
 - 2) 10 Amps continuous.
 - 3) 3,600 volt-amperes make.
 - 4) 360 volt-amperes break.
 - c. Coil voltage: As required for the application.
 - d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off-delay:
 - 1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
 - e. Minimum poles: 2 PDT.
 - f. Units include adjustable dial with graduated scale covering the time range in each case.
 - g. Minimum timing range: 0.1 seconds to 10 minutes, or as required for the application.
 - h. Manufacturers: One of the following or equal:
 - 1) IDEC, RTE Series.
 - 2) Tyco Electronics, Agastat 7000 Series (pneumatic).
 - 3) Allen-Bradley, Type 700-HR.
- G. Terminal blocks:
- 1. DIN rail mounting on 35-millimeter rail.

2. Rated for 15 amperes at 600 volts.
 3. Screw terminal type.
 4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
 5. Finger-safe protection for all terminals for conductors.
 6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
 7. Terminals: Plainly identified to correspond with markings on the diagrams:
 - a. Permanent machine-printed terminal identification.
 8. Disconnect-type field signal conductor terminals with socket/screw for testing.
 9. Identify terminals suitable for use with more than 1 conductor.
 10. Position:
 - a. So that the internal and external wiring does not cross.
 - b. To provide unobstructed access to the terminals and their conductors.
 11. Provide minimum 25-percent spare terminals.
 12. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, UT4 Series.
 - b. Allen-Bradley, 1492 Series.
- H. DIN rail grounding:
1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
 - a. Mount to DIN rail via grounding foot with mounting screw.
 - b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
 - c. Not be used for grounding signal cable shields.
 2. Screw terminal type.
 3. DIN rail mounting on 35-millimeter rail.

4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
 5. Finger-safe protection for all terminals for conductors.
 6. Terminals: Plainly identified to correspond with markings on the diagrams:
 - a. Permanent machine-printed terminal identification.
 7. Manufacturers: One of the following or equal:
 - a. Phoenix Contact, USKLG Series.
 - b. Allen-Bradley, 1492-JG Series.
- I. Wire duct:
1. Provide flame retardant plastic wiring duct, slotted with dust cover.
 2. Type:
 - a. Wide slot.
 - b. Narrow slot.
 - c. Round hole.
 3. Manufacturers: The following or equal:
 - a. Panduit.
 - b. Phoenix Contact.
 - c. Thomas & Betts.
 - d. Iboco.
- J. DIN rail:
1. Perforated steel.
 2. 35 mm width.
 3. 15 mm deep.
 4. Provide 2-inch offset using one of the following:
 - a. Offset brackets.
 - b. Preformed standoff DIN Rail Channel.

K. Surge protection devices (SPD):

1. 120 VAC control panel power SPD:
 - a. Provide SPD for panel 120 VAC power entrances:
 - 1) Non-faulting and non-interrupting design.
 - 2) Provide line to neutral and neutral to ground surge protection.
 - b. Provide surge protection at secondary of main circuit breaker:
 - 1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
 - 2) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
 - c. DIN rail mounting.
 - d. Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
 - 1) Gastight connections.
 - 2) Visual status indication of MOV status on the input and output circuits.
 - 3) Dry contact rated for remote status indication.
 - e. Approvals:
 - 1) Tested in accordance with IEC 61643-11.
 - 2) Tested in accordance with UL 1283.
 - 3) Tested in accordance with UL 1449.
 - 4) Surge protection minimum requirements: Withstand a minimum 10-kA test current of an 8/20 μ s waveform in accordance with IEEE C62.41.1 Category C Area.
 - f. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, Type SFP Filter.
 - 2) ASCO, Model 277.
2. 24 VDC control panel power SPD:
 - a. Provide SPD for 24VDC power circuits.
 - b. Provide surge protection at DC power supply output.

- c. DIN rail mounting.
 - d. Attach wiring to the SPD by means of a screw-type cable clamping terminal block:
 - 1) Optical status indicator.
 - 2) Dry contact rated for remote status indication.
 - e. Approvals:
 - 1) Tested in accordance with IEC 61643-11.
 - f. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, Plugtrab PLT-SEC-T3-24-FM-UT.
3. Panel mounted control, signal, and data line SPD:
- a. General:
 - 1) This section applies to SPD located in a control panel, field panel, network junction box, or marshalling panel.
 - 2) Approvals:
 - a) Tested in accordance with IEC 61643-21.
 - b) Tested in accordance with UL 497B.
 - 3) SPD shall consist of 2 parts:
 - a) Base module:
 - (1) DIN rail mounting.
 - (a) Grounded to DIN rail via mounting rail foot.
 - b) Plug protection module:
 - (1) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
 - 4) Provide indirect shield ground style SPD unless otherwise noted.
 - 5) Provide ability to locally identify and indicate SPD health.

- 6) SPD shall be provided with controller module with dry contact for remote status monitoring of SPD device health.
 - 7) SPD modules shall be compatible with signal, communication bus type, data type, or control power being protected.
 - 8) Provide dedicated SPD for each signal, communication bus type, or data line being protected.
- b. Manufacturers: One of the following or equal:
- 1) Phoenix Contact, Plugtrab PT-IQ Series.
 - 2) Dehn, Blitzductor XTU Series.
4. Copper Ethernet SPD:
- a. Protects network equipment from lightning or other surge events.
 - b. Suitable for Gigabit networks.
 - c. Compatible with shielded Cat 6 cabling with shielded RJ-45 ports.
 - d. Compliant with PoE standards IEEE 802.3af and 802.3at.
 - e. Nominal discharge surge current: 10 kA.
 - f. Approvals:
 - 1) Tested in accordance with IEC 61643-21.
 - 2) Tested in accordance with UL 497B.
 - g. Manufacturers: One of the following or equal:
 - 1) Phoenix Contact, DT-LAN-CAT6+.
 - 2) Weidmuller, VDATA CAT6.
 - 3) Eaton/MTL, ZoneBarrier.
5. Field device mounted SPD:
- a. Conduit entry mounting.
 - 1) Provide parallel or through wiring configurations as required by the application.
 - a) Use parallel wiring configuration if there is an available cable gland at the device.

- b) Use through wiring configuration if there is no available cable gland at the device.
- 2) Provide Screw connections compatible with field device.
- b. NEMA 4X stainless steel material housing.
- c. Approvals:
 - 1) Tested in accordance with IEC 61643-21.
- d. 4-wire field device:
 - 1) Module shall provide simultaneous protection of signal cable, communication bus, or data line, and power supply line.
 - a) Maximum continuous voltage:
 - (1) DC:
 - (a) Signal: 32 VDC.
 - (b) Power supply: 255 VDC.
 - (2) AC:
 - (a) Signal: 22.6 VAC.
 - (b) Power supply: 255 VAC.
 - 2) Manufacturers: The following, engineer knows of no equal:
 - a) Endress+Hauser, HAW569-CB2C.
- e. 2-wire or 3-wire field device:
 - 1) Module shall provide protection for the signal cable, communication bus or data line.
 - 2) Manufacturers: One of the following or equal:
 - a) Endress+Hauser, HAW569 Series.
 - b) Phoenix Contact, Surgetrab S-PT Series.
 - c) Eaton/MTL, TP Series.
- L. Horns and beacons:
 - 1. Beacons/horn combination units:
 - a. Manufacturers: The following or equal:

- 1) Edwards, Multi-Status LED 108i with tone module.
 - b. LED Colors: Red, Green, and Amber.
 - c. Power: 120VAC.
 - d. Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
 - e. Horn rated 80 dB minimum at 10 feet.
2. Dedicated beacon unit:
 - a. Manufacturers: One of the following or equal:
 - 1) Federal Signal Corp., Starfire Series.
 - 2) Allen-Bradley, 855 B *-* 10 Series.
 - 3) Edwards, 102 Series.
 3. Dedicated horn unit:
 - a. Electromechanical:
 - 1) Manufacturers: One of the following or equal:
 - a) Federal Signal, 350 or 31X Series.
 - b) Edwards, 878EX or 879EX Series.
 - b. Electronic:
 - 1) Manufacturers: One of the following or equal:
 - a) Federal Signal, 300GCX or 300X Series.
 - b) Allen-Bradley, 855H or 855XH Series.
 - c) Edwards, 5530M or 5533MD Series.
 - c. Rated for 80 dB minimum at 10 feet.
- M. Power supplies:
1. Design power supply system so that either the primary or backup supply can be removed, repaired or replaced, and returned to service without disrupting the system operation.
 2. Convert 120 VAC to 24-volt DC or other DC voltages required or as required for the application.

3. Provide redundant backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure in either a 1+1 or N+1 configuration as required:
 - a. Provide automatic switchover upon module failure.
 - b. Alarm contacts monitored by the PLC.
5. Provide protective isolation between power supply units either by means of Diodes, Diode Modules, MOSFET Modules, or use power supplies with built in redundancy. Power supplies with built in redundancy must actively isolate each power supply and be designed as such.
6. Sized to provide 40-percent excess rated capacity.
7. UL 508C listed to allow full-rated output without de-rating.
8. Provide fuse or short-circuit protection.
9. Provide a minimum of 1 set of dry contacts for each power supply configured to change state on failure for monitoring and signaling purposes.
10. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change.
11. Operating temperature range: 32 degrees to 140 degrees Fahrenheit.
12. Touch-safe design: All connection terminals to be protected against accidental touch.
13. DIN rail mounting on 35-millimeter rail:
 - a. Mount the power supply in the proper orientation as recommended by the manufacturer to ensure adequate thermal dispersion without derating the power supply.
14. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
15. Manufacturers: One of the following or equal:
 - a. Fully redundant:
 - 1) Phoenix Contact, Quint Power Supply with SFB technology.
 - a) Phoenix Contact, Quint.
 - 2) IDEC, PS5R Series:

- 3) Sola.
- 4) PULS.
- b. Redundancy module:
 - 1) Phoenix contact, o-ring redundancy module.
- N. Limit switches:
 - 1. NEMA Type 4X.
 - 2. AC contact rating 120 volts, 10 A.
 - 3. DC contact rating 125 volts, 0.4 A.
 - 4. Provide robust actuation mechanism not prone to degradation.
 - 5. Provide complete actuator mechanism with all required hardware.
 - 6. Allows for contact opening even during contact weld condition.
 - 7. UL approved.
 - 8. Operating temperature range: 0 degrees to 230 degrees Fahrenheit).
 - 9. Manufacturers: One of the following or equal:
 - a. Allen-Bradley, 802 Series.
 - b. Honeywell, HDLS Series.
 - c. Omron, D4 Series.
 - d. Eaton, E47, E49, E50.
 - e. ABB.
- O. Current switches:
 - 1. Operate from 120-VAC supply voltage.
 - 2. 1 normally open and normally closed contacts.
 - 3. Adjustable current setting.
 - 4. Manufacturers: The following or equal:
 - a. Zelio, RM35.
 - b. Phoenix Contact, EMD Series.

P. Current transmitters:

1. Input current range: As indicated on Drawings.
2. Output: 4-20 mA.
3. Operate from 24 VDC supply voltage.
4. Output overload protected.
5. Accuracy: Within 0.5 percent Full-Scale.
6. Ripple and Noise: 1 percent Max., peak to peak.
7. Frequency: 50/60 hertz.
8. Manufacturer:
 - a. Phoenix Contact: Mini Analog Pro Series.
 - b. CR Magnetics: CR4320 series.
 - c. American Aerospace: 1070 Series.

Q. Panel mount quick connector:

1. Keyed insertion plug.
2. Threaded cap to protect connection when not in use.
3. Material: Stainless steel.
4. Pre-wired pigtails.
5. Indoor/Outdoor:
 - a. Rating: Meets or exceeds panel rating.
 - b. Manufacturers: One of the following or equal:
 - 1) Amphenol.
 - 2) Sealcon.
6. Hazardous (Classified) Areas:
 - a. UL listed and labeled for area as **indicated on the Drawings**.
 - b. Manufacturers: The following or equal:
 - 1) Amphenol HDE Series.

2.08 ACCESSORIES

- A. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.
- B. Provide floor stands or legs with a minimum height of 12 inches where needed or as **indicated on the Drawings**.
- C. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.
- D. Provide nameplate to each panel as **indicated on the Drawings**:
 - 1. Provide as specified in Section 26_05_53 - Identification for Electrical Systems on all internal and external instruments and devices.
 - 2. Provide a nameplate with the following markings that is plainly visible after installation:
 - a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
 - b. Supply voltage, phase, frequency, and full-load current.
 - c. Power source or circuit ID.
 - d. Short-circuit current rating of the panel based on one of the following:
 - 1) Short-circuit current rating of a listed and labeled assembly.
 - 2) Short-circuit current rating established utilizing an approved method.
- E. Provide a window kit where **indicated on the Drawings** or where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
 - 1. Safety plate glass.
 - 2. Secured by rubber locking seal.
 - 3. Allow full viewing of devices issuing visual process data or diagnostics.
- F. Lighting:
 - 1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
 - a. Covered or guarded.

- b. Provide On-Off door-activated switches where **indicated on the Drawings**.
- c. 120-volt, single-phase, 15-amp style plug.
- d. Provide 4,000 K, 900 Lumens - LED fixture.
 - 1) Provide additional fixtures for every 36 inches of width.

G. Receptacles:

- 1. Provide 1 duplex receptacle located every 6 feet of enclosure width, spaced evenly along the back mounting panels.
- 2. GFCI, 120-volt, single-phase, 15-amp style plug.
- 3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.

H. Grounding:

- 1. Provide the following:
 - a. Grounding strap between enclosure doors and the enclosure.
 - b. Equipment grounding conductor terminals.
 - c. Provide equipment grounding busbar with lugs for connection of all equipment grounding wires.
 - d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.
- 2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND," the letter "G," or the color green.
- 3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
- 4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
- 5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
- 6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
- 7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
- 8. Unless otherwise noted, connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.

9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
- I. Provide sunshades and insulation for all outdoor installations.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES

A. Finishes:

1. Metallic (non-stainless):
 - a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
 - b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
 - c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
 - d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
2. Stainless steel:
 - a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

2.12 SOURCE QUALITY CONTROL

- A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
 - 1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.
- B. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.
- C. Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.
- D. Provide concrete housekeeping pads for freestanding enclosures.
 - 1. Refer to the structural typical details.
- E. Install gasket and sealing material under panels with floor slab cutouts for conduit:
 - 1. Undercoat floor-mounted panels.
- F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.
- G. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.
- H. Protect all wiring from sharp edges and corners.
- I. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule but shall be shown on the Loop Drawings prepared by the Contractor.
- J. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.
- K. Side panels:

1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIRS/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40 96 31 SCADA CONTROL LOOP DESCRIPTIONS

PART 1 GENERAL

1.1 SECTION DESCRIPTION

- A. This section, in conjunction with specific requirements contained in the P&ID drawings, plans and specifications, describes the function of the project controls and instrumentation. The contractor is responsible for coordinating a finished supervisory control and data acquisition system and associated programming that can accomplish all of the following functions and provides the necessary operator interface to monitor the process, control the process, generate reports, and adjust setpoints as necessary. The Process Control System Supplier (PCSS) will be responsible for:
1. Integrating all new chemical feed pump controls and instrumentation into the RTUs at the project site;
 2. Adding I/O as necessary to existing RTUs located at the project site;
 3. Providing the site-specific hard-wired interlock features described in this specification;
 4. Radios and antennas existing at the project site;
 5. Programming the city's SCADA system to interface with the new I/O from the site RTUs including providing alarm and reporting functionality;
- B. The control functions described in this section are in addition to any control functions described elsewhere on the plans or specifications.
- C. All analog instruments shall include the following operator adjustable alarms:
1. Instrument fail
 2. High-high
 3. High
 4. Low
 5. Low-low
- D. All software control switches shall include adjustable timer delays.
- E. Trend data, including trend curves, for all analog instrument signals from analyzers, flowmeters, transducers, etc. shall be accessible by the operator at the SCADA workstation and HMI.

- F. The contractor shall ensure that the existing water system is not over pressurized during startup. The contractor shall ensure that the system pressure does not exceed 65 psi during startup.

1.2 RELATED WORK

- A. All Division 40 series instrumentation and controls related specifications
- B. 46 33 43 Motor Operated Diaphragm Chemical Metering Pumps

PART 2 CONTROL LOOP DESCRIPTIONS

2.1 CHLORINATION SITES

A. Chemical Feed System

1. The sodium hypochlorite metering pumps "XX"-CMP-01 at the Well 29 site shall be interlocked to run based on run signal from Well 29 at the well site. The signal shall be transmitted locally.
2. The sodium hypochlorite metering pump "XX"-CMP-01 shall be flow paced to maintain the same dose under varying flow from Well 29 as measured by the existing Well 29 flow meter.
3. The run status, and pump fail signals from the sodium hypochlorite metering pump shall be monitored at SCADA.
4. A fail signal from the chemical metering pump shall result in an operator alarm.

B. Water Quality Analyzers

1. All water quality instrument measurements (chlorine residual analyzer, pH probe) shall be continuously transmitted to SCADA.
2. Chlorine residual level shall be measured by chlorine residual analyzer "XX"-AE/AIT-01.
 - a. High level alarm shall be generated if the chlorine residual level exceeds an operator-selectable set point initially set to 1.0 mg/L.
 - b. Low level alarm shall be generated if the chlorine residual level is less than an operator-selectable set point initially set to 0.5 mg/L.

END SECTION

SECTION 43 41 43

VERTICAL POLYETHYLENE CHEMICAL STORAGE TANKS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes materials, testing, and installation of cross-linked high density vertical polyethylene storage tanks for chemical service including the accessories defined herein where indicated on the drawings or under "Service Conditions".
- B. Tank manufacturer shall design and furnish fittings for seismic anchorage of the tank.

1.2 RELATED WORK

- A. Not used

1.3 REFERENCES

- A. American Water Works Association (AWWA)
- B. American Society for Testing and Materials (ASTM)
- C. American National Standards Institute (ANSI)

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- B. Submit tank manufacturer's data and dimensions showing locations of all openings, locations of level indicators, seismic support structure and anchoring system details, and location of tank accessories.
- C. Submit details on inlet and outlet fittings, manways, flexible connections, vents and level indicators.
- D. Submit statement by the manufacturer stating compatibility of the tank materials with the chemicals to be stored.
- E. Submit tank pad requirements such as pad and block out sizes.
- F. Submit manufacturer's warranty.
- G. Submit unloading procedure and installation manual.
- H. Submit operation and maintenance manual.
- I. Submit supporting documentation of Manufacturer's certification to NSF/ANSI Standard 61 – Drinking Water System Components for water treatment chemicals.

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- J. Submit electrical heat tracing, foam insulation data sheets, and other accessory datasheets as applicable.

1.5 QUALITY ASSURANCE

- A. All materials in contact with potable water or chemicals used for potable water treatment shall be ANSI/NSF-61 certified.
- B. The tanks shall be warranted for 5 years to be free of defects in materials and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Tanks and appurtenances shall be high density cross-linked polyethylene tanks manufactured by Poly Processing Company, Assmann Polyethylene Tanks, Snyder Industries, or approved equal.

2.2 GENERAL

- A. Tanks shall be circular in cross-section, vertical, complete with piping inlets and outlets, drains, overflows, and anchoring system. Covered tanks shall be vented, and where indicated, tanks shall be provided with entrance manways, level indicators. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, and capacity. Tanks shall meet the requirements of ASTM D1998 unless otherwise indicated.

2.3 TANKS

- A. Materials: Polyethylene shall be of the cross-linked, high density type meeting or exceeding the following requirements:

Parameter	ASTM Method	Value
Density, gm/cc	D1505	0.937 to 0.945
Tensile Strength at yield, psi minimum	D638	2600
Elongation at break, min percent	D638	400
Stress-crack resistance, min hours for F50	D1693	1000

Parameter	ASTM Method	Value
Vicat softening temperature, deg F	D1525	230
Brittleness temperature, deg F, maximum	D746	-180
Flexural modulus, psi	D790	100,000

Resin used in the tank shall be equal to Phillips Chemical Marlex CL-200 or CL-250, PAXON grade 7004 or 7204, or equal, and shall contain a minimum of 0.3 percent ultraviolet stabilizer as recommended by the manufacturer. Where black tanks are indicated, the black resin shall contain 2 percent carbon black blended into the resin.

- B. Chemical storage tanks shall be suitable for the service conditions listed under that portion of this specification.
- C. Tanks shall be constructed using a rotationally molded fabrication process. Wall thickness of the tank shall be designed by the manufacturer with a hoop stress no greater than 600 psi using 1.5 times the specific gravity indicated. Stress shall be calculated using the Barlow formula.

2.4 TANK FITTINGS

- A. Tank fittings shall be of the size and location shown on the drawings.
- B. Gasket material shall be compatible with the chemical service.
- C. No metals shall be exposed to the tank contents.
- D. Any screwed fittings shall use American Standard Pipe Threads. No metals shall be exposed to tank contents.
- E. Bolted flange fittings shall be constructed of one 150 lb. flange with ANSI bolt pattern, one flange gasket and stud bolts with gaskets. Stud bolts shall have chemical resistant polyethylene injection molded heads and gaskets to provide a sealing surface between the bolt head and the interior tank wall. All materials shall be compatible with chemical service. For NSF/ANSI 61 certification, EPDM or Viton GF gaskets shall be supplied.
- F. Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 6-ft max intervals. Down pipes and fill pipes shall be PVC or material compatible with the chemical stored.
- G. Vents: Each tank must be vented for the material, fill, and withdrawal rates expected. Vents shall comply with OSHA 1910.106(F)(iii)(2)(IV)(9). Vents shall be sized by the tank manufacturer to prevent pressurization of the tank during filling or drawing a

- vacuum inside the tank during pumping or draining. Vents shall be furnished complete with insect screen.
- H. Tanks shall include a 24-inch bolted manway cover at the top of the tank unless otherwise noted on the drawings.
 - I. On dual wall tanks greater than 1,000 gallons, bottom fitting(s) must be designed to maintain 110% secondary containment integrity. Bottom fitting must include expansion joint designed to accommodate movement of the primary tank.
 - J. If tanks are insulated, fittings shall be installed at the factory prior to application of the insulation.
 - K. Where shown on the plans, the tank manufacturer's standard flexible connection fitting shall be furnished. Additional flexible connectors shall be furnished when required by the tank manufacturer's warranty whether shown on the plans or not.

2.5 LEVEL INDICATION

- A. All chemical tanks shall include some form of level indication. For all tanks, graduations shall be provided at every 50 gallon interval with 100 gallon intervals clearly labeled for bulk storage tanks. Unless otherwise indicated, graduations shall be marked on the tank exterior. The following specific forms of level indication shall be provided where indicated under "service conditions".
- B. Float Indication: The level indicator shall be assembled to the tank and shall consist of PVC float, indicator, polypropylene rope, perforated interior pipe, PVC roller guides, clear UV resistant PVC sight tube, and necessary pipe supports. The level indicator shall act inversely to the tank contents and shall not allow entrance of tank contents into the sight tube at any time. Indicator shall be neon orange color for visual ease for onsite operators.
- C. Liquid Level Gauges: Liquid level gauges shall be constructed from 1-inch minimum diameter clear PVC tubing. Tubing shall be supported from the tank every 3 feet. Isolation valves shall be installed at both the top and the bottom of the level gauge.
- D. Magnetic Flag Type Gauges: Magnetic flag type level indicators shall be externally mounted and consist of a chemically resistant magnetic float, externally mounted float housing, magnetic flag indicator assembly and scale. The indicator housing shall fasten to openings in the side of the tank, with the float assembly the full height of the tank. The level indicators shall have two-colored magnetic flags that flip colors to indicate liquid level. The level indicators shall include a metal scale to provide a numerical readout of the liquid level in gallons. The level indicators shall be GEMS "SureSite Indicators" or equal.
- E. Ultrasonic level indicators and diaphragm level transmitters, where indicated under "service conditions", will be supplied separately from the tank.

2.6 TANK INSULATION

- A. Where indicated under “service conditions”, tanks shall be provided with factory-applied spray-on foam insulation. Insulation shall be polyurethane foam with a density of 2.5 lb/ft³ with a minimum “R” value of 6.3/in. The foam shall be applied with a nominal thickness of 2” to the external tank surfaces except for the tank bottom.
- B. Upon completion of application and curing of the insulation, 2 full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment.

2.7 RESTRAINT SYSTEM

- A. The tanks shall be provided with seismic restraint systems designed by the manufacturer for the following California Building Code seismic design parameters:

Parameter	Value
S _s	0.665g
S ₁	0.264g
Site Class	D (Default)
Design Category	D
S _{DS}	0.562g
S _{D1}	0.365g

- B. Where indicated under “service conditions”, the tanks shall be provided with wind restraints for the wind speed indicated. Wind restraint shall be designed to restrain an empty tank.
- C. Seismic and wind restraint system components likely to be exposed incidentally to the process chemical, shall be fabricated from materials resistant to the process chemical.
- D. Unless otherwise indicated or specified, all tanks shall include a spill pallet for secondary containment and shall be installed on concrete bases. The tanks/spill pallets shall be anchored to the concrete base with suitable anchor bolts designed by the manufacturer

2.8 SIGNAGE

- A. Each tank shall be clearly marked with hazardous material warning signs conforming to NFPA 704. Each tank shall also have a sign with the word "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign ("DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE").

2.9 SERVICE CONDITIONS

A. Sodium Hypochlorite Tank

Chemical Service	12.5% Sodium Hypochlorite
Tank Quantity	1
Location	Outdoors under awning
Tank Volume, Min	250 gallons
Max Tank Dia	48 inches
Wind Exposure	NA
Level Indicator	Liquid Level Float
Color	White
Insulation	NA
Heat Tracing	NA
Ambient Temperature	15 – 115 deg. F

PART 3 EXECUTION

3.1 FACTORY TESTING

- A. Material taken from each tank shall be tested for the following in accordance with ASTM D1998:
1. Impact (120 ft-lb minimum)
 2. Gel, minimum percent
 - a. 1/32-inch of inner wall: 65
 - b. Outer wall: 90
 - c. Total wall: 70
- B. Following fabrication, the tanks, including factory applied inlet and outlet fittings, shall be hydraulically tested with water. The factory test shall compensate for the difference in specific gravity between the test water and chemical stored to simulate actual maximum operating pressures. Test methods may include adding a [2.5 psi]

air pad to a filled tank or filling the tank with standpipes, raising the maximum water surface approximately [5 feet] higher than the normal maximum tank level. The test duration shall be 24 hours. Following successful testing, the tank shall be emptied and dried prior to shipment.

- C. An affidavit signed by the tank manufacturer shall be furnished indicating that the factory tests have been performed and the indicated conditions have been met.

3.2 *INSTALLATION*

- A. Installation shall be in accordance with the manufacturer's recommendations.

3.3 *FIELD QUALITY CONTROL*

- A. After installation of tank and all fittings, the tank shall be water tested by filling the entire tank with water and monitoring the tank as well as all fitting connections for at least 24 hours. Any leaks shall be corrected prior to acceptance. Following successful field tank testing, the tank shall be completely emptied and dried.

END SECTION

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SECTION 46 33 43
MOTOR OPERATED DIAPHRAGM CHEMICAL FEED PUMPS

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes mechanically actuated diaphragm chemical metering pumps incorporating stepper motor drives.

1.2 RELATED WORK

- A. Section 01 33 00 – Submittals
- B. Section 40 05 75 – Piping and Equipment Identification
- C. Section 46 33 85 – Chemical Metering Skids and Accessories

1.3 REFERENCES

- A. ANSI / NSF - 61
- B. National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA)

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00 – Submittals.
- B. Submit drawings showing general dimensions, installation requirements, materials of construction, connections, elevations, and operator interface.
- C. Submit electrical schematics indicating power requirements, control inputs, and telemetry outputs
- D. Submit operational narrative describing in detail the operation of the chemical feed pumps.
- E. Submit documentation demonstrating certification to ANSI/NSF Standard 61.
- F. Submit certification that materials of construction are compatible with the fluid being pumped.
- G. Submit Operation and Maintenance Manuals in accordance with Section 01 33 00 prior to shipping pumps to the project site.

1.5 *QUALITY ASSURANCE*

- A. All components of the metering pumps in contact with the chemical being pumped shall be certified to comply with NSF/ANSI Standard 61 (Drinking Water System Components – Health Effects).
- B. The metering pump manufacturer shall be responsible for assuring that the materials in contact with the process chemical(s) are compatible with the process fluid. If the manufacturer believes that specific materials required by this specification are not appropriate for the process chemical(s), then the manufacturer shall request a substitution prior to bid.

1.6 *WARRANTY*

- A. The metering pumps shall be warranted to be free of defects in material and workmanship for a period of 24 months from the date of installation.

PART 2 PRODUCTS

2.1 *MANUFACTURERS*

- A. The chemical metering pump shall be Model DDA 17-7 manufactured by Grundfos, with no equal.

2.2 *GENERAL*

- A. Chemical metering pump shall be driven by a microprocessor controlled stepper motor providing a minimum of 1000:1 turndown ratio. The stepper motor is to be coupled to a flat, PTFE diaphragm via a gear assembly.
- B. The pump shall operate at 100% stroke length throughout the pumps entire capacity range.

2.3 *ENCLOSURE*

- A. Enclosure shall be rated to IP65 and NEMA 4X standards.
- B. Drive mechanism and microprocessor shall be housed in a corrosion resistant, plastic UV stabilized enclosure.
- C. The pump design shall include provisions for optional positioning of the control interface/display, for right/left side and front mounting.

2.4 *DRIVE*

- A. The motor shall be integral to the pump housing
- B. An integral variable speed stepper motor shall be used to ensure the pump discharge phase extends throughout the full period between suction intervals.
- C. Power supply shall be 120 volts, single phase, 60 hertz.

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2.5 USER INTERFACE

- A. User interface/display shall be backlit LCD. Display shall display the pump output in gallons per hour (gph). Backlight color (white, red, yellow, and green) shall indicate the pump status and alarm conditions.
- B. Interface shall include a turn and push knob (click wheel) for easy menu navigation. The interface shall also include a priming button which initiates a time selectable prime cycle.
- C. Interface shall include a lock function designed to protect against unauthorized settings changes.
- D. A built in counter shall provide a running total of accumulated strokes, cumulative hours of operation, and dosing flow.

2.6 LIQUID END

- A. Suction and discharge valve design shall incorporate a double ball arrangement. Spring loaded valves shall be available as an option.
- B. Head shall incorporate an integral priming valve. The pump shall be able to automatically de-aerate the pump head without the need for external devices.
- C. The suction and discharge connections shall accept polyethylene, PVDF, or PVC tubing via compression connections.
- D. Pump diaphragm shall be completely constructed of PTFE.
- E. Materials of construction shall be as follows for the chemical services indicated:

Service	Head	Gasket/ O-Ring	Valve Ball
Sodium Hypochlorite (0.8 – 13%)	PVC	FKM	Ceramic

- F. Manufacturer shall certify that the materials listed above are appropriate for the services indicated and will not invalidate the pump warranty. Any change in materials required to satisfy the Manufacturer's warranty terms shall be at no additional cost to the Owner.

2.7 OPERATION

- A. Repeatable metering accuracy shall be $\pm 1\%$ at constant hydraulic conditions throughout the entire output range. The pump shall be equipped with a calibration function which when initiated operates the pump for a set number of strokes and displays the anticipated pumped volume.
- B. Pump shall include integral flow control system with selective fault diagnostic and pressure monitoring.

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- C. The pump shall be equipped with an operating mode that allows the suction stroke speed to be reduced to either 25% or 50% of maximum capacity.
- D. The pump shall provide the following controls interfaces:
 - 1. Analog re-scalable 4 – 20 mA signal input
 - 2. External pump enable/disable interface
 - 3. Discrete outputs for pump running and common alarm
 - 4. Programmable proportional 4-20 mA output for pump flow
- E. The pump shall be capable of operating in manual or automatic control modes.
 - 1. In manual mode the pump shall be started and stopped at the operator interface and output adjustment shall be performed by adjustments to the turn and push knob.
 - 2. In automatic control mode, the pump shall respond to a 4-20 mA analog input signal. The pump shall include an alarm for loss of input signal.

2.8 SERVICE CONDITIONS

- A. Pumps satisfying the following service conditions shall be provided:

Tag No.	Pumped Liquid	Maximum Pumping Rate	Maximum Pressure	Model	Flow Measurement Required?
29-PMP-01	12.5% Sodium Hypochlorite	3.0 GPH	100 PSI	DDA-FC	No

2.9 ACCESSORIES

- A. Pumps shall include all required electrical interface cables with pump-specific plug at one end and exposed wire at the other end for connection by the Contractor.
- B. Furnish each pump with a multi-function valve combining the functions of pressure relief, backpressure, and de-aeration. Multi-function valve shall be constructed of the same chemically-compatible materials as the pump.

PART 3 EXECUTION

3.1 MANUFACTURER'S FIELD SERVICES

- A. Provide Manufacturer's services at the jobsite for one day to advise during start-up, testing, and adjustment of the equipment; and to instruct the Owner in the proper operation of the equipment.

- B. Provide Manufacturer's services at the jobsite for one day during startup after the treatment plant has been placed in operation. The purpose of this second visit will be to fine-tune the settings on the pumps and further instruct the Owner in the proper operation of the equipment.

3.2 *FIELD OR SITE QUALITY CONTROL*

- A. Operate each pump for two hours over the full range of operating conditions using only water before supplying the pump with chemical.
- B. Assure that pressure relief valves and backpressure valves have been set as specified prior to starting the pump.

END SECTION

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SECTION 46 33 85
CHEMICAL METERING SKIDS AND ACCESSORIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. This section includes complete factory pre-assembled chemical metering pump skids and accessories. Skids shall include metering pump(s), calibration column(s), back pressure valve(s), pressure relief valve(s), piping, fittings, isolation valves, and electrical panels required to provide a complete system.

1.2 RELATED WORK

- A. Section 01 33 00 – Submittals
- B. Section 40 05 75 – Piping and Equipment Identification
- C. Section 46 33 43 – Motor Operated Diaphragm Chemical Feed Pumps

1.3 REFERENCES

- A. ANSI / NSF – 61
- B. National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA)

1.4 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 – Submittals.
- B. Submit product datasheets for individual accessories.
- C. Submit drawings showing general dimensions, installation requirements, materials of construction, connections, mounting interfaces, and elevations.
- D. Submit electrical schematics indicating power requirements, control inputs, and telemetry outputs
- E. Submit documentation demonstrating certification of skid or all individual components in contact with the process chemicals to NSF/ANSI-61.
- F. Submit certification that materials of construction are compatible with the fluid being pumped.
- G. Submit procedure for factory pressure testing the skid. Submit factory test results before skids are shipped to the project site.
- H. Submit Operation and Maintenance Manuals in accordance with Section 01 33 00 prior to shipping pumps to the project site.

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1.5 *QUALITY ASSURANCE*

- A. All components in contact with the chemical being pumped shall be certified to comply with NSF/ANSI Standard 61 (Drinking Water System Components – Health Effects).
- B. Each chemical metering skid shall be subjected to a non-witnessed factory performance test using water as the test fluid. The factory performance test shall be designed to accomplish the following:
 - 1. Pressurize the metering pump and skid piping to the design operating pressure for a minimum of two hours to ensure there are no leaks. Repair and replace any leaking joints and retest.
 - 2. Confirm that the skid responds to all metering pump control signals and generates and transmits all specified alarm signals.
 - 3. Pre-adjustment of skid accessories (e.g. pressure relief valves, backpressure valves)

PART 2 PRODUCTS

2.1 *MANUFACTURERS*

- A. The chemical metering skid shall be fabricated and assembled by the metering pump manufacturer or a company authorized to do so by the metering pump manufacturer.
- B. The pumps for each chemical system shall be completely assembled, mounted, calibrated, tested, and delivered to the site on a single skid. The pump skid manufacturer shall be responsible for providing all equipment, valves, and piping within the skid boundary. The Contractor shall be required to mount the skid to the building and make connections only for inlet piping, outlet piping, and power and control cabling to the skid electrical junction box. Anchor bolts shall be furnished and installed by the Contractor based on the skid manufacturer's recommendations.

2.2 *CHEMICAL COMPATIBILITY*

- A. All components of the skid in contact with the process chemical, designed to contain spillage of the process chemical, or likely to be splashed by the process chemical (including fasteners) shall be suitable for continuous exposure to the chemical being pumped.

2.3 *CHEMICAL METERING PUMP*

- A. Refer to Specification 46 33 43 for chemical metering pump requirements.

2.4 SKID CONSTRUCTION

- A. Pumps and appurtenances shall be positioned on the skid so that maintenance personnel will have convenient access to the pump. No accessories shall be located in such a way as to require their removal for removal of the pump.
- B. Skids shall be constructed of high density polyethylene sheets, PVC sheets, polypropylene or fiberglass reinforced plastic (FRP) of minimum 1/2" thickness and gusseted to provide adequate stiffness and support to equipment.
- C. The skid shall include two notched openings suitable for moving the skid with a forklift and shall include lifting lugs for overhead lifting.
- D. The bottom of the skid shall include a drip-rim of at least 1-inch in height with a 1/2-inch minimum threaded hole with a plug in the bottom suitable for attachment of drain piping.
- E. Piping and accessories shall be mounted to the skid using chemical resistant clips and fasteners. Attachment of clips or accessories using adhesive will not be accepted.
- F. Provide means of mounting skid to support pad using chemical resistant clips and anchors.

2.5 CALIBRATION CYLINDER

- A. Install a clear PVC calibration cylinder in the suction line. Calibration cylinder shall include easy to read graduations in mls and gph. Cylinder shall have a sealed top with an overflow connection allowing cylinder to be vented back to the chemical storage tank.
- B. The calibration cylinder shall be piped so that all pumps are on the skid. Duplex skids, when provided, can utilize a common column for calibration.
- C. Calibration cylinder capacity shall be appropriate to allow for 30-second draw-down at the maximum metering pump capacity.

2.6 PULSATION DAMPENERS

- A. Each skid shall be equipped with a single-port pulsation dampener equipped with a pressure gauge.
- B. Pulsation dampeners shall be chargeable using a Schrader valve.
- C. Pulsation dampeners shall be designed to limit the pulsation amplitude to 2 psig or less.
- D. The pulsation dampener body and bladder shall be constructed of CPVC and Viton respectively unless otherwise noted. Other materials may be substituted only if CPVC and/or Viton are incompatible with the liquid being pumped. PVC and Nordel (EPDM) shall be used for sodium hydroxide service.

2.7 PRESSURE RELIEF VALVE

- A. Each pump shall be equipped with a pressure relief valve designed to protect the chemical feed system from over-pressure damage. The relief port shall be plumbed to the suction side of the metering pump.
- B. The pressure relief valve shall be field adjustable between 10 – 150 psi via an adjustment screw.
- C. The valve shall be installed as close to the pump as possible, upstream from the back-pressure valve, pressure gauge and pulsation dampener.
- D. The valve body shall be constructed of CPVC. The diaphragm shall be constructed of Teflon.

2.8 BACKPRESSURE VALVE

- A. Each pump shall be equipped with a back-pressure valve designed to provide a continuous back pressure to the pump and to prevent siphoning of chemical through the system.
- B. The back-pressure valve shall be field adjustable between 0 – 150 psi via an adjustment screw.
- C. The valve shall be installed as close to the pump skid discharge connection as possible, downstream from the pressure relief valve, pressure gauge and pulsation dampener.
- D. The valve body shall be constructed of CPVC. The diaphragm shall be constructed of Viton or EPDM as appropriate for compatibility with the chemical being pumped. Diaphragms for sodium hydroxide service shall be EPDM.

2.9 MULTI-FUNCTION VALVE

- A. Not used.

2.10 PIPING, VALVES, AND OTHER APPURTENANCES

- A. Piping shall be Schedule 80 PVC, CPVC, or PVDF as required for compatibility with the service chemicals and pressures. Piping size shall be appropriate for the maximum specified chemical dosage rate, but in no case shall be less than ½ inch.
- B. Isolation ball valves shall be installed at the skid suction connection, skid discharge connection, calibration cylinder, discharge bleed connection, and as additionally shown on the drawings. Valves shall be of the true union type. Ball valves for sodium hypochlorite service shall be vented.
- C. Install a pressure gauge on the discharge side of the pump. The gauge shall be 2-1/2 inch in diameter and have a scale high enough for the maximum pressure attainable by the pump. Gauges shall be liquid filled and include a chemically compatible seal isolating the gauge from the chemical.

- D. Install a Y-type strainer on the suction line of the pump to prevent debris from entering the pump.
- E. The metering pumps, valves, and appurtenances shall be installed using unions so that they can be removed without disturbing the remainder of the skid.

2.11 CONTROL PANEL / ELECTRICAL JUNCTION BOX

- A. All skid power and control wiring shall terminate at an FRP NEMA 4X rated terminal box.

2.12 SERVICE CONDITIONS

- A. Service conditions shall be as described in Specification 46 33 43.

PART 3 EXECUTION

3.1 ASSEMBLY

- A. Skids shall be fully assembled in the factory and shall only require mounting to the building or slab; inlet connection; outlet connection; and wiring to the skid junction box in the field.

3.2 CONNECTION LOCATIONS

- A. Process connection locations shall be as shown on the plans.
- B. Where specific connection locations are not shown on the plans, connection locations shall be defined by the Engineer during the submittal process.

3.3 TESTING

- A. Assembled skids shall be pressure tested in the factory as described in Part 1.
- B. Following installation operate each skid for two hours over the full range of operating conditions using water before supplying the pump with chemical.
- C. Verify factory pressure relief valve and backpressure valves settings prior to supplying the pump with chemical.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Manufacturer's field services shall be as specified in Section 46 33 43.

END SECTION

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