CITY OF IMPERIAL

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

Bid No. 2022-05

JUNE 2022

PREPARED BY

ALBERT A. WEBB ASSOCIATES
3788 McCRAY STREET
RIVERSIDE, CA 92506
(951) 686-1070

SKM, INC.
533 WEST 2600 SOUTH
SUITE 100
BOUNTIFUL, UT 84010
(801) 677-0011

PREPARED FOR

CITY OF IMPERIAL
PUBLIC WORKS DEPARTMENT
420 SOUTH IMPERIAL AVENUE
IMPERIAL, CA 92251
(760) 355-1152

BID INVITATION PACKAGE

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

BID 2022-05

Bid Package Contents:

1. Notice and Invitation to Bidders;
2. Instructions to Bidders;
3. Bid Form;
4. Bid Bond;
5. List of Proposed Subcontractors;
6. Noncollusion Affidavit;
7. General Conditions;
8. Certificate Regarding Workers' Compensation;
9. Project Contract Execution Document;
10. Special Requirements
11. Detailed Specifications
12. Contract Drawings

TABLE OF CONTENTS

Page

TABLE OF CONTENTS……TOC 1–2

NOTICE AND INVITATION TO BIDDERS NTB-1–4

INSTRUCTIONS TO BIDDERS ITB-1–8

BID FORM BF-1–15

LIST OF PROPOSED SUBCONTRACTORS 1

BID BOND BB-1

NONCOLLUSION AFFIDAVIT 1

GENERAL CONDITIONS GC-1–18

WORKERS' COMPENSATION 1

EXECUTION DOCUMENT 1–2

SPECIAL REQUIREMENTS SR-1–6

DETAILED SPECIFICATIONS .....See Below

Division 1 - General

01340 – Shop Drawings, Product Data and Samples 01340-1
01510 – Construction Facilities and Temporary Controls.....01510-1
01530 – Protection of Existing Facilities.....01530-1
01700 – Contract Closeout.....01700-1
01820 – Field Testing and Operation Demonstrations 01820-1

Division 2 - Site Work

02140 – Dewatering.....02140-1
02200 – Earthwork and Site Preparation 02200-1
02221 – Trenching, Backfilling, and Compacting.....02221-1
02415 – Sheeting, Waling and Shoring 02415-1
02610 – Buried Piping Installation 02610-1
02620 - Existing Underground Utilities.....02620-1

Division 3 - Concrete

03110 – Concrete Formwork 03110-1

03210 – Concrete Reinforcement 03210-1
03300 – Cast-in-Place Concrete.....03300-1

Division 9 - Finishes

09871 – Painting and Protective Coatings 09871-1
09873 – Field Coating for Pressure Vessels 09873-1

Division 11 – Equipment

11300 – GAC Adsorption System 11300-1

Division 13 – Metal Building

13120 – Metal Building 13120-1

Division 15 – Mechanical

15010 - General Mechanical & Equipment Provisions 15010-1
15041 – Disinfection of Piping.....15041-1
15044 – Pressure Testing of Piping 15044-1
15060 - Process Piping and Appurtenances 15060-1
15064 – Water Pipe and Process Pipe.....15064-1
15081 – Gaskets.....15081-1
15089 – Nuts and Bolts.....15089-1
15099 – Process Valves Regulators and Misc. Components.....15099-1
15101 – Butterfly Valves.....15101-1
15102 - Resilient Seat Gate Valves 15102-1
15103 – Actuators for Process Valves and Gates 15103-1
15105 – Air Valves 15105-1
15107 – Resilient Seat Ball Valves.....15107-1
15112 – Double-Door Check Valves.....15112-1
15161 - Vertical Turbine Pumps.....15161-1
15170 - Induction Motors 15170-1
15171 – Vertical Hollowshaft (VHS) Electric Motors 15171-1

Division 16 – Electrical

16000 – General Electrical Requirements 16000-1
16010 – Scope of Work 16010-1
16060 - Electrical Demolition.....16060-1
16111 - Conduits.....16111-1
16123 - 600 Volt Class Cable 16123-1
16124 - Instrumentation Class Cable.....16124-1
16130 – Outlet, Pull, and Junction Boxes.....16130-1
16141 - Wiring Devices.....16141-1

16142 – Weatherproofing While in use Outlet Enclosures 16142-1
16143 - Terminal Blocks 16143-1
16160 - Enclosures.....16160-1
16161 - Control Panel 16161-1
16170 - Grounding.....16170-1
16190 - Supporting Devices.....16190-1
16195 - Electrical Identification 16195-1
16461 – Transformers-Dry Type 16461-1
16470 – Panelboards 16470-1
16476 - Low Voltage Circuit Breakers.....16476-1
16477 - 600 Volt Fuses 16477-1
16481 - Motor Control Center 16481-1
16490 – Arc Flash Coordination Study 16490-1
16500 – Lighting.....16500-1
16611 – Static Uninterruptible Power Supply 16611-1
16902 – Electrical Controls, Relays, and Alarms 16902-1
16903 - Programmable Logic Controllers 16903-1
16904 – Variable Frequency Drives 16904-1
16940 – Communication Cabling Systems.....16940-1
16950 – Electrical Testing 16950-1

Division 17 – Instrumentation

17000 - Instrumentation.....17000-1
17120 – Pressure Transmitters.....17120-1
17121 – Pressure Switches.....17121-1
17122 – Pressure Gauges 17122-1
17126 – Submersible Level Transmitter.....17126-1
17137 – Mag Meter.....17137-1

Appendix A – Seismic Parameters

NOTICE AND INVITATION TO BIDDERS

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project
BID 2022-05

NOTICE IS HEREBY GIVEN that sealed bids for the above project shall be received in the offices of the City Clerk at the City of Imperial at 420 So. Imperial Ave, Imperial, CA 92251, until **2:00 p.m.** Pacific Standard Time, on ***August 2, 2022***. Bids will be publicly opened on ***August 2, 2022*** at **2:05 p.m.** Pacific Standard Time, or as soon thereafter as possible, at the City of Imperial located at 420 So. Imperial Ave., Imperial, CA 92251.

The Contract for the work advertised shall be awarded to lowest responsible bidder. City reserves the right to reject all bids.

A mandatory prebid site tour will be conducted on July 26, 2022 at 10:00 a.m.. Bidders attending the site tour shall meet at 201 South B Street no later than fifteen (15) minutes prior to the scheduled site tour.

PROJECT DESCRIPTION:

Contractor shall furnish all labor, material, equipment and services to perform and complete all work required for the **Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project** as per the Project Specifications. The project will generally include the construction of a new potable water pump station, including a metal building, new suction/discharge piping, 10' diameter manhole/clearwell installation, site grading, electrical equipment, and all mechanical equipment. Installation of a 4 vessel GAC Treatment System, concrete foundation, piping, and general electrical. The Contractor shall construct the specified filter piping, modify the existing filter piping valves and actuators, pipe supports, and electrical connections to accommodate the new filter piping, for the City of Imperial, Imperial County, California; furnishing all labor, materials, equipment, and methods, necessary to complete said construction, in order to provide the City with complete, correctly operating filter piping, all in accordance with the Contract Documents. This is an active water treatment facility that must stay in operation while the work is performed. The existing filter piping within the filter complex building is corroded at the pipe/floor interface and the Contractor shall take extra precaution not to damage the existing filter piping during the construction. Coordination with the City will be required to isolate each filter bay (4 total) to modify the existing filter piping/valves/actuator and install the new filter piping as indicated on the plans. The Contractor shall be responsible for the initial operation of the relocated valves, and he shall check all material installed by him, making repairs and/or adjustments necessary

in order to provide the City with a correctly functioning facility. Bid packages are available on the City's website, www.cityofimperial.org.

Engineer's Estimate for this Project is $4,900,000.

CONTRACTOR'S LICENSE:

Contractor must have a California State Contractor's Class "A" license. All electrical work shall be performed by a Class C-10 licensed contractor. A City of Imperial business license is required prior to start of project.

A bid submitted by any contractor not properly licensed shall be considered non-responsive and will be rejected.

No contractor or subcontractor may be listed on a bid proposal for a public works project (submitted on or after March 1, 2015) unless registered with the Department of Industrial Relations pursuant to Labor Code section 1725.5 [with limited exceptions from this requirement for bid purposes only under Labor Code section 1771.1 (a)]. No contractor or subcontractor may be awarded a contract for public work on a public works projects (awarded on or after April 1, 2015) unless registered with the Department of Industrial Relations pursuant to Labor Code 1725.5. This project is subject to compliance monitoring and enforcement by the Department of Industrial Relations. Any bid submitted by a contractor or subcontractor not property licensed any not registered with the Department of Industrial Relations shall be considered non-responsive and will be rejected.

APPRENTICES:

Section 1777.5 requires the Contractor or Subcontractor employing tradesmen in any apprenticeable occupation to apply to the Joint Apprenticeship Committee nearest the site of the public works project and which administers the apprenticeship program in that trade for a certificate of approval. The certificate will also fix the ratio of apprentices to journeymen to be used in the performance of the contract.

The Contractor is required to make contributions to funds established for the administration of apprenticeship programs if he employs registered apprentices or journeymen in any apprenticeable trade and if other Contractors on the public works site are making such contributions.

Information relative to apprenticeship standards, contributions, wage schedules and other requirements may be obtained from the State Director of Industrial Relations or from the Division of Apprenticeship Standards.

PREVAILING WAGE RATES:

Not less than the general prevailing rate of per diem wages for work of a similar character in the locality in which this contract is to be performed, and not less than the general prevailing rate of per diem wages for holiday and overtime work fixed as provided in Chapter 1 (commencing with Section 1720) Part 7, Division 2 of the Labor Code, shall be paid to all workers employed on this public work. Statutory provisions for penalties for failure to pay prevailing wages will be enforced. A copy of the applicable rate of per diem wages is on file in the office of the City Clerk, 420 South Imperial Avenue, Imperial, California.

BID BOND:

Each bid must be accompanied by a guaranty of cash, certified check, cashier's check or bid bond made payable to the City of Imperial for an amount equal to at least ten percent (10%) of the bid. Such guaranty to be forfeited should the bidder to whom the contract is awarded fails to enter the contract. All guaranties to be returned after the contract is awarded. In conformance with the State of California Public Contract Code Section 22300, the contractor may substitute securities for any funds withheld by the City to ensure performance under the contract.

At request and expense of the contractor, securities equivalent to the amount withheld shall be deposited with the City or with a State or Federally chartered bank as the escrow agent who shall pay such funds to the contractor upon notification by the City of contractor's satisfactory completion of contract.
The type of securities deposited and the method of release shall be approved by the City Attorney.

PAYMENT BOND:

If the successful bid is in excess of $25,000, the successful bidder shall be required to post a payment bond in the amount of the bid in accordance with California Civil Code Section §3247.

RETENTION:

The City shall retain five (5%) percent of the Contract price. The retention shall be released (with the exception of one hundred fifty percent of any disputed amount) within sixty days after the date of completion of the work. The Contractor may substitute securities in place of the retained funds withheld by the City. Alternatively, an escrow agreement, in the form prescribed under Ca. Pub. Cont. Code § 22300, may be used by Contractor.

RESOLUTION OF CLAIMS:

Claims shall be managed as set forth in Public Contracts Code Section 20104 and 9204. Where there is conflict, the provisions of 9204 shall control. In general terms, said process contemplates a meet and confer procedure and non-binding mediation as a precursor to litigation.

MISCELLANEOUS:

All inquiries regarding this project should be directed to:

City of Imperial
Jackie Loper – Public Services Director
420 South Imperial Avenue
Imperial, California 92251
760-427-4238
jloper@cityofimperial.org

THE CITY OF IMPERIAL

By: Dennis Morita, City Manager

INSTRUCTIONS TO BIDDERS

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

BID 2022-05

1. Explanations to Bidders

(a) Any explanation desired by a bidder regarding the meaning or interpretation of the Invitation for Bids, including drawings, specifications, prior approvals, etc., must be requested in writing no later than 5 calendar days before the bid deadline. Any interpretation made will be in the form of an addendum to the Invitation for Bids and will be furnished to all prospective bidders. Receipt of Addenda by the bidder must be acknowledged in the space provided on the Bid Form or by letter or transmittal received before the time set for opening of sealed bids. Verbal explanations or instructions given before the award of the contract will not be binding.

(b) All questions regarding the Invitation for Bids shall be in writing and directed to:

City of Imperial
Jackie Loper
Public Services Director
420 South Imperial Avenue
Imperial, CA 92251
760-427-4238
jloper@cityofimperial.org

Albert A. Webb Associates
Shane Bloomfield
Design Engineer
3788 McCray Street
Riverside, CA 92506
951-248-4293
shane.bloomfield@webbassociates.com

2. Conditions Affecting the Work

(a) Before submitting a bid, each bidder must (1) examine the bid and contract documents thoroughly, (2) visit the site to familiarize himself with local conditions that may in any manner affect cost, progress or performance of the work (**Optional**), (3) familiarize himself with federal, state and local laws, ordinances, rules and regulations that may in any manner affect cost, progress or performance of the work; and (4) study and carefully correlate bidder's observations with the bid and contract documents. Failure to do so will not relieve bidders from responsibility for estimating properly the difficulty or cost of successfully performing the work. The City will assume no responsibility for any understanding or representations concerning conditions made by any of its officers or agents prior to the execution of the contract, unless included in the bid or contract documents.

(b) The submission of a bid will constitute an incontrovertible representation by the Bidder that it has complied with every requirement of the request for bids and that the bid and contract documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the work.

3. Bidder's Qualifications

(a) Contractor must have a California State Contractor's Class "A" license to perform the work and all electrical work shall be performed by a C-10 State Contractor. Any bid submitted by a contractor not properly licensed shall be considered non-responsive and will be rejected.

4. Bid Guaranty

(a) The bid guaranty shall be in the form of a bid bond, certified check, or cashier's check, payable to the order of the City of Imperial, in an amount not less than 10% of the Bid. If the bid guaranty is in the form of a bond it must be of the type included in this bid package. Any bid bond shall be executed by a corporate surety acceptable to the City and authorized to issue such surety bond in the State of California. Bid guaranties, other than bid bonds, will be returned (1) to unsuccessful Bidders as soon as practicable after the opening of bids, and (2) to the successful Bidder upon execution and delivery of all contract documents. However, the City reserves the right to retain the bid guaranty of the second lowest qualified Bidder until the lowest qualified Bidder executes and delivers all required contract documents to the City or until 60 calendar days after bid opening, whichever occurs first.

(b) Failure to furnish a bid guaranty in the proper form and amount, by the time set for the receipt of bids, shall be cause for rejection of the bid.

(c) If the successful Bidder, upon acceptance of its bid by the City fails to execute and deliver all contract documents within 10 calendar days after receipt of City's Notice of Award, the successful Bidder's bid guaranty shall be retained by the City as liquidated damages. Such failure on the Bidder's part to execute and deliver those documents will cause substantial damage to the City, including delay in its construction program, which damage is not easily reduced to monetary terms and, therefore, the full amount of the bid guaranty is properly considered to be liquidated damages.

5. Preparation of Bids

(a) Bids shall be submitted on the forms furnished, or copies thereof, and must be manually signed. All blank spaces shall be filled in. If erasures or other changes appear on the forms, each erasure or change must be initialed by

the person signing the bid. Telephonic or fax bids will not be considered.

(b) Substitutions for specified materials will not be considered without prior approval.

(c) Modifications of bids already submitted will be considered if received at the office designated in the invitation for bids by the time set for receipt of bids. Telephonic or fax modifications will not be considered.

(d) Discrepancies between words and figures shall be resolved in favor of words.

(e) Discrepancies between the indicated sum of any column of figures and the correct sum thereof shall be resolved in favor of the correct sum.

6. Submission of Bids

(a) Bids must be sealed, marked, and addressed as indicated below. Failure to do so may result in a premature opening of, or a failure to open, such bid, thereby eliminating that Bidder from consideration. If the bid is mailed, the sealed envelope containing the bid should be enclosed in another envelope addressed as indicated below.

(b) All bids shall be received no later than **2:00 p.m.** Pacific Standard Time, on ***August 2, 2022*** hand-delivered or mailed, addressed to:

Jillian Mehdipour, Public Records Analyst
City of Imperial
420 South Imperial Avenue
Imperial, California 92251

(c) The envelope containing the original copy of the bid must be sealed, marked, and addressed as follows:

(1) Name and address of Bidder

(2) Marked in the lower left-hand corner of the envelope:

CLEARWELL PUMP STATION REPLACEMENT AND GAC TREATMENT EXPANSION AND FILTER PIPING REPLACEMENT AT THE WATER TREATMENT PLANT PROJECT - BID NO. 2022-05

(d) The original bid shall consist of those documents listed below. The original document shall be returned with the bid.
(1) Bid Form;

(2) List of Proposed Subcontractors;

(3) Bid Bond;

(4) Noncollusion Affidavit; and

(5) Contractor's Certificate Regarding Workers' Compensation

7. Late Bid, Modification or Withdrawal of Bid by Bidder

(a) Any bid received by the City after the exact time specified for receipt will be returned unopened.

(b) Any modification or withdrawal of bids must be made in writing and is subject to the same condition as in (a) above. A bid may be withdrawn by written or transmittal request received from a Bidder prior to the time set for opening bids. A bid may also be withdrawn in person by a Bidder or the Bidder's authorized representative, provided the representative's identity is made known and the representative signs a receipt for the bid, but only if the withdrawal is made prior to the time set for opening bids.

8. City Modifications Prior to Date Set for Opening Bids

The City may revise or amend the bid or contract documents, including the specifications and drawings, prior to the date set for opening bids. Such revisions and addenda, if any, will be announced by addenda to the Invitation for Bids. If the revisions and addenda are of a nature which require material changes in the bid, the date set for opening bids may be postponed by such number of days as in the opinion of the City will enable Bidders to revise their bids. In such a case, the addendum will include an announcement of the new date and time for opening bids.

9. Public Opening of Bids

Bids will be publicly opened at the time set for opening in the Notice to Bidders. Their content will be made public for the information of Bidders and others interested, who may be present either in person or by representative.

10. Award of Contract

(a) Award of contract will be made to the low responsible Bidder whose bid, conforming to the Invitation for Bids, is most advantageous to the City, price and other factors considered.

(b) The City Council may, when in its interest, reject any or all bids.

(c) The City may accept any item or combination of items of a bid, unless precluded by the Invitation for Bids or the Bidder includes in its bid a restrictive limitation.

11. Bonds and Insurance

(a) If the successful bid is in excess of $25,000, the bidder to whom the contract is awarded shall furnish a Payment Bond on forms approved by the City, executed by a corporate surety acceptable to the City and authorized to issue such surety bonds in the State of California. The Payment Bond shall be in an amount equal to 100% of the Contract Price. The entire cost of bond shall be borne by the successful Bidder.

(b) The successful Bidder shall furnish a Performance Bond on forms approved by the City, executed by a corporate surety acceptable to the City, and authorized and admitted to issue surety bonds in California. The Performance Bond shall be in an amount equal to 100% of the Contract Price. The entire cost of the Performance Bond shall be borne by the successful Bidder.

(c) The successful Bidder shall deliver to the City certification attesting to the fact that the required policies of insurance have been obtained by the Bidder to the limits described in section 5.1.1 of the *General Conditions (pg GC-3)*.

(d) The signed contract, required bonds and certificates of insurance shall be delivered to the City within 10 calendar days after receipt by Bidder of City's Notice of Award.

12. Subcontractors

(a) Each Bidder in its bid shall set forth the following:

(1) The name and location of the place of business of each subcontractor whom it intends to use to perform work or labor, or render service to the Bidder in or about construction of any work, in an amount in excess of 0.5% of the Base Bid. (California law forbids the substitution of subcontractors on public works projects, such as this project, except under very narrow and limited circumstances.)

(2) The portion of the work which will be done by each such proposed subcontractor, if the Bidder is awarded the Contract.

(b) Each Bidder shall furnish such information in substantially the form set forth in the Invitation for Bids. If no subcontractors are to be used, other than within the 0.5% limit referred to above the Bidder shall state "None" on the form.

(c) Each proposed subcontractor must complete a Subcontractor's Experience Statement, which shall be attached to the List of Proposed Subcontractors in order for the bid to be considered complete.

13. Noncollusion Affidavit

Each Bidder shall include a noncollusion affidavit with its bid in substantially the form set forth in the Invitation for Bids.

14. Permits and Fees

The Bidder's attention is called to the requirements of the General Conditions regarding the acquisition of and payment for permits, licenses and fees related to the work of this project. All such acquisitions and payments are the sole responsibility of the Contractor. It is the sole responsibility of the Bidder to contact agencies or utilities having jurisdiction over the project to ascertain the extent of permits and fees required and the cost thereof, and to include all such costs in its bid.

15. Prevailing Wage Rates

Not less than the general prevailing rate of per diem wages for work of a similar character in the locality in which this contract is to be performed, and not less than the general prevailing rate of per diem wages for holiday and overtime work fixed as provided in Chapter 1 (commencing with Section 1720) Part 7, Division 2 of the Labor Code, shall be paid to all workers employed on this public work. Should the prevailing wage rate be increased, decreased, or eliminated a corresponding adjustment shall be made to the Contract Price which shall reflect the effect of that change in or elimination of the prevailing wage rate. A copy of the applicable rate of per diem wages is on file in the office of the City Clerk, 420 South Imperial Avenue, Imperial, California.

The successful Bidder must also comply with statutory requirements relating to certified copies of payroll and maintenance records, and availability for inspection of same. Successful Bidder must comply with statutory requirements relating to employment of apprentices. In accordance with Labor Code Section 1810, eight hours labor constitutes a legal day's work.

16. Construction Schedule

After the Contract Documents are executed, the City will give the Contractor notice to proceed. After this notice is given, the Contractor shall substantially complete the project within **Two Hundred and Fifty (*250)*** Calendar days. The Contractor will be liable for damages for any inexcusable delay beyond this period. Liquidated damages for such delay shall be $500 per calendar day for each day past the

substantial completion date.

17. Deparment of Contractors and Subcontractors

In accordance with the provisions of the Labor Code, contractors or subcontractors may not perform work on a public works project with a subcontractor who is ineligible to perform work on a public project pursuant to Section 1777.1 or Section 1777.7 or the Labor Code. Any contract on a public works project entered into between a contractor and a debarred subcontractor is void as a matter of law. A debarred subcontractor may not receive any public money for performing work as a subcontractor on a public works contract. Any public money that is paid to a debarred subcontractor by the Contractor for the Project shall be returned to the City. The Contractor shall be responsible for the payment of wages to workers of a debarred subcontractor who has been allowed to work on the Project.

Verification of Compliance with Economic Sanctions

Per California Executive Order N-6-22, the City of Imperial is required to assure that all contractors doing business with the City of Imperial are in compliance with economic sanctions imposed by the U.S. government in response to Russia's actions in Ukraine, as well as sanctions imposed under state law, if any. Please execute this document to verify current compliance of contractor with Executive Order N-6-22 and to ensure that this project will be in compliance with Executive Order N-6-22.

NOTICE: Having conducted a good faith review, I attest that the contractor submitting this bid is in compliance with the economic sanctions imposed by the U.S. government in response to Russia's actions in Ukraine, as well as sanctions imposed under state law, if any. Further, I attest that I am aware of Executive Order N-6-22 and agree monitor the project to ensure the project remains in compliance with Executive Order N-6-22.

[INSERT SIGNATURE HERE]

Note that responses may be subject to disclosure under the California Public Records Act. Accordingly, it is within the discretion of the respondent to determine what information to provide. Additionally, please do not include any confidential information or disclosures that could pose security risks.

BID FORM

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

BID 2022-05

To: City Of Imperial
Public Works Department
420 South Imperial Avenue
Imperial, California 92251

In response to the Invitation for Bids, the undersigned Bidder hereby proposes to furnish all labor, material, equipment and services and perform and complete all work required for the **Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project** as described in the Plans and Specifications.

Performance shall include all work necessary to complete the Project in strict accordance with the Contract and for the price(s) to be specified by the Bidder below, including all applicable taxes.

Bidder certifies that it has examined and is fully familiar with all of the provisions of the Invitation for Bids and any Addenda thereto; that it is submitting this Bid in strict accordance with the Instructions to Bidders; and that it has carefully reviewed the accuracy of all statements attached to this Bid.

Bidder certifies that it has visited and examined the work site (Optional), and is satisfied with the nature and location of all work, the general and local conditions to be encountered in the performance of the work, the requirements of the Contract and all other matters which can in any way affect the work or the cost thereof. Bidder further certifies that Bidder has performed such tests deemed necessary for the preparation of this bid.

Bidder agrees that this Bid constitutes a firm offer to the City which cannot be withdrawn by Bidder for 60 calendar days from the date of actual opening of bids. If awarded the Contract, Bidder agrees to execute and deliver to the City within 10 calendar days after receipt of City's Notice of Award, the applicable Construction Contract form and the required Payment Bond, Certificates of Insurance, and any other required Contract Documents.

BIDDING SCHEDULES

CLEARWELL PUMP STATION REPLACEMENT AND GAC TREATMENT EXPANSION AND FILTER PIPING REPLACEMENT AT THE WATER TREATMENT PLANT PROJECT

CITY OF IMPERIAL

BID SCHEDULE I – Booster Station and GAC Expansion

Item No.	Description Unit Price Written in Words	Unit Price	Total Amount (Figures)
1.	**Mobilization**(1); Including: bonds, insurance, breakdown of contract price, potholing of existing utilities prior to commencing construction, bonds, shop drawings and submittals, weekly meetings, and demobilization; complete for the lump sum price of: _____ _____ _____ _____ (words)	Lump Sum	$_____*
2.	**Metal Building**; Construct 31.25'W x 65'L x 12'H (eave height) pre-engineered steel building, including over excavation, re-compaction, subgrade material, concrete footings, slab, and concrete stoops, install and supply one (1) 10'W x 10'H roll-up door, man doors, exhaust fan, electrical room air conditioner (3 Ton), skylights, fixed acoustic louver, interior and exterior lighting, partition wall, switches, receptacles, finish work and all hardware and appurtenances all as shown on the Drawings and as stated in the Specifications; complete in place for the lump sum price of: _____ _____ _____ _____ (words)	Lump Sum	$_____*

(1) For payment purposes, Bid Item 1 will be split 75% for mobilization versus 25% for demobilization, and the amount for Bid Item 1 shall not exceed 5% of the total bid price.

* Prices include any amount payable by the City for taxes by reason of the Contract

Item No.	Description Unit Price Written in Words	Unit Price	Total Amount (Figures)
3.	**VFD Booster Pumps & Related Piping;** Furnish and install three (3) new 40HP vertical turbine pumps and 20" diameter reinforced concrete pump cans, 12" dia. standard weight steel suction/discharge piping, 12" dia. flexible couplings, 12" check valves, 12" mag meters, 12" gate valves, air valves, pressure gauges, 24" dia. discharge steel or ductile iron discharge header to Connection No. 1, including all fittings and appurtenances; all as shown on the design drawings and as stated in the Specifications; complete for the lump sum price of: _____ _____ _____ _____ _____ (words)	Lump Sum	$_____*
4.	**Clearwell Installation;** Install three (3) new 120" dia. manholes x 24' w/30" frame and cover with water tight joints and NSF 61 materials; including excavation, re-compaction, dewatering, preparation of sub-grade; 18" crushed rock and 12" thick cast in place reinforced concrete base; 4" air vent, two (2) 24" dia. butterfly valves w/valve cans and 24" dia. steel piping between manholes; core and seal holes for 12" dia. inlet/outlet piping and 24" piping; (3) 12" dia. butterfly valves w/valve cans; installation of electrical measuring devices and float back-up system per the project specifications; all as shown on the design drawings and as stated in the Specifications; complete for the lump sum price of:_____ _____ _____ _____ (words)	Lump Sum	$_____*

* Prices include any amount payable by the City for taxes by reason of the Contract

Item No.	Description Unit Price Written in Words	Unit Price	Total Amount (Figures)
5.	**GAC Adsorption System;** Install two (2) new GAC Adsorption systems (4 vessels) with all associated piping, and valving for a complete and operational system; including placement of select import material and Class 2 base material; 4-inch A.C. paving, A.C. berm, GAC reinforced concrete pad and paving, and initial fill of virgin granular activated carbon (20,000 lbs per vessel); all as shown on the design drawings and as stated in the Specifications; complete for the lump sum price of:_____ _____ _____ _____ (words)	Lump Sum	$_____*
6.	**Instrumentation & Controls Work**; Including: design and provide new PLC panel PLC-F; design and provide new Filter Console A and Filter Console B; provide instrumentation for the new clear wells and pumps including level transmitters, float switches, pressure gauges and magnetic flow meters; instrumentation for the new GAC units including pressure gauges, magnetic flow meters, and flow transmitter enclosure; coordination of programming with the owner's system integrator; factory acceptance testing of PLC-F; loop drawings; instrument setup and calibration; coordination of startup and commissioning and all other miscellaneous instrumentation and controls work; all as shown on the design drawings and as stated in the Specifications; complete for the lump sum price of:_____ _____ _____ _____ (words)	Lump Sum	$_____*

* Prices include any amount payable by the City for taxes by reason of the Contract.

Item No.	Description Unit Price Written in Words	Unit Price	Total Amount (Figures)
7.	**Electrical**; Including: demolition of existing clear well pumps, associated VFD panels, and controls; add a 350A feeder to existing 480V main switchboard; 480V motor control center MCC-CW, 480V power panels EPP-4, EPP-5, and EPP-6; transformer and 120/208V lighting panel ELP-6; 480V power and controls for booster pumps and associated clear wells; demolition of existing filter PLC panel and consoles; installation of new filter PLC panel and consoles and relocation of all associated conduit and wire to the new PLC panel; installation of flow meters and flow meter panel for the new GAC units; lighting, receptacles, conduit, wire, grounding, junction boxes, pull boxes and all other miscellaneous electrical work; all as shown on the design drawings and as stated in the Specifications; complete for the lump sum price of:_____ _____ _____ _____ (words)	Lump Sum	$_____*
8.	**Site Work**; Including: Fill import/excavation as required to meet design grades; asphalt paving, adjustment of all valve cans to finish grade; relocation of existing chemical line in conflict with construction of metal building, removal and disposal of any excess excavated material as required to meet design grades and all other site work as indicated on the Drawings; complete for the lump sum price of:_____ _____ _____ _____ (words)	Lump Sum	$_____*

* Prices include any amount payable by the City for taxes by reason of the Contract.

Item No.	Description Unit Price Written in Words	Unit Price	Total Amount (Figures)
9.	**Miscellaneous Work;** Including: Chlorination and disinfection; hydro-static pressure testing and miscellaneous testing; eyewash/shower; trench shoring, sheeting and bracing per California Labor Code; field start-up, testing, operational demonstrations and operation and maintenance manuals; and <u>including</u> the cost of all contract work not specifically listed in any other Bid Item (Nos. 1 through 8) herein; complete for the lump sum price of: _____ _____ _____ (words)	Lump Sum	$_____*

Total Bid Schedule I **$_____***
(Sum of Extension Nos. 1 thru 9) **(Figures)**

TOTAL BID PRICE FOR BID SCHEDULE I _____

_____

_____ DOLLARS

(DOLLAR AMOUNT IN WRITTEN FORM)

BID SCHEDULE II – Filter Piping Replacement and Yard Piping

Item No.	Description	Qty[(1)]	Unit	Unit Price[*]	Bid Extensions[*]
201	Pothole existing utilities prior to construction	40	EA.	$_____	$_____
202	Provide and install 16-inch dia. welded steel (concrete mortar lined and outside painted) or 316 stainless steel filter piping and fittings within existing filter building. Provide pipe supports to match existing as shown on the plans.	30	L.F.	$_____	$_____
203	Furnish and install 24-inch dia. welded steel (concrete mortar lined and outside painted) 316 stainless steel filter piping and fittings within existing filter building. Provide pipe supports to match existing as shown on the plans.	60	L.F.	$_____	$_____
204	Furnish and install 24-inch dia. welded steel (concrete mortar lined and coated) filter piping and fittings from existing building to connection point and clearwells.	120	L.F.	$_____	$_____
205	Connection to existing 24" Dia. steel filter piping as shown on Sheet 6 with butt-straps and fittings.	1	EA.	$_____	$_____
206	Trench sheeting, shoring and bracing.	1	L.S.	$_____	$_____

[(1)] Quantities (except for "Lump Sum:" item numbers) are estimated and are for the purpose of comparing bid only. Payment will be based upon actual quantities furnished, installed or constructed in accordance with the Contract Documents.

[*] The above prices include any amount payable by the City for taxes by reason of this contract.

Item No.	Description	Qty[1]	Unit	Unit Price*	Bid Extensions*
207	Core 30-inch dia. hole through existing building wall and seal around pipe	1	L.S.	$_____	$_____
208	Relocate (flip) existing 24-inch butterfly valves and actuators, including necessary electrical modifications.	3	EA.	$_____	$_____
209	2" Blow Off Installation per City of Imperial Std. Dwg. No. 505 (including guard posts)	2	EA.	$_____	$_____
210	Remove and dispose of existing filter piping within building, including filling existing belowgrade piping with slurry once new pipe is in service and 18-inch blind flanges.	1	L.S.	$_____	$_____
211	Prepare and Implement Groundwater Dewatering Plan in accordance with Section 02140.	1	L.S.	$_____	$_____
212	Force Account Work	1	L.S.	$ 50,000	$ 50,000
213	Furnish and install 24" Dia. Butterfly Valve per City of Imperial Std. Dwg. No. 102.	6	EA.	$_____	$_____
214	Furnish and install 24-inch dia. Class 250 ductile iron or Class 200 PVC pipe from connection Detail 1 to Connection Detail 2 as shown on C-5 and the project specifications.	231	L.F.	$_____	$_____

[1] Quantities (except for "Lump Sum:" item numbers) are estimated and are for the purpose of comparing bid only. Payment will be based upon actual quantities furnished, installed or constructed in accordance with the Contract Documents.

* The above prices include any amount payable by the City for taxes by reason of this contract.

Item No.	Description	Qty[1]	Unit*	Unit Price	Bid Extensions*
215	Remove and replace existing motorized valve actuators within the filter complex building as indicated on Dwg. No. E102 and the project specifications.	10	EA	$_____	$_____
216	Connection Detail 1 including excavation, cutting of existing 24-inch dia. PVC pipe, couplings, fittings, and compaction as shown on C-5 and the project specifications.	1	LS	$_____	$_____
217	Connection Detail 2 including excavation, cutting of existing 24-inch dia. PVC pipe, couplings, fittings, and compaction as shown on C-5 and the project specifications.	1	LS	$_____	$_____
218	Pressure testing, chlorination, and disinfection of pipelines along with all other work in the Contract Documents not outlined in Bid Items 201 to 217 to make the system operational.	1	L.S.	$_____	$_____

Total Bid Schedule II $_____*

(Sum of Extension Nos. 201 thru 218) (Figures)

TOTAL BID PRICE FOR BID SCHEDULE II_____

_____

_____ DOLLARS

(DOLLAR AMOUNT IN WRITTEN FORM)

[1] Quantities (except for "Lump Sum:" item numbers) are estimated and are for the purpose of comparing bid only. Payment will be based upon actual quantities furnished, installed or constructed in accordance with the Contract Documents.

* The above prices include any amount payable by the City for taxes by reason of this contract.

PROPOSAL
BIDDING SHEET SUMMARY
(to be filled in by Bidder)

TOTAL BID PRICE FOR BID SCHEDULE I (Nos. 1 thru 9) $ _____ *

TOTAL BID PRICE FOR BID SCHEDULE II (Nos. 201 thru 218) $ _____ *

TOTAL BID PRICE FOR SCHEDULES I and II $ _____

_____

_____

_____ DOLLARS

(DOLLAR AMOUNT IN WRITTEN FORM)

The undersigned agrees that these Proposal/Bid Forms constitute a firm offer to the City which cannot be withdrawn for the number of Calendar Days indicated in the Notice Inviting Bids from and after the bid opening date, or until a Contract for the Work is fully executed by the City and a third party, whichever is earlier. The undersigned also agrees that if there is a discrepancy between the written amount of the Bid Price and the numerical amount of the Bid Price, the written amount shall govern.

Acknowledgement of reading above statement:

By: _____ _____
Signature **Date**

CERTIFIED DATA SHEET

(Supplemental Instructions: 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. Awarding of a contract under this bid will not imply approval by the City of Imperial of the manufacturers and/or suppliers listed by the bidder. No substitution will be permitted after award of contract unless equipment or material of the listed manufacturer or supplier cannot meet the specifications.)

Item	Manufacturer and Supplier
1. Steel Pipe and Fittings	_____
2. Butterfly Valves	_____
3. GAC Adsorption System	_____
4. Granular Activated Carbon	_____
5. Pumping Units	
Pump	_____ (Manufacturer/Model)
Motor	_____ (Manufacturer)
6. Motor Control Center	
Manufacturer	_____
MCC Model No.	_____
7. Electrical Service Equipment	
Manufacturer	_____
Model No.	_____

8. Variable Frequency Drives

    Manufacturer _____

    Model No. _____

9. Check Valves _____

10. Resilient Seat Gate Valves _____

11. Air Release Valves _____

12. Pressure Gauges _____

13. Magnetic Flow Meters _____

14. Ductile Iron Pipe _____

15. Electric Actuators

    Manufacturer _____

    Model No. _____

ATTACHMENTS

Attached are the following forms which have been completed by Bidder and made a part of this bid:

1. List of Proposed Subcontractors;

2. Noncollusion Affidavit;

3. Contractor's Certificate Regarding Workers' Compensation

ADDENDA

Bidder also acknowledges receipt of the following Addenda, which Addenda have been considered by Bidder in submitting this Bid (if none, state "None"):

Addenda Nos. _____

CONTRACTOR'S LICENSE

Bidder certifies that Bidder is currently licensed under the California State Contractor's License Law as follows:

Contract License Number	Name of Licensee	Type of License	Issue and Expiration date

COMPLETION TIME

The Project, including its respective components, must be substantially completed within ***Two Hundred and Fifty (250) Calendar*** days after the notice to proceed. Substantial completion is defined in the Special Requirements. Bidder certifies that it can complete the Project within this time period.

Submitted by,

BIDDER'S NAME:

_____

By: _____

Title :_____

BIDDER'S BUSINESS ADDRESS:

_____

_____

BIDDER’S TELEPHONE AND FAX NUMBERS:

_____

_____

IF BIDDER IS A CORPORATION:

State and date of incorporation

_____

IF A PARTNERSHIP OR JOINT VENTURE:

Full names of all partners or joint venturers (attach additional pages if necessary)

_____

_____

DIRECTIONS FOR SUBMITTING BIDS:

1. The envelope containing the original of this Bid Form with all attachments must be sealed, marked, and addressed as follows:

   a. Marked in the lower left-hand corner of the envelope:

      The City of Imperial**, Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project – BID NO. 2022-05**

   b. Addressed to:

      Jillian Mehdipour, Public Records Analyst
      City of Imperial
      420 South Imperial Avenue
      Imperial, CA 92251

LIST OF PROPOSED SUBCONTRACTORS

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project
BID 2022-05

NAME OF BIDDER: _____

If awarded the Contract, Bidder shall employ the following subcontractors who will perform work or labor, or render service to the Bidder in or about the project, in an amount in excess of 0.5% of the bid lump sum listed on the Bid Form. If no subcontract work is proposed, other than within the 0.5% limit set forth, Bidder shall so state. (Attach additional pages if necessary.)

Names and Addresses of Subcontractors	Description of Work to be Subcontracted	DIR Registration Number

Bidder _____ Date _____
Firm Name

Signed by _____ _____
Name Title

BID BOND

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

(Not required if Certified Check of Cashier's Check accompanies Bid)

KNOW ALL PERSONS BY THESE PRESENTS: That we_____
as Principal, and _____
as Surety, are held and firmly bound unto the City of Imperial, in the sum of $_____
[10% OF THE TOTAL AMOUNT OF THE BID] for the payment of which sum we hereby bind ourselves, our successors, heirs, executors, and administrators, jointly and severally, firmly as set out more fully herein.

The condition of the foregoing obligation is such that, whereas the above principal is about to submit to the City of Imperial a bid for the performance of the work for the above project in compliance with the plans and specifications therefore and pursuant to a published notice inviting bids.

Now, if the bid of the principal is accepted and the work awarded to the principal by the City of Imperial, and if the principal shall fail or neglect to enter into a contract, therefore, in accordance with the provision of said bid and the accompanying Instructions to Bidders and to furnish adequate faithful performance and labor and material surety bonds and certificates of insurance to the satisfaction of the City of Imperial; then the total sum guaranteed by this bond is forfeited to the City of Imperial as liquidated damages.

In the event suit is brought by the City of Imperial and judgment is entered in its favor, the surety shall pay all costs incurred by the City in such suit, including reasonable attorneys' fees to be fixed by the Court, in addition to the above sum.

WITNESS our hands and seals this _____ day of _____, 2022.

(Seal)

By_____ Name/Title_____

(Seal)

NOTE: Signatures of those executing for the surety must be properly acknowledged.

Bond No. _____

NONCOLLUSION AFFIDAVIT

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

(To Be Executed by Bidder and Submitted With Bid)

State of California) ss.
County of _____)

_____, being first duly sworn, deposes and says that he or she is _____ of _____, the party making the foregoing bid, that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive or a sham; that the bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder of any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and, further, that the bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed this ____day of _____, 2022 at _____.

Signature of:
Bidder, if the Bidder is an Individual,
Partner, if the Bidder is a Partnership,
Officer, if the Bidder is a Corporation
Name_____
Title_____

GENERAL CONDITIONS

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

1.0 PARAGRAPH HEADINGS AND DEFINITIONS

1.1 Paragraph headings in this Contract are for convenience only, and are not to be construed to define, limit, expand, interpret, or amplify the provisions of this Contract. When initially capitalized in this Contract, or amendments hereto, the following words or phrases shall have the meanings specified:

1.2.1 Adjusted Contract Price - The initial Contract Price adjusted for change orders, Force Majeure, termination for convenience or any other reason permitted by this Contract.

1.2.2 Best Efforts - Those efforts which a competent, experienced, and prudent contractor would use to perform and complete the requirements of this Contract in a timely manner, exercising the degree of care, competence, and prudence customarily imposed on a contractor performing similar work in the State of California.

1.2.3 Contract - This agreement, including all referenced documents, between the City of Imperial and Contractor for the performance of the Work, and subsequent written modifications executed by the City and Contractor.

1.2.4 Contractor - The legal entity which executes this Contract with the City to perform the Work.

1.2.5 Contract Manager- The title of the person designated by the City to be its representative with authority to act for and bind the City.

1.2.6 Documentation - Drawings, plans, models, studies, surveys, specifications, reports, design analysis, data, policies, information, work product, proposals, and any other similar documents or material prepared or used in connection with the Work.

1.2.7 Final Completion Date - The date when the Work is completed in accordance with the Contract, including all Punch List Items.

1.2.8 Force Majeure - An act of God, or event beyond the control of a party, including an act or omission of government, act or omission of civil or

military authority, strike or lockout, act of a public enemy, war, blockade, insurrection, riot, epidemic, landslide, earthquake, fire, storm, lightning, flood, washout, or civil disturbance which could not have been avoided through the exercise of reasonable care and prudence.

1.2.9 Price or Contract Price - The total sum to be paid by the City to Contractor for performance of the Work.

1.2.10 Project - Contractor shall furnish all labor, material, equipment and services and perform and complete all work required as per the project specifications.

1.2.11 Project Engineer or Coordinator - The title of the person designated by the City to be its representative with authority to act for the City regarding engineering and construction matters.

1.2.12 Punch List Items - Items of work comprising a part of the Work as set out on a Punch List prepared by the City, with said items to be completed by Contractor consistent with the terms and conditions and scope of the Contract.

1.2.13 Schedule - The time frame for the construction project as established by the City and/or the Contract Documents.

1.2.14 Site - The area where Contractor shall perform the Work.

1.2.15 Work or Scope of Work - All obligations undertaken by Contractor pursuant to the Contract.

2.0 SCOPE OF WORK

Contractor shall perform and complete the Work in a safe manner, and shall supply all personnel, tools, equipment, and material to complete the Work. The scope of work is further established in the following documents: Plans and Specifications**.**

3.0 SCHEDULE

Contractor shall perform and substantially complete the Work within ***Two Hundred and Fifty (250) Calendar*** days after the date in the notice to proceed. After execution of this Contract, Contractor shall develop and submit for City's approval, a detailed construction schedule designed to meet City's project schedule. Any abnormal expenses such as premium time or overtime incurred by Contractor to meet the detailed schedule, unless specifically directed or approved by the City in writing, shall be borne by Contractor.

4.0 COMPENSATION AND PAYMENT

The City shall compensate Contractor through progress payments according to percentage of completion and/or milestones, as determined by the City Contract Administrator or as agreed hereafter by the parties. The City shall not be obligated to make final payment(s) until Contractor has submitted to the City written evidence that the Work has been fully completed in accordance with this Contract, and satisfactory evidence that all of Contractor's indebtedness in connection with the Work has been paid or written releases provided of all potential liens arising out of this Contract. Upon receipt of such evidence, the City will record a Notice of Completion in Imperial County. City shall retain 5% of the Contract Price. Contractor may substitute securities or provide an escrow agreement pursuant to California Public Contracts Code section 22300.

5.0 INSURANCE AND BONDS

5.1 Prior to the beginning of and throughout the duration of the Work, CONTRACTOR and its subcontractors shall maintain insurance in conformance with the requirements set forth below. CONTRACTOR will use existing coverage to comply with these requirements. If that existing coverage does not meet the requirements set forth herein, CONTRACTOR agrees to amend, supplement or endorse the existing coverage to do so.

CONTRACTOR acknowledges that the insurance coverage and policy limits set forth in this section constitute the minimum amount of coverage required. Any insurance proceeds available to CONTRACTOR or its subcontractors in excess of the limits and coverage identified in this Agreement and which is applicable to a given loss, claim or demand, will be equally available to CITY.

A. CONTRACTOR shall provide the following types and amounts of insurance:

Without limiting CONTRACTOR’s indemnification of CITY, and prior to commencement of Work, CONTRACTOR shall obtain, provide and maintain at its own expense during the term of this Agreement, policies of insurance of the type and amounts described below and in a form satisfactory to CITY.

5.1.1 General Liability Insurance – CONTRACTOR shall commercial general liability insurance with coverage at least as broad as Insurance Services Office from CG 00 01, in an amount not less than $1,000,000 per occurrence and $2,000,000 general aggregate, for bodily injury, personal injury, and property damage, and a $2,000,000 completed operations aggregate. The policy must include contractual liability that has not been amended. Any endorsement restricting standard ISO “insured contract” language will not be accepted.

5.1.2 Automobile liability insurance. CONTRACTOR shall maintain automobile insurance at least as broad as Insurance Services Office form CA 00 01 covering bodily injury and property damage for all activities of the CONTRACTOR arising out of or in connection with Work to be performed under this Agreement, including coverage for any owned, hired, non-owned or rented vehicles, in an amount not less than $1,000,000 combined single limit for each accident.

5.1.3 Umbrella or excess liability insurance. [Optional depending on limits required] CONTRACTOR shall obtain and maintain an umbrella or excess liability insurance that will provide bodily injury, personal injury and property damage liability coverage at least as broad as the primary coverages set forth above, including commercial general liability, automobile liability, and employer's liability. Such policy or policies shall include the following terms and conditions:

- A drop-down feature requiring the policy to respond in the event that any primary insurance that would otherwise have applied proves to be uncollectable in whole or in part for any reason;
- Pay on behalf of wording as opposed to reimbursement;
- Concurrency of effective dates with primary policies;
- Policies shall "follow form" to the underlying primary policies; and
- Insureds under primary policies shall also be insureds under the umbrella or excess policies.

5.1.4 Workers' compensation insurance. CONTRACTOR shall maintain Workers' Compensation Insurance (Statutory Limits) and Employer's Liability Insurance (with limits of at least $1,000,000) for CONTRACTOR's employees in accordance with the laws of the State of California, Section 3700 of the Labor Code. In addition, CONTRACTOR shall require each subcontractor to similarly maintain Workers' Compensation Insurance and Employer's Liability Insurance in accordance with the laws of the State of California, Section 3700 for all of the subcontractor's employees.

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.

5.1.5 Pollution liability insurance. Environmental Impairment Liability Insurance shall be written on a CONTRACTOR's 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 $1,000,000 dollars per claim and in the aggregate. All activities contemplated in this Agreement 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.

5.1.6 Builder's risk insurance. Upon commencement of construction and with approval of CITY, CONTRACTOR shall obtain and maintain builder's risk insurance for the entire duration of the Project until only the CITY has an insurable interest. The Builder's Risk coverage shall include the coverages as specified below.

The named insureds shall be CONTRACTOR and CITY, including its officers, officials, employees, and agents. All Subcontractors (excluding those solely responsible for design Work) of any tier and suppliers shall be included as additional insureds as their interests may appear. CONTRACTOR shall not be required to maintain property insurance for any portion of the Project following transfer of control thereof to CITY. The policy shall contain a provision that all proceeds from the builder's risk policy shall be made payable to the CITY. The CITY will act as a fiduciary for all other interests in the Project.

Policy shall be provided for replacement value on an "all risk" basis for the completed value of the project. There shall be no coinsurance penalty or provisional limit provision in any such policy. Policy must include: (1) coverage for any ensuing loss from faulty workmanship, Nonconforming Work, omission or deficiency in design or specifications; (2) coverage against machinery accidents and operational testing; (3) coverage for removal of debris, and insuring the buildings, structures, machinery, equipment, materials, facilities, fixtures and all other properties constituting a part of the Project; (4) Ordinance or law coverage for contingent rebuilding, demolition, and increased costs of construction; (5) transit coverage (unless insured by the supplier or receiving contractor), with sub-limits sufficient to insure the full replacement value of any key equipment item; (6) Ocean marine cargo coverage insuring any Project materials or supplies, if applicable; (7) coverage with sub-limits sufficient to insure the full replacement value of any property or equipment stored either on or off the Site or any staging area. Such insurance shall be on a form acceptable to City to ensure adequacy of terms and sublimits and shall be submitted to the City prior to commencement of construction.

5.2 Other provisions or requirements

5.2.1 Proof of insurance. CONTRACTOR shall provide certificates of insurance to CITY as evidence of the insurance coverage required herein, along with a waiver of subrogation endorsement for workers' compensation. Insurance certificates and endorsements must be approved by CITY's risk manager prior to commencement of performance. Current certification of insurance shall be kept on file with CITY at all times during the term of this

contract. CITY reserves the right to require complete, certified copies of all required insurance policies, at any time.

5.2.2 Duration of coverage. 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 Work hereunder by CONTRACTOR, his agents, representatives, employees or subcontractors. CONTRACTOR must maintain general liability and umbrella or excess liability insurance for as long as there is a statutory exposure to completed operations claims. CITY and its officers, officials, employees, and agents shall continue as additional insureds under such policies.

5.2.3 Primary/noncontributing. Coverage provided by CONTRACTOR shall be primary and any insurance or self-insurance procured or maintained by CITY shall not be required to contribute with it. The limits of insurance required herein may be satisfied by a combination of primary and umbrella or excess insurance. Any umbrella or excess insurance shall contain or be endorsed to contain a provision that such coverage shall also apply on a primary and non-contributory basis for the benefit of CITY before the CITY's own insurance or self-insurance shall be called upon to protect it as a named insured.

5.2.4 Products/completed operations coverage. Products/completed operations coverage shall extend a minimum of three (3) years after project completion. Coverage shall be included on behalf of the insured for covered claims arising out of the actions of independent contractors. If the insured is using subcontractors, the Policy must include work performed "by or on behalf" of the insured. Policy shall contain no language that would invalidate or remove the insurer's duty to defend or indemnify for claims or suits expressly excluded from coverage. Policy shall specifically provide for a duty to defend on the part of the insurer. The CITY, its officials, officers, agents, and employees, shall be included as additional insureds under the Products and Completed Operations coverage.

5.2.5 City's rights of enforcement. In the event any policy of insurance required under this Agreement does not comply with these requirements or is canceled and not replaced, CITY has the right but not the duty to obtain the insurance it deems necessary and any premium paid by CITY will be promptly reimbursed by CONTRACTOR or CITY will withhold amounts sufficient to pay premium from CONTRACTOR payments. In the alternative, CITY may cancel this Agreement.

5.2.6 Acceptable insurers. All insurance policies shall be issued by an insurance company currently authorized by the Insurance Commissioner to transact business of insurance or is on the List of Approved Surplus Line Insurers

in the State of California, with an assigned policyholders' Rating of A- (or higher) and Financial Size Category Class VII (or larger) in accordance with the latest edition of Best's Key Rating Guide, unless otherwise approved by the CITY's risk manager.

5.2.7 Waiver of subrogation. All insurance coverage maintained or procured pursuant to this agreement shall be endorsed to waive subrogation against CITY, its elected or appointed officers, agents, officials, employees and volunteers or shall specifically allow CONTRACTOR or others providing insurance evidence in compliance with these specifications to waive their right of recovery prior to a loss. CONTRACTOR hereby waives its own right of recovery against CITY, and shall require similar written express waivers and insurance clauses from each of its subconsultants.

5.2.8 Waiver of contract provisions (non estoppel). CONTRACTOR acknowledges and agrees that any actual or alleged failure on the part of the CITY to inform CONTRACTOR of non-compliance with any requirement imposes no additional obligations on the CITY nor does it waive any rights hereunder.

5.2.9 Requirements not limiting. Requirements of specific coverage features or limits contained in this Section are not intended as a limitation on coverage, limits or other requirements, or a waiver of any coverage normally provided by any insurance. Specific reference to a given coverage feature is for purposes of clarification only as it pertains to a given issue and is not intended by any party or insured to be all inclusive, or to the exclusion of other coverage, or a waiver of any type. If the CONTRACTOR maintains higher limits than the minimums shown above, the CITY requires and shall be entitled to coverage for the higher limits maintained by the CONTRACTOR. Any available insurance proceeds in excess of the specified minimum limits of insurance and coverage shall be available to the CITY.

5.2.10 Notice of cancellation. CONTRACTOR agrees to oblige its insurance agent or broker and insurers to provide to CITY with a thirty (30) day notice of cancellation (except for nonpayment for which a ten (10) day notice is required) or nonrenewal of coverage for each required coverage.

5.2.11 Additional insured status. General liability policies shall provide or be endorsed to provide that CITY and its officers, officials, employees, agents, and volunteers shall be additional insureds under such policies. This provision shall also apply to any excess/umbrella liability policies.

5.2.12 Prohibition of undisclosed coverage limitations. None of the coverages required herein will be in compliance with these requirements if they

include any limiting endorsement of any kind that has not been first submitted to CITY and approved of in writing.

5.2.13 Separation of insureds. A severability of interests provision must apply for all additional insureds ensuring that CONTRACTOR's insurance shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the insurer's limits of liability. The policy(ies) shall not contain any cross-liability exclusions.

5.2.14 Pass through clause. CONTRACTOR agrees to ensure that its subconsultants, subcontractors, and any other party involved with the project who is brought onto or involved in the project by CONTRACTOR, provide the same minimum insurance coverage and endorsements required of CONTRACTOR. CONTRACTOR agrees to monitor and review all such coverage and assumes all responsibility for ensuring that such coverage is provided in conformity with the requirements of this section. CONTRACTOR agrees that upon request, all agreements with consultants, subcontractors, and others engaged in the project will be submitted to CITY for review.

5.2.15 City's right to revise requirements. The CITY reserves the right at any time during the term of the contract to change the amounts and types of insurance required by giving the CONTRACTOR a ninety (90) day advance written notice of such change. If such change results in substantial additional cost to the CONTRACTOR, the CITY and CONTRACTOR may renegotiate CONTRACTOR's compensation.

5.2.16 Self-insured retentions. Any self-insured retentions must be declared to and approved by CITY. CITY reserves the right to require that self-insured retentions be eliminated, lowered, or replaced by a deductible. Self-insurance will not be considered to comply with these specifications unless approved by CITY.

5.2.17 Timely notice of claims. CONTRACTOR shall give CITY prompt and timely notice of claims made or suits instituted that arise out of or result from CONTRACTOR's performance under this Agreement, and that involve or may involve coverage under any of the required liability policies.

5.2.18 Additional insurance. CONTRACTOR shall also procure and maintain, at its own cost and expense, any additional kinds of insurance, which in its own judgment may be necessary for its proper protection and prosecution of the Work.

5.3 Bonds - Contractor shall furnish the following surety bond with surety acceptable to City.

5.3.1 If the successful bid is in excess of $25,000, the successful bidder shall be required to post a payment bond in the amount of the bid in accordance with California Civil Code Section §3247. This bond shall give labor and material suppliers direct right of action against the surety. Contractor shall furnish the Payment bond on a form acceptable by the City.

5.3.2 Successful Bidder shall post a Performance Bond in the amount of 100% of the Contract Price by a corporate surety authorized and admitted to issue such surety bond in the State of California.

5.4 Sureties

5.4.1 Should any surety upon any bond furnished in connection with this Contract become unacceptable to the City, or should any such surety fail to furnish reports as to its financial condition as may be requested by the City at any time while the bond is in force, Contractor shall promptly furnish such additional surety or alternate bond at Contractor's expense as may be required by the City to protect the interests of the City or of persons supplying labor or material in the performance of this Contract.

5.4.2 Contractor shall keep the sureties informed as to all material matters or changes affecting the project and this Contract.

6.0 INDEMNITY, DEFENSE AND HOLD HARMLESS AGREEMENT

CONTRACTOR shall indemnify, defend with legal counsel approved by CITY, and hold harmless CITY, its officers, officials, employees and volunteers from and against all liability, loss, damage, expense, cost (including without limitation reasonable legal counsel fees, expert fees and all other costs and fees of litigation) of every nature arising out of or in connection with CONTRACTOR's negligence, recklessness or willful misconduct in the performance of work hereunder or its failure to comply with any of its obligations contained in this Agreement, except such loss or damage which is caused by the sole or active negligence or willful misconduct of the CITY. Should conflict of interest principles preclude a single legal counsel from representing both CITY and CONTRACTOR, or should CITY otherwise find CONTRACTOR's legal counsel unacceptable, then CONTRACTOR shall reimburse the CITY its costs of defense, including without limitation reasonable legal counsel fees, expert fees and all other costs and fees of litigation. The CONTRACTOR shall promptly pay any final judgment rendered against the CITY (and its officers, officials, employees and volunteers) with respect to claims determined by a trier of fact to have been the result of the CONTRACTOR's negligent, reckless or wrongful performance. It is expressly understood and agreed that the foregoing provisions are intended to be as broad and inclusive as is permitted by the law of the State of California and will survive termination of this Agreement.

CONTRACTOR obligations under this section apply regardless of whether such claim, charge, damage, demand, action, proceeding, loss, stop notice, cost, expense, judgment, civil fine or penalty, or liability was caused in part or contributed to by an Indemnitee. However, without affecting the rights of CITY under any provision of this agreement, CONTRACTOR shall not be required to indemnify and hold harmless CITY for liability attributable to the active negligence of CITY, provided such active negligence is determined by agreement between the parties or by the findings of a court of competent jurisdiction. In instances where CITY is shown to have been actively negligent and where CITY'S active negligence accounts for only a percentage of the liability involved, the obligation of CONTRACTOR will be for that entire portion or percentage of liability not attributable to the active negligence of CITY.

7.0 GENERAL REQUIREMENTS

7.1 Physical Site Conditions - Contractor shall satisfy itself concerning the nature and location of the Work, the general and local conditions, and other restrictions affecting the Work. The failure of Contractor to acquaint itself with any applicable conditions and restrictions shall not relieve it from the responsibility for properly estimating either the difficulties or the costs of successfully performing the Work and completing this Contract, and shall not be grounds for adjusting either the price or the schedule.

7.2 Independent Contractor - Contractor represents that it is fully experienced and properly qualified to perform the Work, is properly licensed in the state where the Work is performed, and is equipped, organized, and financed to perform such Work. The Contractor or a subcontractor of the Contractor shall act as an independent contractor and not as an agent of the City in performing the Work and duties of this Contract.

7.3 Performance Requirements

7.3.1 Best Efforts - Contractor shall use Best Efforts in the performance of this Contract. Contractor shall, to the best of its abilities, cooperate with the City to enable the successful completion of the Work according to the terms of this Contract including, but not limited to, commitment of additional resources, material and personnel, if requested by the City, to assure that the Work is properly performed on time and completed in accordance with the provisions of this Contract.

7.3.2 Quality of Equipment Supplied by Contractor - Contractor shall provide and use only such construction equipment and facilities as are capable of producing the quality and quantity of Work required by this Contract within the time specified herein. Upon written notice from the City or its designated representative, Contractor shall promptly remove from the Site

all unsatisfactory construction equipment and facilities furnished or provided by Contractor.

7.4 Precedence of Operating Facilities - Continuity of service of the operating facilities is of the essence. In the event of a conflict of interest between any and all Work and any operating facilities, the operating facilities shall have precedence.

7.5 Responsibility for Work and Material - Contractor shall be responsible for and shall bear all risk of loss of or damage to Work in progress, all Work-related material and equipment delivered to the Site or in transit under Contractor control, until completion and final acceptance of the Work.

8.0 CHANGES

8.1 General - Notwithstanding any other provisions of this Contract to the contrary, the City reserves the right for any reason, without invalidating this Contract or without notice to sureties, to make any changes in the Work including the performance of additional services. Such change shall be made in writing by a City representative, except for emergency conditions, where such change shall be confirmed in writing.

8.2 Price of Change - All change orders shall be accepted by Contractor pursuant to the terms contained in this Contract and Contractor shall promptly proceed to implement such change. Should any change result in an increase or decrease in Price or a change in Schedule, Contractor shall, within 10 calendar days following receipt of the written change order, submit to the City a written proposal which illustrates the price for Contractor to perform the change and the proposed adjustment to the Schedule. Sufficient detail shall be given in the proposal to permit a thorough analysis and evaluation. No claim shall be made by Contractor based solely on the number or volume of changes made.

8.3 Price Adjustment - The price of such change will be agreed upon by the parties. If the parties cannot agree, an adjustment will be determined by the City on the basis of Contractor's reasonable expenditures and savings, including a reasonable allowance for overhead and profit.

8.4 Delegation - Only a City officer, or the designated City representative concerning the Project, may issue and sign written change orders on behalf of the City.

8.5 Contractor Objections - In the event a change requested by the City would, in the opinion of Contractor, affect Contractor’s ability to meet its obligation under the Contract, Contractor will deliver to the City, within 5 calendar days of receipt of the change request, written notice of the fact before accepting such change request. If the City feels such a change is warranted, an appropriate modification to the Contract shall be made before the Contractor is required to proceed.

8.6 Changes by Contractor - The Contractor may propose changes in the specifications for reasons of improved quality, delivery or economy provided such changes do not impair quality or delivery. Such changes must be approved in writing by the City prior to implementation. Approval shall be at the discretion of the City.

9.0 WARRANTY

9.1 Performance and Workmanship - Contractor warrants that the workmanship performed by Contractor and its subcontractors will be performed in accordance with Best Efforts. The warranty period shall be for a period equal to 1 year after the Final Completion Date.

10.0 RETENTION AND ACCEPTANCE OF MATERIAL AND WORKMANSHIP

10.1 Retention - The City shall retain 5% of the Contract price. The retention shall be released (with the exception of 150% of any disputed amount) within 35 days after the date of final completion of the work. Contractor may substitute securities in place of the retained funds withheld by the City. Alternatively, an escrow agreement, in the form prescribed under Ca. Pub. Cont. Code Section 22300, may be used by Contractor.

10.2 Inspection of Work - All Work and materials, both before and after installation, shall be subject to City's inspection, and any deficiencies detected by the City will be addressed by Contractor immediately. The City may take inventory and inspect the Work and witness tests thereon at all reasonable times and places during the progress of the Work. If Contractor covers all or any portion of the Work prior to any inspection or tests as required by the Scope of Work, the cost of any necessary uncovering and replacing shall be borne by Contractor.

10.3 Notice of Completion

10.3.1 When Contractor, in its opinion, has completed the performance of the Work, it shall so notify the City in writing that the Work is completed and ready for final acceptance by the City. Within 10 calendar days after receipt of such written notice, the City shall inspect the Work and advise Contractor of its concurrence.

10.3.2 If the City advises Contractor that the Work is not satisfactorily completed, the City shall at the time of such notice, submit to Contractor, a Punch List of all additions and corrections necessary for the completion of this Contract.

10.3.3 Upon receipt of the Punch List, Contractor shall commence action with respect thereto at no cost to the City. All corrections shall be made within

the time period given in the Contract as established in the Project Schedule. Upon completion of such Work, Contractor shall again notify the City in writing that the Work is completed and ready for final acceptance by the City. Within 10 calendar days after receipt of such written notice, the City shall inspect the Work and advise Contractor whether it concurs. The punch List process will continue until the Work is completed to the satisfaction of the City. Contractor shall be obligated to make good, correct or modify any rejected material or workmanship prior to final acceptance of the Work by the City.

10.3.4 If the City concurs that the Work has been completed satisfactorily, the City will record a Notice of Completion with the County of Imperial which will specify the Final Completion Date. Such Notice of Completion shall not be unreasonably withheld.

11.0 FORCE MAJEURE

In the event either party by reason of a Force Majeure is rendered unable to perform its duties under this Contract, then upon the party giving written notice of the particulars and estimated duration of Force Majeure to the other party within 5 calendar days after knowledge of the occurrence of the Force Majeure, the party may have the time for performance of its duties extended for the period equal to the time performance is delayed by the Force Majeure. The effects of the Force Majeure shall be remedied with all reasonable dispatch, and the party giving notice shall use Best Efforts to eliminate and mitigate all consequences. A Force Majeure for which notice has not been given shall be an unexcused delay.

12.0 DELAYS AND EXTENSION OF TIME

Time for performance may be extended by the City because of delays such as Force Majeure, changes, or suspension. Any such extension shall not be grounds for a claim by Contractor for damages or for additional compensation, except as specifically authorized in this Contract. In the event of delay in the performance of the Work not caused by the City or its representatives, whether or not the cause thereof is within the control of Contractor, the City shall be entitled to suspend the applicable portion of the scheduled payments for the period of such delay.

13. 0 TERMINATION FOR CONVENIENCE

13.1 General - The City may, at any time, terminate the Contract or any portion of the Work not then completed by giving Contractor written notice of termination. Upon receipt of notice of termination, Contractor, unless the notice requires otherwise, shall (1) discontinue Work on the date and to the extent specified in the notice, except Work necessary to preserve and protect the Work in progress, (2) place no further orders or subcontracts for material, services, or supplies

related to terminated Work, (3) make every reasonable effort to procure termination of all orders, subcontracts, and rental agreements to the extent they relate to performance of Work terminated upon terms satisfactory to the City, and (4) otherwise minimize costs and mitigate damages to the City .

13.2 Compensation - In the event of termination under this Section, there shall be an equitable adjustment to the Contract Price taking into account, among other things (1) decreases for Work not performed, (2) the cost of any work requested by the City from the date of termination.

14.0 TERMINATION FOR CAUSE; NOTICE AND CURE OF DEFAULT

14.1 General - The City may declare this Contract canceled for default by notifying Contractor in writing, should Contractor at any time (1) materially refuse or neglect to meet the Schedule(s), (2) refuse to supply sufficient and appropriately skilled workmen or equipment to perform the Work, (3) become insolvent or unable to meet its payroll or other current obligations.

14.2 Notice of Termination - Prior to termination for cause, the City shall give Contractor written notice describing such default in reasonable detail and demand that Contractor cure such default within 30 calendar days after receipt of such notice of default. If Contractor does not cure the default within 30 calendar days after its receipt of such notice or if the default cannot be cured within such 30 calendar day period and Contractor has not initiated action or proposed a plan within such 30 calendar day period to cure the default within a reasonable period which the City reasonably agrees will cure such default, then the City shall have the right to terminate this Contract.

15.0 LAWS AND REGULATIONS

Contractor and its employees shall at all times comply with all applicable laws, including those relating to wages, hours, discrimination, and safety (including CAL/OSHA).

15.1 Third Party Claim

City shall give Contractor notification of any third party claim in accordance with Public Contract Code Section 9201. City may recover its reasonable costs incurred in providing notification.

16.0 EMPLOYEES

16.1 Prevailing Wage Law-

16.1.1 Not less than the general prevailing rate of per diem wages for work of a similar character in the locality in which this Contract is to be performed, and not less than the general prevailing rate of per diem wages for holiday and overtime work fixed as provided in Chapter 1 (commencing with Section 1720) Part 7, Division 2 of the Labor Code, shall be paid to all workers employed on this public work.

16.1.2 Should the prevailing wage rate be increased, decreased, or eliminated a corresponding adjustment shall be made to the Contract Price which shall reflect the effect of that change in or elimination of the prevailing wage rate.

16.2 Payroll Records -

16.2.1 Contractor and its subcontractors shall keep an accurate payroll record, showing the name, address, social security number, work classification, and straight time and overtime hours worked each day and week, and the actual per diem wages paid to each journeyman, apprentice, worker, or other employee employed by him or her in connection with the Project.

16.2.2 The payroll records shall be certified and shall be available for inspection at all reasonable hours at the principal office of Contractor.

17.0 SAFETY REQUIREMENTS

17.1 General - Contractor shall implement the following general safety precautions:

17.1.1 Safe Work - Contractor shall carry out the Work in a safe manner. Contractor's site representative shall be knowledgeable of all applicable safety rules, regulations and practices that relate to the assigned work. If necessary, a qualified safety representative should be contracted to fulfill this requirement.

18.0 GOVERNING LAW AND VENUE

This Contract shall be interpreted in accordance with the substantive and procedural laws of the State of California.

19.0 AUTHORIZED REPRESENTATIVES AND NOTICES

19.1 Representatives - Prior to commencement of the Work, the City and Contractor shall each designate a representative authorized to act in behalf of each party and shall advise the other party in writing of the name, address and telephone number of such designated representative and shall inform the other party of any subsequent change in such designation.

19.2 Notice and Communications - All communications relating to the day to day activities under this Contract shall be exchanged between the representatives of the City and Contractor. All legal notices and communications required under or related to this Contract shall be in writing, and shall be delivered personally or mailed by certified mail, postage prepaid, return receipt requested, to the representative of the City and Contractor identified below. Notice shall be effective on the date of delivery.

To the City:	To Contractor:
Jackie Loper	_____
Director of Public Services	
City of Imperial	_____
420 South Imperial Ave.	
Imperial, CA 92251	_____

A party may change or supplement the addresses given above, or designate additional addresses, for purposes of this Section by giving the other party written notice of the new address in the manner set forth above.

19.3 Unfair Business Practice Claims – In entering into a public works contract or subcontract to supply goods, services, or materials pursuant to a public works contract, the Contractor or subcontractor offers and agrees to assign to the City all rights, title and interest in and to all causes of action it may have under Section 4 of the Clayton Act (15 U.S.C. Sec. 15) or under the Cartwright Act (Chapter 2 (commencing with Section 16700) of Part 2 of Division 7 of the Business and Professions Code), arising from purchases of goods, services, or materials pursuant to the public works contract or the subcontract. This assignment shall be made and become effective at the time the awarding body tenders final payment to the Contractor, without further acknowledgment by the parties.

19.4 Resolution of Claims – Claims of $375,000.00 or less shall be addressed as set forth in California Public Contracts Code §§20104, set seq. In general terms, said process contemplates a meet and confer procedure and non-binding mediation as a precursor to litigation.

19.5 Utilities Relocation – The provisions of Government Code Section 4215 are hereby incorporated by this reference. Said section provides, among other things, that the Contractor will be compensated for costs of locating, repairing damage not due to the failure of the Contractor to exercise reasonable care, and removing or relocating such utility facilities not indicated in the plans and specifications with reasonable accuracy, and for equipment on the Project necessarily idled during such work. Contractor shall not be assessed liquidated damages for delay in completion of the Project when such delay was caused by

the failure of the public City or the owner of the utility to provide for removal or relocation of such utility facilities.

If Contractor discovers utility facilities not identified by City in the contract plans or specifications, Contractor shall immediately notify City and utility in writing.

20.0 ATTORNEYS FEES

If either party to this Contract shall bring any action, claim, appeal, or alternative dispute resolution proceedings, for any relief against the other, declaratory or otherwise, to enforce the terms of or to declare rights under this Contract (collectively, an Action), the losing party shall pay to the prevailing party a reasonable sum for attorneys' fees and costs incurred in bringing and prosecuting such Action and/or enforcing any judgment, order, ruling, or award (collectively, a Decision) granted therein. Any Decision entered in such Action shall provide for the recovery of attorneys' fees and costs incurred in enforcing such Decision. The court or arbitrator may fix the amount of reasonable attorneys' fees and costs on the request of either party. For the purposes of this paragraph, attorneys' fees shall include, without limitation, fees incurred in the following: (1) postjudgment motions and collection actions; (2) contempt proceedings; (3) garnishment, levy, and debtor and third party examinations; (4) discovery; and (5) bankruptcy litigation. "Prevailing party" within the meaning of this paragraph includes, without limitation, a party who agrees to dismiss an Action on the other party's payment of the sums allegedly due or performance of the covenants allegedly breached, or who obtains substantially the relief it seeks.

21.0 WAIVER

The failure of the City to insist upon strict performance of any of the terms and conditions of this Contract, or to exercise or delay the exercise of any rights or remedies provided by this Contract or by law, or the acceptance of Work or payment for Work shall not release Contractor from any of the responsibilities or obligations imposed by law or by this Contract and shall not be deemed a waiver of any right of the City to insist upon strict performance of this Contract. None of the provisions of the Contract shall be considered waived by either party except when such waivers are agreed upon in writing by the parties.

22.0 ASSIGNMENT

Contractor shall not assign the rights, nor delegate the duties, or otherwise dispose of any right, title, or interest in all or any part of this Contract, or assign any monies due or to become due to Contractor without the prior written consent of the City. Any such approved assignment or delegation shall be for the benefit of, and shall be binding on Contractor, assignee, and all future successors; and shall not relieve Contractor, assignee, or future successors of any duties or obligations. If the City approves any assignment of monies due or to become

due to Contractor hereunder, such assignment shall not become effective until at least 30 calendar days after City's approval.

23.0 ACCEPTANCE

The City will be deemed to have accepted Contractor's performance of the Work when the City officer or manager signing this Contract, or the designated representative of said officer or manager, records a Notice of Completion that the Work is accepted.

24.0 EXECUTION AND EFFECTIVE DATE

This Contract has been executed by the duly authorized officers of the parties and shall be effective as of the date that the **PROJECT CONTRACT EXECUTION DOCUMENT** is signed by the parties.

25.0 PRECAUTIONS ON THE JOB SITE

When the Work involves trenching of more than four feet in depth, Contractor shall promptly, and before the following conditions are disturbed, notify the City, in writing, of any:

25.1 Material that the Contractor believes may be material that is hazardous waste, as defined in Section 25117 of the Health and Safety Code, and that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing law.

25.2 Subsurface or latent physical conditions of Site differing from those indicated.

25.3 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 receipt of such notice, 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, shall issue a change order under the procedures described in the contract.

In the event that a dispute arises between the City and the 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 parties.

CERTIFICATE OF CONTRACTOR REGARDING WORKERS' COMPENSATION

The successful Bidder shall execute the following certificate:

I am aware of the provisions of Section 3700 of the Labor Code which require every employer to be insured against liability for workers' 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.

Dated: _____ Contractor

By_____

PROJECT CONTRACT EXECUTION DOCUMENT

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project
BID 2022-05

DATE OF CONTRACT:

NAME AND ADDRESS OF CONTRACTOR:

The City of Imperial and Contractor named above hereby mutually agree to perform this Contract in strict accordance with the following designated documents which were a part of the bid or required to be submitted under the Invitation for Bids as a part of the Contract Documents and which are hereby incorporated into this Contract by reference:

CONTRACT DOCUMENTS

1. Notice to Bidders;

2. Instructions to Bidders;

3. Bid Form, with Required Attachments;

4. General Conditions;

5. Specifications;

6. All Addenda to the Contract Documents;

7. Payment and Performance Bonds Submitted by Contractor;

8. Certificates of Insurance Submitted by Contractor; and

9. Certificate Regarding Workers' Compensation.

This Contract, together with all documents and exhibits incorporated herein by reference, constitutes the entire agreement of the parties. All prior or contemporaneous verbal agreements between the parties are revoked by this Contract.

In the event any section, sentence, clause or phrase of the Contract is adjudicated by a court of last resort, and of competent jurisdiction, to be invalid or illegal, the remainder of this Contract shall be unaffected by such adjudication, and all other provisions of this Contract shall remain in full force and effect as though the section, sentence, clause or phrase so adjudicated to be invalid had not been included herein.

PROJECT DESCRIPTION

Contractor shall furnish all labor, material, equipment and services and perform and complete all work required for the **Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project**.

ALTERATIONS

The following alterations were made in this contract before it was signed by the parties hereto (if no alternates, state "NONE"):

The Project must be completed as set forth in the Project Schedule. Bidder certifies that he/she can complete the Project, ignoring Delays and Changes as defined in the General Conditions as set forth in the Project Schedule.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the date entered on the first page of the contract.

THE CITY OF IMPERIAL

Signature _____

Title_____

Attest:

_____
Jillian Mehdipour, Public Records Analyst
City Clerk

CONTRACTOR

Signature _____

Name_____

Title

EMPLOYER IDENTIFICATION NO.
(As used on Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941)

BID 2022-05

DETAILED SPECIFICATIONS

THE CITY OF IMPERIAL
STATE OF CALIFORNIA

Clearwell Pump Station Replacement and GAC Treatment Expansion and Filter Piping Replacement at the Water Treatment Plant Project

DIVISION 1

GENERAL

DIVISION 1
TABLE OF CONTENTS

SECTION		PAGE
01340	Shop Drawings, Product Data and Samples	01340-1
01510	Construction Facilities and Temporary Controls	01510-1
01530	Protection of Existing Facilities	01530-1
01700	Project Closeout	01700-1
01820	Field Testing and Operation Demonstrations	01820-1

SECTION 01340
SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 - GENERAL

1.01 SUMMARY

This Section includes the preparation and submission of shop drawings, product data, and samples as specified herein and in the various sections of these specifications. The requirements specified herein are in addition to requirements for shop drawings, product data, samples, materials lists, substitutions of materials, or other submittals specified elsewhere in these specifications. The Conditions of the Contract and the other sections of Division 1 apply to this section as fully as if repeated herein. (Refer to "Special Provisions").

1.02 GENERAL SUBMITTAL PROCEDURES

A. SCHEDULING: Extension of Contract time will not be granted because of the Contractor's failure to make timely submittals. Do not purchase materials or equipment or begin construction activities covered by the required submittals until submittals have been reviewed, approved, and returned.

B. TRANSMITTAL: Accompany each submittal with a dated, signed and sequence numbered transmittal on forms prescribed by the City. Include information required by this form including project identification, name and address of Contractor and of subcontractor or supplier, a list of items included in the submittal, and identification of drawing numbers, specification section and paragraph numbers to which the submittal pertains, and space for Contractor's and Engineer's review and approval stamp.

C. SETS AND COPIES: Provide for approval a minimum of seven (7) sets of each required submittal.

1.03 SHOP DRAWINGS AND PRODUCT DATA

A. SHOP DRAWINGS: The term "shop drawings" as used herein includes fabrication and installation, layout and setting drawings; wiring and control diagrams; and other drawings.

1. Check and verify all field measurements and submit for review, with such promptness as to cause no delay in the Work or in that of any other contractor or subcontractor, all shop or setting drawings and schedules required for the construction activities of the various trades.
2. Drawings shall show all information required by the applicable technical section and shall be in sufficient detail as may be required

to show that fabricated materials, equipment or systems, and the positions thereof conform to the Contract Documents.

3. Shop drawings shall establish the actual detail of fabricated items, indicate proper relation of adjoining construction, amplify design details of mechanical and electrical equipment in proper relation to physical spaces in the structure, and incorporate minor changes of design or construction to suit actual conditions. Shop drawings shall be drawn to scale and shall be completely dimensioned.
4. Prepare shop drawings on sheet of same size as contract drawings or on 8-1/2" x 11" three-hole punched vellum-type sheets suitable for both xerox and ozalid reproduction.
5. Each shop drawing shall have a title block containing the following information:
   (a) Name and location of the Project.
   (b) Name and address of the Contractor.
   (c) Name and address of the subcontractor, manufacturer, supplier or distributor as applicable.
   (d) Name and address of City.
   (e) Date, scale of drawings and identification number.
   (f) Space for the Contractor's review and approval stamp.
6. Submit seven (7) blue or black line prints and one reproducible transparency of each shop drawing or email a PDF copy.

B. PRODUCT DATA: The term "product data" as used herein includes manufacturer's standard drawings, certificates of conformance, substantiating calculations and other data.
1. The data shall include all information required by the applicable technical section and shall be in sufficient detail to show that manufactured materials and equipment conform to the Contract Documents.
2. Catalog Cuts: Clearly mark each copy to indicate the product or model as well as optional sizes, finishes or other features proposed for use. Delete inapplicable data.

1.04 SAMPLE

Furnish for review samples of the various materials, together with the finish thereon, as specified for and intended to be used on or in the Work. Submit samples to the Engineer for review before purchasing, fabricating, applying, or installing such materials and finishes.

Submit samples, other than field samples, in duplicate. A cover letter shall accompany the sample and shall list all items being transmitted, designating their particular usage and

location in the Work and shall be identified as to manufacturer, trade name, style, model. One approved sample will be returned to the Contractor.

Approval of a sample shall not be taken in itself to change or modify any contract requirement. Materials, finishes, and workmanship in the completed building shall be equal in every respect to that of the approved sample.

1.05 ENGINEER'S ACTION

A. The Engineer will review the submittals with reasonable promptness, fourteen (14) calendar days maximum, and will affix the Engineer's initials or signature as follows:
   1. Submittals stamped "NO EXCEPTION TAKEN" require no further action, and fabrication or construction may proceed. The Engineer will forward to the Contractor two (2) stamped copies of shop drawings, brochures, schedules, materials lists, and other product data, except where required otherwise for the Engineer's review, approval and distribution to the Contractor.
   2. Submittals stamped "MAKE CORRECTIONS NOTED" or "APPROVED AS NOTED" require no further action, and fabrication or construction may proceed contingent upon all corrections being made as noted. Quantities returned will be as specified in paragraph 1.05.A.1.
   3. Submittals stamped "REJECTED" or "REVISE AND RESUBMIT" require the Contractor to resubmit them with reasonable promptness, and no fabrication or construction may begin. The Engineer will return to the Contractor two (2) marked copies of shop drawings, brochures, schedules, materials lists, and other product data (all stamped).

B. RESUBMITTALS: If first or subsequent submittal is stamped "REJECTED" or "REVISE AND RESUBMIT", corrective action shall be taken and resubmittal procedure shall be the same as for first submittal. Upon resubmitting, the Contractor shall direct specific attention in writing to revisions other than those corrections requested by the Engineer on the returned, original submittal or shop drawings.

C. The Engineer will check and take action on such drawings and schedules only for conformance with the design concept of the Work and compliance with information given in the Contract Documents. When so directed by the Engineer or the City, the Contractor shall make corrections required.

D. The Engineer's and City's review of shop drawings will be general only and shall not relieve the Contractor from responsibility for errors of any sort, for deviations from Drawings or Specifications, or for conflict with the construction activities of others that may result from such deviations.

Engineer's and City's review of a separate item does not indicate a review of an assembly in which the item functions.

1.06 CONTRACTOR'S ACTION

A. DISTRIBUTION COPIES: The Contractor shall be responsible for obtaining required prints and for distribution to subcontractors. Distribution copies shall be made from the transparency bearing the Engineer's stamp.

B. The Contractor shall check the drawings of his suppliers and subcontractors as well as his own drawings before submitting them. In particular, the Contractor shall ascertain that the drawings meet all requirements of the Contract Drawings and Specifications and conform to the structural and space conditions. If such shop drawings show variations from Contract Documents, whether because of standard shop practice or other reasons, the Contractor shall clearly describe such variations including other changes required to correlate the construction in his letter of transmittal.

C. Each submittal by the Contractor shall have the following Certification Statement, signed by the Contractor:

"Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable submittals and other requirements of the contract documents."

D. Submittals shall be complete in all respects. If the submittals show any deviations from the requirements of the contract documents because of standard shop practices or other reasons, the deviations and the reasons therefor shall be set forth in the letter of transmittal.

E. By submitting the submittals, the Contractor represents that the material, equipment, and other work shown thereon conforms to the contract documents, except for the deviations set forth in the letter of transmittal.

END OF SECTION 01340

SECTION 01510
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 DESCRIPTION
This Section includes the requirements for temporary facilities for the project work. Contractor shall provide the temporary facilities for the entire duration of the project work at no additional cost to the City.

1.02 FIRST AID AND PROTECTIVE FACILITIES
First aid facilities and supplies shall be kept on the jobsite. Instructions in first aid shall be given, and Contractor shall provide emergency first aid treatment and supplies for his employees sufficient to comply with all legal requirements.

1.03 FACILITIES FOR EMPLOYEES
Contractor shall, at his own expense, provide all labor, materials, equipment, and facilities which may be required to carry out effectively the provisions of these specifications.

1.04 POWER
Provide all necessary power required for operations under the contract. The Contractor shall provide and maintain in good order such modern power equipment and installation as shall be adequate, in the opinion of the City, to perform in a safe and satisfactory manner the work required by the Contract.

1.05 SANITATION
All parts of the work shall be maintained in a neat, clean, sanitary condition. Fixed and portable toilets, which are made inaccessible to flies, shall be provided wherever needed for use of employees, and their use shall be strictly enforced. All waste and refuse from sanitary facilities provided by the Contractor or from any source related to Contractor's operations shall be disposed of in a sanitary manner, satisfactory to the City, and in accordance with the laws and regulations pertaining thereto. Contractor shall rigorously prohibit and prevent committing of nuisance within the work site area or upon the City's right-of-way or adjacent to private property. Contractor shall furnish all facilities and means for proper sanitation of the work, and shall protect and safe harmless the City, its officers and employees from any liability resulting from improper or insufficient sanitation.

1.06 PROJECT CLEANUP

A. CLEANUP REQUIREMENTS:
   1. Maintain project site(s) in a neat and clean condition at all times.
   2. Abate dust nuisance by cleaning, sweeping and sprinkling with water; and other means as necessary.

3. Prevent spillage on haul routes.
4. Immediately remove excess excavated material from pipe trench except for sufficient backfill material.
5. Remove forms and lumber from site immediately after stripping.
6. Do not discharge smoke, dust or other air contaminants into the atmosphere in such quantity as will violate the regulations of any legally constituted authority.

B. COMPLIANCE: Failure of the Contractor to comply with the City's cleanup orders may result in an order to suspend work until the condition is corrected. No additional compensation will be allowed as a result of such suspension.

C. FINAL CLEANUP: Upon completion of work and before the final estimate is submitted, the Contractor shall, at his own expense and cost, satisfactorily dispose of or remove from the vicinity of the work all plants, buildings, rubbish, unused materials, concrete forms, and other equipment and materials belonging to him or used under his direction during the construction, and in the event of his failure to do so, the same may be removed and disposed of by the City at the Contractor's expense.

1.07 TRAFFIC CONTROL

A. CONTROL EQUIPMENT AND DEVICES: Provide traffic warning signs, barricades, flagmen, and other control devices as required to maintain two-way traffic, over roadways in project work area.

B. AGENCY REQUIREMENTS: Investigate and adhere to traffic control and equipment of various agencies having jurisdiction over the right-of-way in the work area.

C. COMPLIANCE: Costs for compliance with all traffic control provisions shall be considered as included in the bid unit price for various items, and no other compensation shall be made therefor.

1.08 ACCESS TO ADJACENT PROPERTIES

A. PROPERTY ACCESS REQUIREMENTS:
1. Provide access to the properties in the work area at all times during construction.
2. Notify City in advance of any necessary closure to adjacent property and provide 24 hours notice to that affected properties.
3. Provide temporary structures as required for reasonable access to the adjacent properties.
4. At least one (1) lane on cross streets shall be available at all times for use of vehicles and emergency equipment.

B. COMPLIANCE: Costs for compliance with all traffic control provisions shall be considered as included in the bid unit price for various items, and no other compensation shall be made therefor.

END OF SECTION 01510

SECTION 01530
PROTECTION OF EXISTING FACILITIES

PART 1 - GENERAL

1.01 GENERAL:

A. The Contractor shall protect all existing utilities, piping and improvements not designated for removal and shall restore damaged or temporarily relocated utilities, piping and improvements to a condition equal to or better than they were prior to such damage or temporary relocation.

B. The Contractor shall verify the exact locations and depths of all underground piping and utilities shown and not shown and shall make exploratory excavations of all piping and utilities that may interfere with the Work. It shall be the Contractor's responsibility to ascertain the actual location of all existing utilities, piping and other improvements that will be encountered in its construction operations and to see that such utilities or other improvements are adequately protected from damage due to such operations.

C. Maintaining in Service: All pipelines, electrical, power, telephone, communication cables, gas and water mains shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the Owner. Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing utility or other improvement the Contractor, after necessary scheduling and approval, shall remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to the Engineer and the owner of the facility. In all cases of such temporary removal or relocation, the Work shall be accomplished by the Contractor in a manner that will restore or replace the utility or improvement to a new condition meeting the specification requirements.

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

1.02 RIGHTS-OF-WAY:

A. The Contractor shall not do any work or enter upon the rights-of-way of any oil, gas, sewer or water pipeline; any telephone or electric transmission line; any fence; or any other structure, until notified by the Engineer that the Owner has secured authority to do so. After authority

has been obtained, the Contractor shall give the governing utility proper advanced notice of its intention to begin work.

1.03 RESTORATION OF PAVEMENT AND SIDEWALKS:

A. All paved areas and sidewalks not designated for replacement, cut or damaged during construction shall be replaced with similar materials and of equal thickness to match the existing adjacent undisturbed areas unless otherwise noted. All sidewalks and pavements which are subject to partial removal shall be neatly saw cut in straight lines.

1.04 UNDERGROUND UTILITIES NOT SHOWN OR INDICATED:

A. If the Contractor damages existing utilities, piping or improvements that are not shown or the location of which was not made known to the Contractor prior to excavation and the damage was not due to failure of the Contractor to exercise reasonable care the Contractor shall immediately notify the Engineer. If directed by the Engineer repairs shall be made by the Contractor under the provisions for changes and extra work contained in Articles 13, 14, and 15 of the General Conditions.

1.05 NOTIFICATION BY THE CONTRACTOR:

A. Prior to any excavation in the vicinity of any existing underground facilities, including water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications or telecommunication cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than three (3) working days prior to excavation so that a representative can be present during such work if they are required to do so.

END OF SECTION 01530

SECTION 01700
PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 DESCRIPTION

This section details requirements and provisions to be performed by the Contractor and for the City prior to final acceptance of the project and closing out the Contract. The requirements specified in the Conditions of the Contract, Special Provisions, and the Detailed Technical Specifications apply to this section as fully as if repeated herein.

1.02 FIELD TESTING AND OPERATIONAL DEMONSTRATION

A. PROCEDURES: Submit schedule and complete procedures and informational data to Engineer for review and approval in accordance with Special Provisions and Section 15064.

B. FIELD TESTING: Conduct field start-up, testing and operational demonstration in accordance with Special Provisions and Section 15064.

C. SUBMITTALS: Provide all final submittals to Engineer for review and approval in accordance with all applicable sections of Divisions 15 and 16.

1.03 REQUIREMENT PREPATORY TO FINAL INSPECTION

A. TEMPORARY FACILITIES: Remove all temporary facilities from site.

B. CLEANING: Clean the entire project site(s) of all debris, Contractor materials, etc. as approved by Inspector. The pump building shall also be thoroughly cleaned prior to the Final Inspection.

C. PUNCH LIST: Complete all preliminary punch list items as approved by Inspector.

D. TESTING: Complete all field testing requirements per the Specifications.

E. RECORD DRAWINGS: Submit record (as-built) drawings to City. Drawings shall be complete and signed by the Contractor.

F. OPERATING AND MAINTENANCE MANUAL: Submit preliminary copies to Engineer for review and approval in accordance with the Special Requirements. Final, approved submittals will be required in advance of the filing of the "Notice of Completion."

G. TOOLS, KEYS AND MISCELLANEOUS EQUIPMENT: Deliver all tools which are a permanent part of the equipment installation in the work

to the City. Also deliver touch-up paint, spare parts, all keys (properly identified), etc.

H. PERMITS: Obtain final approvals from all agencies issuing permits and/or having involvement in the project such as Fire Department, Flood Control District, various City Departments, etc.

I. FINAL QUANTITIES: See Paragraph 1.06 herein.

1.04 SPECIAL SYSTEM OPERATING AND MAINTENANCE INSTRUCTIONS

A. OPERATING INSTRUCTIONS: Separate from the required Operating and Maintenance Manual, submit typewritten instructions covering operation of the entire system as installed (not duplicating manufacturer's instruction for operating components). Include schematic flow and control diagrams as appropriate and show and list system valves, control elements, and equipment components using identification symbols and numbers. Show proper settings for valves, controls and switches.

B. MAINTENANCE INSTRUCTIONS: Separate from the Operating and Maintenance Manual, and not duplicating manufacturer's detailed instructions, submit typewritten instructions covering routine maintenance of the system. List each item of equipment requiring inspection, lubrication, or service and briefly describe such maintenance, including types of lubricants and frequency of service. Give name, address and phone number of nearest firm authorized and/or qualified to service equipment or provide parts.

C. WALL MOUNTED DATA: Frame one set of the approved typewritten instructions and diagrams described under paragraph 1.04 A and 1.04 B above, covered with glass and mounted in locations as directed by City.

1.05 MANUFACTURERS' WARRANTIES

Deliver all manufacturers' warranties required by the Contract Documents, with City named as the beneficiary. In addition, for all equipment and machinery, or components thereof, bearing a manufacturers' warranty that extends for a longer time period than the Contractor's warranty, secure and deliver the manufacturers' warranties in the same manner.

Written warranties, except manufacturers' standard printed warranties, shall be on the Contractor's, subcontractor's, material suppliers', or manufacturer's own letterhead, or a form approved by City. Submit all warranties in duplicate. All warranties shall be collected and assembled into a bound booklet form, and delivered to the City for final review and approval.

1.06 FINAL QUANTITIES AND PAY ESTIMATE

The Contractor's superintendent shall coordinate with the project inspector, prior to the final inspection, for purposes of reviewing and resolving all final as-built quantities for payment purposes. Once the tabulation of final quantities is completed and approved by the Inspector, the final pay estimate may be submitted. Final quantities are subject to approval of the City. Payment of retention will not be approved until after final inspection and acceptance of project. Refer to General Provisions for additional information.

1.07 FINAL INSPECTION

If the Work has been completed in accordance with the Contract Documents, and no further corrective measures are required, the City will accept the Work, finalize the payment processing, obtain the "Release" from the Contractor, and file for the Notice of Completion.

If the Work has not been completed in accordance with the Contract Documents, and several corrective measures are still required, the City will not accept the Work or file for the Notice of Completion. Instead, a final punch list shall be prepared by the City, based on the information gathered from the final inspection. The Contractor will be required to complete or correct the items listed on this punch list to the satisfaction of the Inspector, and then call for another final inspection, following the procedure outlined above.

Upon acceptance of the Work by the City, Contractor shall submit his request for acceptance and final payment. Final payment will not be made by the City, however, until 35 days after filing for the Notice of Completion.

END OF SECTION 01700

SECTION 01820
FIELD TESTING AND OPERATIONAL DEMONSTRATIONS

1.01 GENERAL

Upon completion of work and prior to acceptance by City, Contractor shall provide field testing, demonstrations, validations, etc. for the well pump facilities as described herein.

1.02 MANUFACTURERS' SUPERVISION AND INSTALLATION CHECK

Each equipment manufacturer shall furnish the services of an authorized representative especially trained and experienced in the installation of his equipment to (1) supervise the equipment installation in accordance with the reviewed Instruction Manual, (2) be present when the equipment is first put into operation, (3) inspect, check, adjust as necessary, and approve the installation, (4) repeat the inspection, checking, and adjusting until all trouble or defects are corrected and the equipment installation and operation are acceptable, (5) witness and supervise operational demonstrations and system validation tests to the extent specified, and (6) prepare and submit the specified Manufacturers' Certified Report (Appendix). Include all costs for representatives service in the Contract Price.

1.03 SUBMITTALS FOR OPERATIONAL DEMONSTRATION AND SYSTEM VALIDATION TESTS

1. Operational Demonstration: When the Contractor's application for a progress payment equals or exceeds 75% of the Contract value for the first time, submit a detailed and comprehensive procedure plan for performance of each operational demonstration required. Identical equipment items may be covered under one plan. Include an estimated date and duration for each procedure and the personnel required.
2. System Validation Tests: When the Contractor's application for a progress payment equals or exceeds 75% of the Contract value for the first time, submit a detailed and comprehensive procedure plan for performance of each separate validation test and for each validation test that covers two or more systems. Each procedure plan shall describe and itemize the involved system, including associated electrical equipment and instrumentation and control systems, and shall include evidence of an organized step-by-step procedure properly coordinating the efforts of the various trades and manufacturers' representatives involved and of the operations of the facilities. Procedures shall include an estimated duration and date for each procedure and the personnel required.
3. Procedure Plan Information: In addition to the information specified above, each procedure plan shall include the following information as applicable:

a. Description of temporary procedure facilities, including Drawings and sketches as required to fully illustrate the facilities.
b. List of test materials and estimated quantities.
c. List of instruments, measuring and recording devices, and other test equipment, whether a part of the plant or furnished separately for temporary use.
d. Names of supervising and inspecting manufacturers.
e. Complete listing of all functional parameters to be observed and recorded.
f. Recording intervals.

4. Records Materials: Submit samples of the forms, charts, and other materials to be used in recording demonstration and validation test results.
5. Results: Within 10 days after completion of each procedure plan submit 3 copies of all recordings and results of all operational demonstrations and system validation tests.

1.04 FIELD QUALITY CONTROL

A. GENERAL: All costs for performing operational demonstrations and system validation tests shall be included in the Contract Price, and no extra payment will be made to the Contractor due to overtime, weekend, or holiday labor costs required to perform and complete the demonstrations and validation tests. Requirements specified in this Article are in addition to the demonstration and test requirements specified under other Sections of these Specifications.

1. Operational Demonstration and Systems Validation Testing shall be performed by the Contractor in accordance with the approved procedure plans to demonstrate to City's satisfaction that:
   a. All components of the process systems defined herein, the complete systems, and the new plant systems are fully completed and operable.
   b. All units, components, system, and the entire plant systems operate with the efficiency, repeatability, and accuracy indicated and specified.
   c. All components, systems and the entire plant conform to the Contract Documents and the reviewed shop drawings, samples, construction manuals, materials lists, and other reviewed submittals.
2. Scope of Demonstrations and Validation Testing: Operational demonstrations and system validation tests are required for all Work, equipment, and systems specified in these Specifications including all associated and related electrical systems and control devices.

a. Equipment and work to be operationally demonstrated are defined as individual equipment items such as pumps, compressors, mixers, sludge collecting mechanisms, belt press and like equipment items. Demonstrations shall be performed simultaneously on groups of identical equipment items and groups of items supplied by one manufacturer to the extent feasible.

b. Systems to be validation tested are defined as complete systems that perform a discrete process function of the plant such as chemical systems, pumping system, screen and conveyor system, sluice gates, and similar systems. Each system shall include associated structures, tanks, piping, utilities, instrumentation and controls, and like related items. Two or more separate systems shall be validation tested simultaneously when necessary to validate an entire discrete plant function.

3. Prerequisite Conditions: Operational demonstrations and validation testing shall not commence for any equipment item or system until all related structures, piping, electrical, instrumentation, control, and like Work has been installed, tested, and connected in compliance with the pertaining requirements specified elsewhere in the Specifications.

4. Demonstration and Testing Materials: Furnish materials, natural gas and/or electrical power for operational demonstrations and validation tests. Use fresh water to fill tanks, wells, piping, and systems that contain water in normal operation. Use the specified chemicals for chemical systems but do not exceed "in service" concentrations. Furnish temporary facilities as required such as by-pass or re-circulation piping, diversions, storage, and similar facilities. Use procedures that conserve testing materials and avoid wastage, especially with respect to large quantities of fresh water and electrical power.

5. Inspection and Supervision by Manufacturers: perform operational demonstrations and system validation testing under continuous inspection by City. Technical representatives of the various equipment manufacturers shall be present at the start of the operational demonstrations, shall examine their equipment at least twice near the beginning and end of the validation tests, shall supervise the start up and adjustment procedures, and shall perform all other services necessary for the manufacturer's certified reports required herein.

6. Correction of Defects: Immediately correct all defects and malfunctions disclosed by demonstrations and validation tests using approved methods and new materials for repairs as required.

Interruption time necessary for corrective work shall be added to the specified total demonstration and validation test periods.

7. Acceptance: Satisfactory completion and approval of required operational demonstrations and system validation testing is one of the conditions precedent to City's acceptance of the Work and does not constitute final acceptance. Refer to the Conditions of the Contract.

B. OPERATIONAL DEMONSTRATIONS: Demonstrate that the performance of installed equipment complies with all requirements indicated and specified. Operate each equipment items through entire no-load to full-load range in accordance with the approved procedure plan for not less than 24 consecutive hours, unless a longer period is specified under other Sections.

C. SYSTEM VALIDATION TESTS: All equipment components of each system shall have successfully completed the required operational demonstration before the system is validation tested. Perform validation testing in accordance with the approved procedure plan.

1. Test Period: Test each system, including standby systems, by continuous operation in "in-service" condition for not less than 48 consecutive hours, with no interruptions except for normal maintenance of corrective Work.
2. Testing Methods: Operate systems continuously 24 hours a day under constant inspection of trained operators. Cycle system operation from full load to light load and back to full load each 24 hours; cause variable speed equipment to cycle through the applicable speed range at a steady rate of change. Induce simulated alarm and distressed operating conditions, and test controls and protective devices for correct operation in adjusting system functions or causing system shutdown.
3. Simulation of Conditions: Subject to Contractor's request and City’s review in each case, the Contractor may simulate certain operating conditions relating to flow rates, water levels, and malfunctions. Permission for simulations will be granted only where it is unwise or impossible to obtain the conditions covered by the capability of ranges or equipment. The simulation methods shall reflect reasonable anticipated operating conditions.
4. Ranges for Testing:
    a. Flow metering Systems shall be tested at not less than 3 values corresponding approximately to a minimum, average and maximum capacity, respectively.
    b. Liquid Level Indicating Systems shall be tested at not less than 5 levels corresponding approximately to low, average, normal, maximum and high alarm levels, respectively. Low-

low and high-high level alarms and system reaction shall also be tested where equipment or instruments are required to react to such conditions.

c. Remotely Controlled Valves shall demonstrate suitable operation both from local controls and remote controls. As a minimum, these procedures shall include full-open and full-close positioning. Each test shall be repeated not less than 3 times for non-throttling and non-modulating valves. In addition to these minimum requirements, and subject to approval, all throttling valves and modulating valves shall be operated at not less than 3 intermediate positions and shall demonstrate the ability of each valve to hold the set position under operating conditions.

d. Variable Speed Equipment shall demonstrate accurate response to speed controlling devices and controls within the required operating ranges. Actual output shaft speeds of manually adjustable speed equipment shall be validated by measurement of shaft speeds versus speeds shown by equipment instruments.

5. Automatic Response of Equipment: Response of equipment to appropriate manual or automatic controls, or combinations of both automatic and manual controls, shall be demonstrated to be correct and accurate. Where applicable, all components shall be tested for both manual and automatic operation. Where a component performs more than one function, every function shall be validated.

a. Pumping Equipment shall respond accurately and reliably to liquid level and flow rate signals from appurtenant reservoirs, or wet wells. Automatic alternation and back-up pump functions shall also be validated.

b. Auxiliary Equipment Items such as automatic samplers, annunciators, alarms, and like items shall respond accurately and reliably to every condition for which they are programmed, in the manner specified.

D. RECORDING OF DATA: Neat and comprehensive records of each operational demonstration and system validation test shall be maintained by the Contractor. Each portion of the demonstration or validation procedure shall be described with all components itemized. Records shall be prepared on forms in a step-by-step fashion paralleling the approved plans. Forms shall list for each condition:

a. Step taken;
b. Result anticipated;
c. Result obtained
d. If incorrect, corrective action taken; and
e. Retest result.

f. Steps (d) and (e) shall be repeated until all systems operate as required.

1. Recording Devices: Instruments, gages, and other sensor and display devices forming a part of the various systems shall be employed for data acquisition to the extent applicable. The Contractor shall furnish all other instruments, gages, recorders, and test devices as required, types conforming to the approved procedure plans.
2. Information and Intervals: All applicable data such as, but not limited to, water and other liquid levels, flows, pressures, head differentials, duration of runs, instrument readings, chemical feed rates, voltage settings, drive speeds, motor running currents, torque, voltage, gpm, pressures, clarity, residual chlorine and related information, as applicable, and in accordance with the approved procedure plans, shall be recorded at the start and finish of every operational demonstration and at maximum 8-hour intervals during system validation tests, unless shorter intervals are specified elsewhere.
3. Repetitions: When a repeat of the same demonstration or validation test is required to verify the results, the repeat procedure shall be indicated on the recorded data by numerical indication, date, and time.

1.05 CONSOLIDATION OF DEMONSTRATION, TESTING, AND INSTRUCTION REQUIREMENTS

Operational demonstrations, system validation testing, and instruction of the City's personnel may be performed simultaneously, subject to prior approval of the extent of consolidation in each case.

END OF SECTION 01820

DIVISION 2

SITE WORK

DIVISION 2
TABLE OF CONTENTS

SECTION		PAGE
02140	Dewatering	02140-1
02200	Earthwork and Site Preparation	02200-1
02221	Trenching, Backfilling and Compacting	02221-1
02415	Sheeting, Wailing and Shoring	02415-1
02610	Buried Piping Installation	02610-1
02620	Existing Underground Utilities	02620-1

SECTION 02140

DEWATERING

PART 1 - GENERAL

1.01 APPLICATION

A. Control of subsurface groundwater shall conform to this section.

B. Design, furnish, install, operate, monitor, maintain and remove a temporary dewatering system as required to lower and control water levels at least 5 feet below subgrades of excavations and to permit construction to proceed in-the-dry.

C. Furnish and maintain temporary surface water runoff control measures adequate to capture and remove surface water entering excavations.

D. Retain the services of a professional engineer registered in the State of California to prepare dewatering system designs and submittals described herein.

E. Work shall include the design, equipment, materials, installation, protection, and monitoring of the performance of the dewatering system as required herein.

F. Collect and properly dispose of all discharge water from the dewatering systems in accordance with all State, County, and Local requirements and applicable water quality standards. Under no circumstances shall water from dewatering systems be discharged into the existing or new sanitary sewer systems.

G. Obtain and pay for all permits required for dewatering systems.

H. Repair damage caused by dewatering system operations.

I. Remove temporary surface water runoff control measures after the completion of the excavation and backfilling work, and when approved by the Owner's Representative.

1.02 SUBMITTALS

A. Dewatering system designs shall be prepared by a licensed professional engineer ("Dewatering Engineer") retained by the Contractor and shall, as a minimum, comply with recommendations and/or requirements in the project's Geotechnical Investigation Report. The Contractor is responsible for

investigating the soil and groundwater conditions at the site prior to submitting a dewatering plan. The Contractor shall submit the Dewatering Engineer's and the dewatering subcontractor's qualifications for review and approval by the Owner's Representative and the Engineer of Record (Engineer).

B. The Contractor shall submit a dewatering system design plan developed and signed and sealed by the Dewatering Engineer. The plan shall include a description of the proposed dewatering system and include the proposed installation methods to be used for dewatering system elements and for observation wells. The plan shall include equipment, drilling methods, hole sizes, filter sand placement techniques, sealing materials, development techniques, the number and location of dewatering points and observations wells, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey the water away from the site to an adequate disposal area, etc. Include the dewatering system design calculations in the plan.

C. The plan shall identify the anticipated area influenced by the dewatering system and address impacts to adjacent existing and proposed structures.

D. Coordinate dewatering submittals with the excavation and support of excavation submittals. The dewatering submittal shall show the areas and depths of excavation to be dewatered.

E. Submit drawings and data showing the method to be employed in dewatering excavated areas 30 days before commencement of excavation. Do not proceed with any excavation or dewatering activities until the dewatering submittal has been reviewed and accepted in writing by the Owner/Engineer.

F. Prior to excavation activities, the Dewatering Engineer shall certify in writing that the dewatering system has been installed according to the accepted plan and that it is functioning properly. However, acceptance by the Owner/Engineer shall not relieve the Contractor of the responsibility for the adequacy of the dewatering system to achieve the required results.

G. Include a written report outlining control procedures to be adopted if dewatering problems arise.

H. Materials submitted shall be in a format acceptable for inclusion in required permit applications to any and all regulatory agencies for which permits for discharge water from the dewatering system are required due to the discharge reaching regulated bodies of water.

I. Ensure compliance with all conditions of regulating permits and provide such information to the Owner/Engineer. Obtain written approval from the Owner/Engineer before discontinuing operation of the dewatering system.

J. All decisions in regard to acceptability of groundwater exclusion methods will be made by the Engineer and all such decisions shall be final.

1.03 QUALITY ASSURANCE

A. The discharge of water or drilling waste products shall be in accordance with the requirements of the federal, state, or local agencies having jurisdiction. The Contractor shall be responsible for determining the responsible authority and complying with its regulations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall maintain safe and stable excavations. Further, the Contractor shall be prepared to handle perched water conditions in localized areas.

B. The dewatering system shall be effective to such depth that, where excavations for foundations extend within 5 feet of the water table, the water table shall be lowered in advance of excavation and maintained at least 5 feet below the bottom of excavation or top of backfill at all times.

C. Except for shutdowns for maintenance of dewatering equipment, no interruption in the approved dewatering procedures will be permitted during excavation and construction operations. Full time surveillance (24 hours a day) and maintenance of the equipment shall be provided by the Contractor to avoid breakdowns.

D. The system installed to lower the groundwater shall be capable of providing continuous and reliable draw throughout the construction period. The Contractor shall be responsible for the design construction and maintenance of the dewatering system.

E. The Contractor shall keep a daily log of the flow rate. The information shall be transmitted to the Owner on a weekly basis.

3.02 EARTHWORK

A. During placement and compaction of fill materials, the lowered level of groundwater shall be maintained at every point until the compacted material is 10 feet higher than normal static groundwater level or until final grade is reached.

B. Dewatering shall not affect the bearing capacity of the subgrade soils at the proposed bottom of excavation.

C. Flotation of pipelines and structures shall be prevented by maintaining a positive and continuous removal of water until the construction is completed to the design grades.

END OF SECTION 02140

SECTION 02200

EARTHWORK AND SITE PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in Conditions of the Contract and Division 1 form a part of this Section. Provide labor, equipment, tools, materials, and services needed to accomplish all site preparation, earthwork and incidental appurtenant work as described herein or shown on the Drawings.

Work Included in This Section: Principal items are –

1. Site preparation, clearing and grubbing.
2. Preparation of fill areas.
3. Excavation and controlled fill construction.
4. Structural excavation, and backfills.
5. Pavement subgrade.
6. Disposal of surplus and/or unsuitable materials.
7. Dust control and drainage control.
8. Clean-up.

1.02 RELATED SECTIONS

A. TRENCHING, BACKFILLING AND COMPACTION: Section 02221

B. SHEETING, WALING, SHORING: Section 02415

1.03 DEFINITIONS

A. SITE: The property owned by, or under the jurisdiction of the Owner within the boundaries shown on the Drawings, easements and/or rights-of-way roads, drainage facilities, and pipelines, and the Contractor's working and storage areas adjacent to the facilities.

B. CONTROLLED FILL: Compacted suitable fill material in all areas of the site requiring filling to grade as shown on the Drawings.

C. CONTROL DENSITY FILL: One-sack cement slurry used to backfill areas where pipeline undercrossing make it difficult to mechanically compact fill materials.

D. STRUCTURAL FILL: Compacted suitable fill material which will support a structure or some part of a structure.

E. STRUCTURAL BACKFILL: Compacted suitable material placed between the wall of a structure and construction excavation slope up to finished grade.

F. SUITABLE MATERIAL: As specified herein shall be any material imported or excavated from the cut areas that is, in the opinion of the Owner, suitable for use in constructing fills.

G. WASTE EXCAVATION: Material from project excavations which is not suitable for use in backfill or compacted fills or is in excess of that required to be used for backfill or to construct fills.

1.04 SITE INVESTIGATION

A. SOIL INVESTIGATION REPORT: A specific geotechnical report was prepared for this project and is included as Appendix C of the specifications.

B. CONTRACTOR'S RESPONSIBILITY: The Contractor shall carefully examine the site and make all inspections necessary in order to determine the full extent of the work required to make the completed Work conform to the Drawings and Specifications. The Contractor shall satisfy himself as to the nature and location of the Work, conditions, the conformation and conditions of the existing ground surface, and the character of equipment and facilities needed prior to and during prosecution of the Work. The Contractor shall satisfy himself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered. Any inaccuracies or discrepancies between the actual field conditions and the Drawings, or between the Drawings and Specifications must be brought to the Owner's attention in order to clarify the exact nature of the Work to be performed.

C. EXISTING ELEVATIONS: All existing elevations shown on the plans are approximate only. The Contractor shall recognize and acknowledge the condition that the bid lump sum price shall include all earthwork activities irrespective of the possible localized difference in contour elevations and actual ground; and that there will be no additional compensation from the Owner for earthwork changes, engineering, or field staking in this regard.

1.05 SAFETY

The Contractor shall familiarize himself with, and shall at all times conform to, the regulations of the "OSHA General Industry Occupational Safety and Health Standards", and "OSHA Safety and Health Regulations for Construction Safety Orders" and "Trench Construction Safety Orders" of the State of California, Department of Industrial Relations, Division of Occupational Health and Safety." A copy of these documents shall be kept on the job site.

1.06 ENVIRONMENTAL SAFEGUARDS AND REGULATIONS

The Contractor shall comply with regulations in force at all times to prevent pollution of air and water.

1.07 QUALITY ASSURANCE

A. BY CONTRACTOR: Exercise due care to assure procurement, storage and placement of materials from site or offsite sources which shall comply with the requirements, Specifications and standards set out herein. The Contractor may have, at his discretion, such tests and inspections as he may desire performed by qualified personnel or independent testing services, for his guidance and control of the Work.

B. BY OWNER: The Owner through its project representative(s), will be the onsite arbiter and judge of the acceptability of the Work done, based on such observations and tests he may require or perform.

The Owner may provide inspection and testing by its own representatives or by independent testing services, engaged and paid for by the Owner. In this regard, a Soils Engineer may be engaged by the Owner, who shall act as the direct representative of the Owner in soils work, to perform inspection of the removal and replacement of unsuitable materials, all excavations, and the placement and compaction of all fills and backfills within the limits of earthwork on this Project. Costs for all such inspections and tests will be paid by the Owner, except Contractor shall bear the cost of retest and reinspection of reworked faulty work.

C. APPLICABLE CRITERIA, TESTS AND STANDARDS:

1. For Site Earthwork - Rough graded surface ready to receive top soil, sod, or seed, crushed rock, or aggregate base shall be graded to + or - 0.1 feet of the Plan elevation, except where meeting curbs, walks, or building entrances, grade to + or - 0.05 feet of Plan. However, the acceptance of such irregularities shall not be construed to reduce the thickness of topsoil, sod or pavement. Permanent surface water courses shall be constructed to average

Plan grades and shall drain completely throughout their length. Finish surfaces shall be + or - 0.05 feet of the Plan elevation, and all areas shall be finished so as to drain readily.

2. For Earthwork for Structures - The Owner will provide the services of a qualified Soils Engineer to make tests of prepared subgrade and compacted fill. Testing will be at the discretion of the Soils Engineer. The Contractor shall give the Soils Engineer twenty-four (24) hours notice of the schedule commencement or subgrade preparation.

3. For Waste - Rubbish, debris, junk, material deemed unsuitable by the Owner from tests or visual inspection, and all material delivered to fill or embankment, which cannot be satisfactorily compacted, shall be removed from the project site and wasted in an area, provided by Contractor, that is acceptable to local authorities. Disposal of such materials shall be in accordance with all applicable laws, regulations, permits, and approvals from Owner of property upon which the material will be disposed.

4. For Clean-Up - Removal of all rubbish, debris, junk, temporary materials, and undesirable plants within the construction limits, restoration of staging areas and obliteration of temporary roads and stockpiles, and removal of trees damaged by the Contractor's operations shall be performed by the Contractor, to the satisfaction of the Owner as determined by visual inspection and is a condition for acceptance and final payment.

5. Standards for Soil Classification, Properties and Tests

   (a) <u>Earthwork and Embankment (excluding roads):</u>

      1. Classification - ASTM D-2487.
      2. Physical Properties - ASTM D854, D-2216
      3. Compaction - Modified Proctor ASTM D1557-91

   (b) <u>Backfill for Trench:</u>

      1. Classification - ASTM D2487
      2. Compaction - Modified Proctor ASTM D1557-91
      3. Field Density Test - ASTM 1556-82
         D2937-83, D2922-81 (As approved by Owner)

   (c) <u>Structural Fill and Backfill:</u>

1. Classification - ASTM D2487
2. Attenberg Limits - Plasticity Index and - Liquid Limit ASTM D4318
3. Compaction - Modified Proctor ASTM D1557-91
4. Physical Properties - ASTM D854, D2216
5. Field Density Test - ASTM D1556-82
   D2937-83, D2922-81 (As approved by Owner)

(d) Controlled Fills:

1. Classification - ASTM D2487
2. Physical properties - ASTM D854, D2216
3. Compaction - Modified Proctor ASTM D1557-91
4. CBR - ASTM D1883 (R-Value - ASTM 2844)
5. Field Density Test - ASTM D1556-82
   D2937-83, D2922-81 (As approved by Owner)

(e) Road Embankment:

1. Classification - ASTM D2487
2. Physical properties - ASTM D854, D2216
3. Compaction - Modified Proctor ASTM D1557-91
4. CBR - ASTM D-1883
5. Field Density Test - ASTM D1556-82
   D2937-83, D2922-81 (As approved by Owner)

(f) Borrow:

1. Classification - ASTM D2487.
2. Other properties - as determined by requirements at point of use.

1.08 COMPACTION

The maximum dry density, optimum moisture content and field density of each soil type used in the controlled compacted fill shall be determined as stated above.

1.09 INSPECTION

Observation and compaction tests shall be made by the Owner during the filling and compacting operations.

During the grading operation, continuous inspection may be made to assure that grading is performed in accordance with specified requirements. Should testing indicate unsatisfactory compaction, additional compactive effort shall be applied with the adjustment of moisture content until satisfactory compaction is obtained.

1.10 GUARANTEE

Work done under this Section shall in all respects come under the terms of the guarantee stated in the Conditions of the Contract.

PART 2 - PRODUCTS

2.01 MATERIALS

A. CONTROLLED FILL MATERIAL: Materials for controlled fill shall consist of any material imported or excavated from the cut areas that, in the opinion of the Owner, is suit-able for use in constructing fills. The material shall contain no rocks or hard lumps greater than 12 inches in size and shall contain at least 40 percent of material smaller than 3/4 inch in size. Materials greater than 6 inches in size shall be placed by the Contractor in windrows on a clean, over-excavated or unyielding compacted fill or firm natural ground surface. Select native or imported granular soil (sand equivalent greater than 30) shall be placed and thoroughly flooded over and around all windrowed rock, such that voids are filled. Windrows of oversize material should be staggered so that successive strata of over-sized material are not in the same vertical plane. No nesting or rocks shall be permitted. No material of a perishable, spongy, or otherwise of an improper nature shall be used in filling.

Material placed within 24 inches of rough grade shall be select material that contains no rocks or hard lumps greater than 6 inches in size and that swells less than 3 percent when compacted as hereinafter specified for compacted fill and when subjected to an axial pressure of 160 psf.

Representative samples of material to be used for fill shall be tested in the laboratory by the Soil Engineer in order to determine the maximum density, optimum moisture content and classification of the soil. In addition, the Soil Engineer shall determine the approximate bearing value of a recompacted saturated sample by direct shear tests or other tests applicable to the particular soil.

During grading operations, soil types other than those analyzed in the report of the soil investigation may be encountered by the Contractor. The Soil Engineer shall be consulted to determine the suitability of these soils.

B. STRUCTURAL FILL MATERIAL: Materials shall consist of crushed aggregate base, either imported or manufactured from excavated onsite rocky material.

The crushed aggregate base shall be uniformly graded and shall conform to State of California Standard Specifications Aggregate Base Class 2 with the following gradations:

AGGREGATE GRADING REQUIREMENTS
Percentage Passing
(California Test 202)

			3/4 Maximum Individual Test Results	Moving Average
1"	-	-	100	100
3/4"	45-90	50-85	87-100	90-100
No. 4	20-50	25-45	30-60	35-55
No. 30	6-29	10-25	5-35	10-30
No. 200	0-12	2-9	0-12	2-9

QUALITY REQUIREMENTS

Tests	California Test	Individual Test Result	Moving Average
Resistance (R-value) [1]	301	78 Min.	-
Sand Equivalent	217	28 Min.	31 Min.
Durability Index	229	35 Min.	-

[1] R-value testing may be waived if:
(1) a previous sample of the aggregate being supplied met the R-value requirements and had a Sand Equivalent value of 33 or more;
(2) the Sand Equivalent value of the sample being tested is not more than 5 points lower than the Sand Equivalent value of the sample that met the R-value requirements; and
(3) the aggregate has not been treated with lime, cement, or other chemical material.

All rock materials shall be clean, hard, sound, durable, uniform in quality, free of any detrimental quantity of soft, friable, thin, elongated or laminated pieces, disintegrated material, organic matter, oil, alkali or deleterious substance.

C. STRUCTURAL BACKFILL MATERIAL: Materials for structural backfill shall be as material used for controlled fill, 2.1.1, except the material shall contain no rocks or hard lumps greater than 12 inches in size.

Only non-expansive materials shall be used.

D. GRANULAR MATERIAL: Materials for granular material shall consist of a coarse mortar and conforming to ASTM C144.

E. SPECIAL CRUSHED ROCK BEDDING AND STRUCTURE FOUNDATION: When groundwater is encountered in the excavation and/or where indicated on the Contract Drawings, the material in the bottom of the trench or excavation shall be removed to a depth directed by the Owner and replaced with 3/4 inch maximum crushed rock bedding. The crushed rock bedding shall be installed and compacted per these specifications. The 3/4 inch maximum crushed rock material shall be approved by the Owner before use.

Crushed rock shall be the product of crushing rock or gravel. Fifty percent of the particles by weight retained on a 3/8-inch sieve shall have their entire surface area composed of faces resulting from fracture due to mechanical crushing. Not over 5% shall be particles that show no faces resulting from crushing. Less than 10% of the particles that pass the 3/8-inch sieve and are retained on the No. 4 sieve shall be waterworn particles. Gravel shall not be added to crushed rock. Crushed rock (3/4") shall have the following gradation:

Sieve Sizes	3/4-inch Max. Crushed Rock % Passing
1"	100
3/4"	90-100
1/2"	30-60
3/8"	0-20
No. 4	0-5
No. 8	-

For specified 3" crushed rock, Contractor shall submit gradation to Owner for review and approval.

Special Crushed rock Bedding or foundation material, where ordered by the Owner, shall be paid as indicated in the Bid Schedule and set forth in the Special Requirements.

PART 3 - EXECUTION

3.01 GENERAL

The Work performed under this Specification shall be constructed to the lines, grades, elevations, slopes and cross sections indicated on the Drawings, specified herein, and/or directed by the Owner. Slopes, graded surfaces, and drainage features shall present a neat uniform appearance upon completion of the Work.

It shall be the Contractor's responsibility (1) to maintain adequate safety measures and working conditions; and (2) to take all measures necessary during the performance of the

Work to protect the entire project area and adjacent properties which would be affected by this Work from storm damage, flood hazard, caving of trenches and embankments, and sloughing of material, until final acceptance by the Owner. It shall be the Contractor's responsibility to maintain completed areas until the entire project area is in satisfactory compliance with the job specification.

Utility lines and structures indicated on the Drawings which are to remain in service shall be protected by the Contractor from any damage as a result of his operations. Where utility lines or structures not shown on the Drawings are encountered, the Contractor shall report them to the Owner before proceeding with the Work. The Contractor shall bear the cost of repair or replacement of any utility lines or structures which are broken or damaged by his operations.

3.02 REMOVALS, CLEARING AND GRUBBING

A. CLEARING: Clearing consists of the complete removal of objectionable materials and obstructions above and below the ground surface including tree stumps, brush, grass, vegetative matter and other objectionable materials within the project limits. All brush and organic material shall be removed before placing any earth fills. It shall be the Contractor's responsibility to save and protect all trees that lie outside the construction area. No trees shall be removed unless approved by the Owner.

B. GRUBBING: Grubbing consists of the complete removal of stumps, including tap roots or lateral roots 1-1/2 inches or more in diameter, and the removal of brush, grass or weeds to depths below the natural ground as specified herein. Stumps shall be grubbed to a depth of 3 feet and grass or weeds shall be grubbed to a depth of 6 inches below the natural ground surface, or to the depths as determined in the field by the Soil Engineer at the time of construction.

C. PROTECTION: Existing items not designated to be demolished or removed shall be protected from damage. Any such item damaged by the Contractor shall be restored or replaced immediately at the Contractor's expense.

D. DEBRIS AND WASTE MATERIAL: All debris and waste material resulting from demolition, clearing, and grubbing shall be removed from the site and disposed of by the Contractor.

3.03 DUST CONTROL

The Contractor shall take all steps possible to prevent and reduce dust arising from the construction activity. He shall have adequate water trucks on the site at all times and water, as necessary, the areas where dust may arise. He shall cooperate fully with the Owner and water immediately when instructed to do so.

3.04 CARE OF DRAINAGE WATER

Contractor shall take care of drainage water from the construction operations, and of storm water and/or wastewater reaching the construction area from any source, so that no damage will be done to the excavation, pipe or structures. The Contractor shall be responsible for any damages to persons or property on or off the construction site due to such drainage water or to the interruption or diversion of such storm water or wastewater on account of his operations.

Such grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any water accumulating therein shall be removed by pumping or by other reviewed methods.

Protection of the site during the construction shall be the responsibility of the Contractor. Completion of a portion of the project shall not preclude that portion or adjacent areas from the requirements for site protection until such time as the entire project is complete.

3.05 EXCAVATION

A. GENERAL: The Contractor shall perform all excavation necessary or required as shown on the Drawings. The excavation shall include the removal and disposal of all earth materials of whatever nature encountered, which shall include both rock excavation and common excavation when both are present, and shall include the furnishing, placing, and maintaining of shoring and bracing necessary to safely support the sides of the excavations. The Work shall also include all pumping, ditching and other required measures for the removal or exclusion of water.

B. EXCAVATION FOR STRUCTURES: Structure excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of such materials shall conform to the lines and grades shown on the Drawings and/or herein specified. Temporary structure excavations shall at all times conform to the Requirements of the State of California, Division of Occupational Health and Safety, and pertinent requirements contained in referenced Geotechnical Investigation Report and Specification Section 02415, Sheeting, Waling and Shoring.

Continuous wall and isolated footings shall be underlain by a minimum compacted controlled fill thickness equal to 1.5 times the footing width or greater if indicated in the referenced Geotechnical Investigation Report. This zone of over-excavation, scarification and recompaction shall extend a minimum of five feet beyond the footing lines. Exposed surface shall be

scarified, and brought to optimum moisture content and compacted to a minimum of 95 percent relative compaction.

All surfaces to receive concrete slabs-on-grade shall be underlain by a minimum compacted controlled fill thickness of 18 inches or greater if indicated in the referenced Geotechnical Investigation Report. This shall be accomplished by combination of over-excavation and recompaction to 95% relative compaction.

Contingent upon locations, all surfaces to receive compacted fill shall be scarified, brought to near optimum moisture content and compacted to required percentage of relative compaction as specified herein.

Rough grade excavations for structures and footings will be inspected by the Owner to verify that the excavations extend into satisfactory soils and are free of loose and disturbed materials.

Foundation for tanks, pump vaults or subsurface chambers shall have structural fill material extending 12 inches, minimum, below the structural base slab to native material, which has been scarified and compacted to 95% relative compaction.

3.06 STRUCTURAL BACKFILL

A. PLACEMENT OF STRUCTURE BACKFILL: Before beginning back-filling, all foreign material, including water, shall be removed from the space to be backfilled and the area to be backfilled shall be inspected and approved by the Owner. Sloping sides of the excavated space shall be stepped to prevent wedging action of the backfill against the structure. No backfill shall be placed around or upon any structure until it is proven that the concrete has attained satisfactory strength in accordance with Section 03300 and that the structure as a whole is adequate to receive backfill. The compressive strength shall be determined by tests on representative cylinders cured under conditions similar to those prevailing at the site.

Backfill shall be placed in uniform layers on opposite sides of structures and walls before compaction. The Contractor shall inform the Owner of the sequence of backfilling to be followed around each structure and this sequence shall be reviewed by the Owner before any backfilling is placed.

B. COMPACTION OF STRUCTURE BACKFILL: Structure backfill shall be placed in horizontal layers of such depths compatible to the type of compaction equipment being used, but in no case shall the lifts exceed eight (8) inches. Each layer shall be evenly spread, the moisture content brought to near optimum conditions and then compacted. The density shall be as follows:

STRUCTURAL FILL COMPACTION

Type of Fill	Percent of Maximum Density of Optimum Moisture
Structural Fill Material	95
Structural Backfill Material	90

Backfill shall be mechanically compacted by equipment of a size and type reviewed by the Owner. Permission to use specified compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment shall not result in damage to adjacent ground, existing improvements, or improvements installed under the Contract.

Flooding, jetting or ponding shall not be permitted for the compaction of any structure backfill.

3.07 CONTROLLED FILL

A. GENERAL: Unless otherwise specified, fill material shall be compacted by the Contractor while at a moisture content near the optimum moisture content and to a density that is not less than 90 percent of the maximum density at optimum moisture.

Potentially expansive soils may be used in fills below a depth of 24 inches and shall be compacted at moisture content greater than the optimum moisture content for the material.

Slopes shall be 2:1 unless otherwise shown on the Plans. No slopes shall be constructed steeper than 2:1. Areas to receive fill shall be prepared as shown on the Plans and approved in writing by the Owner prior to placement.

B. PREPARING AREAS TO BE FILLED: All vegetable matter and objectionable material shall be removed by the Contractor from the surface upon which the fill is to be placed and any loose and porous soils shall be removed or compacted to a depth specified by the Soil Engineer. The surface shall then be plowed or scarified to a minimum depth of 6 inches until the surface is free from uneven features that would tend to prevent uniform compaction by the equipment to be used.

When placing fill in horizontal lifts adjacent to areas sloping steeper than 5:1 (horizontal: vertical), horizontal keys and vertical benches shall be excavated into the adjacent slope area. Keying and benching shall be sufficient to provide at least 6-foot wide benches and a minimum of 4 feet vertical bench height within the firm natural ground, firm bedrock or

engineered compacted fill. No compacted fill shall be placed in an area subsequent to keying and benching until the area has been reviewed by the Soils Engineer. Material generated by the benching operation shall be moved sufficiently away from the bench area to allow for the review of the horizontal bench prior to placement of fill. Typical keying and benching details shall be as shown on the Drawings.

After the foundation for the fill has been cleared, plowed or scarified, it shall be disced or bladed by the Contractor until it is uniform and free from large clods, brought to the proper moisture content and compacted as specified.

C. PLACING, SPREADING, AND COMPACTING FILL MATERIAL: The fill material shall be placed by the Contractor in thin layers that when compacted shall not exceed 8 inches. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to obtain uniformity of material in each layer.

When the moisture content of the fill material is below that required by the Soils Engineer, water shall be added by the Contractor until the moisture content is as required for the specified compaction.

When the moisture content of the fill material is above that required by the Soils Engineer, the fill material shall be aerated by the Contractor by blading, mixing, or other satisfactory methods until the moisture content is as required for the specified compaction.

After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted by the Contractor to the specified density. Compaction shall be accomplished by sheepsfoot rollers, vibratory rollers, multiple-wheel pneumatic-tired rollers or other types of acceptable compacting equipment. Equipment shall be of such design that it shall be able to compact the fill to the specified density. Compaction shall be continuous over the entire area and the equipment shall make sufficient passes over the material to ensure that the desired density has been obtained.

Compacted fill slopes shall be overbuilt and cut back to grade, exposing the firm, compacted inner core. The slopes shall be overbuilt a minimum of five feet. If the desired compaction is not achieved, the existing slope shall be over-excavated and reconstructed. The amount of overbuilding shall be increased until the desired compaction is achieved on the slope. The Contractor shall provide thorough mechanical compaction to the outer edge of the overbuilt slope surface. There shall be no excessive loose soil on the slopes.

The Contractor shall provide and maintain adequate erosion control facilities during the construction of the fill areas. The erosion control facilities shall be maintained in optimum condition until the permanent drainage system and vegetation is complete. The facilities shall be inspected following significant rainfall, repairs made and excess sediment removed. It shall be the Contractor's responsibility to prevent the discharge of sediment off-site or to adjacent water courses.

3.08 PAVEMENT SUBGRADE

All base course and AC pavement shall be underlain by a minimum 12 inch thickness of controlled compacted fill. In areas where less than 12 inches of fill or no filling is proposed, the existing grade shall be scarified and the moisture content adjusted to obtain optimum moisture content and recompacted to a depth of at least 18 inches. Compaction shall be a minimum of 95 percent of relative compaction.

3.09 CLEAN-UP

Upon completion of Work in this Section, all rubbish and debris shall be removed from the job site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat, clean and acceptable condition.

3.10 DISPOSAL OF SURPLUS AND/OR UNSUITABLE MATERIALS

Excavated materials which are determined by the Soil Engineer to be unsuitable for use in controlled fill, structural fill or structural backfill shall be disposed of, offsite, by the Contractor or in an area pre-approved by the Owner.

3.11 IMPORTATION OF SUITABLE FILL MATERIALS

In the event that sufficient quantities of excavated material are not available at the Contract work site, Contractor shall provide suitable material for controlled fills from an alternate source, as approved by Owner's Geotechnical Engineer. Include all associated costs in items provided on Bidding Sheet.

END OF SECTION 02200

SECTION 02221
TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in Conditions of Contract and Division 1 form a part of this Section. The Work of this Section includes all labor, machinery, construction equipment, and appliances to perform in a good workmanlike manner all trench excavation and backfill work shown on the Drawings and herein specified.

A. WORK INCLUDED IN THIS SECTION: Principal items included:
   1. Trench excavation, backfill and compaction.

B. RELATED WORK NOT INCLUDED IN THIS SECTION:

Item		Section
1.	Earthwork & Site Preparation	02200
2.	Sheeting, Waling & Shoring	02415
3.	Piping & Conduit Work specified in other Sections.	

1.02 GENERAL REQUIREMENTS

Requirements of Section 02200 apply to this Section.

1.03 SAFETY

The Contractor shall familiarize himself with, and shall at all times conform to all applicable regulations of "Excavations, Trenching, and Shoring" of OSHA Safety and Health Regulations for Construction, "General Construction Safety Orders" and "Trench Construction Safety Orders" of the State of California, Department of Industrial Relations, Division of Occupational Health and Safety, and pertinent requirements of Soils Investigations Report referenced in Specification Section 02200 (if applicable) and applicable requirements specified in Section 02415.

1.04 INSPECTION AND CONTROL

A Soils Engineer may be engaged by the City, who shall act as the direct representative of the City in soils work, to perform inspection of the removal and replacement of unsuitable materials, and the placement and compaction of all fills and backfills within the limits of earthwork on this project. All work shall be done in accordance with these Specifications and as directed by the City. Costs for all such inspections and tests will be paid by the City. If retesting is required because the Contractor did not meet the Specification, the Contractor shall pay for all retesting.

1.05 REQUIREMENTS

A. GENERAL:

1. The Work performed under this Specification shall be constructed to the lines, grades, elevations, slopes and cross sections indicated on the Drawings, specified herein, and/or directed by the City in writing. Slopes, graded surfaces, and drainage features shall present a neat, uniform appearance upon completion of the Work.
2. It shall be the Contractor's responsibility (1) to maintain adequate safety measures and working conditions; and (2) to take all measures necessary during the performance of the Work to protect the entire project area and adjacent properties which would be affected by this Work from storm damage, flood hazard, caving of trenches and embankments, and sloughing of material, until final acceptance by the City. It shall be the Contractor's responsibility to maintain completed areas until the entire project area is in satisfactory compliance with the project Specifications.
3. Contractor shall be responsible for the excavation and disposition of unsuitable or surplus material by approved means of conveyance away from the working area.

B. UTILITY PROTECTION: Utility lines and structures indicated on the Drawings which are to remain in service shall be protected by the Contractor from any damage as a result of his operations. Where utility lines or structures not shown on the Drawings are encountered, the Contractor shall report them to the City before proceeding with the Work. The Contractor shall bear the cost of repair or replacement of any utility lines or structures which are broken or damaged by his operations.

PART 2 - PRODUCTS

2.01 MATERIALS

A. SELECT GRANULAR MATERIAL: Select granular material shall conform to the size gradation listed below. The use of other material shall be reviewed by the City prior to use. The City may require certification that the material meets the following gradation.

SELECT GRANULAR MATERIAL

Sieve Size	Percent Passing	
	Min.	Max.
3/4 inch	100	-
3/8 inch	80	90
No. 4	10	15
No. 8	0	5

B. SELECT BACKFILL MATERIAL: Select backfill material shall be material excavated from the trench. The material shall be free of rubbish, broken pavement, debris, stones greater than 4 inches in greatest dimension, organic mulch, or other deleterious materials. If the excavated trench material is unsuitable for backfill, other imported material shall be used, provided the material is reviewed by the City prior to import or placement. The imported material shall be select earth, sand, or gravel, conforming to the requirements for the material excavated from the trench and used for backfill.

C. CONCRETE: 3,000 psi compressive strength, minimum, as specified in Section 03300.

D. PIPELINES: Use materials shown on the Drawings and as specified in other pertinent Sections of this Specification.

PART 3 - EXECUTION

3.01 TRENCH EXCAVATION

A. EXCAVATION FOR TRENCHES: Shall include the removal of all material of any nature for the installation of the pipe or facility and shall include the construction of trench shoring and stabilization measures, timbering and all necessary installations for dewatering.

B. MINIMUM WIDTH OF TRENCH: The minimum width of pipe trenches, measured at the crown of the pipe, shall not be less than 12 inches greater than the exterior diameter of the pipe, exclusive of bells and the minimum base width of such trench shall be not less than 12 inches greater than the exterior diameter of the pipe, exclusive of special structures or connections, and such minimum width shall be exclusive of all trench supports.

C. MAXIMUM WIDTH OF TRENCH: The maximum allowable width of trench for all pipelines measured at the top of the pipe shall be the outside diameter of the pipe (exclusive of bells or collars) plus 16 inches, and such maximum shall be inclusive of all timbers. A trench wider than the outside diameter plus 16 inches may be used without special bedding if the Contractor, at his expense, furnishes pipe of the required strength to carry the additional trench load. Such modifications shall be submitted for the City's review. Whenever such maximum allowable width of trench is exceeded for any reason, except as provided for on the Plans or in the Specifications, or by the written direction of the City, the City may, at its discretion, require that the Contractor, at his own expense for all labor and materials, cradle the pipe in 2500 psi compressive strength concrete, or other approved pipe bedding.

D. MAXIMUM LENGTH OF OPEN TRENCH: Except by special permission by the City only that amount of open trench shall be permitted, which shall allow for that amount of pipeline construction, including excavation, construction of pipeline, and backfill in any one location, which can be completed in one day; however, maximum length of open trench shall never exceed 600 feet. This length includes open excavation, pipe laying and appurtenant construction and backfill which has not been temporarily resurfaced.

E. TRENCH SIDE SLOPES:
1. Temporary trench excavations shall at all times conform to the safety requirements hereinbefore specified in Paragraph entitled "Safety".
2. Loose cobbles or boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, or the trench slopes must be protected with screening or other methods. Trench side slopes shall be kept moist during construction to prevent local sloughing and raveling. Surcharge loads due to construction equipment shall not be permitted within 8 feet of the top of any excavated slope.
3. If the Contractor elects to shore or otherwise stabilize the trench sides, he shall file with the City copies of drawings for same prepared and signed by a Civil Engineer duly registered in the State of California before commencing excavation.

F. EXCESS TRENCH EXCAVATION: If any trench, through the neglect of the Contractor, is excavated below the bottom grade required, it shall be refilled to the bottom grade, at the Contractor's expense for all labor and material, with select granular material compacted to a firm stable foundation.

3.02 BRACING TRENCHES

The sides of the trenches shall be supported with plank sheeting and bracing in such a manner as to prevent caving of the sides of the trench. Space left by withdrawal of sheeting or shoring shall be filled completely with dry granular material blown or rammed in place. All trenches deeper than 5 feet shall be shored unless cut to the angle of repose of the excavated soils.

3.03 PIPING BEDDING

The Contractor shall excavate to 4 inches below the bells or couplings for the full width of the trench and shall place four (4) inches of select granular material upon which the pipe is to be laid. In cases, as determined by the City where trench material is suitable for use as bedding, the trench may be excavated to a point above the invert grade, and the trench bottom hand-shaped so that the bottom segment of the pipe is firmly supported on undisturbed material.

At pipe subgrade, if foundation soil in trench is soft, wet, spongy, unstable or does not afford solid foundation for pipe, the Contractor shall excavate as directed by the City and provide stable base by excavating any unsuitable material 24" minimum below the subgrade base or as the City decides is necessary for placement of pipe bedding.

Where rock is encountered in the trench, the Contractor shall excavate to a minimum 18 inch depth below subgrade or as the City decides is necessary, and shall construct a base by placing select granular material upon which a subgrade can be prepared.

Before any pipe is lowered in place, the trench bottom shall be prepared so that each pipe shall be supported for the full length of the barrel with full bearing on the bottom segment of the pipe equal to a minimum of one-half of the pipe OD, and a width equal to the trench width. All adjustments in line and grade shall be made by scraping away or filling and tamping in under the barrel of the pipe. Wedging or blocking is not permitted.

The pipe bedding shall be compacted to a minimum of 90 percent relative compaction as herein after specified.

3.04 BACKFILLING PIPE TRENCHES

A. BACKFILLING PIPE ZONE: Backfill material for the pipe zone shall consist of select granular material as specified in paragraph 2.01.1. Place material in the trench simultaneously on each side of the pipe for the full width of the trench and the depth of the pipe zone in layers 6 inches in depth. Each layer shall be thoroughly compacted by tamping. In all cases, backfilling of the pipe zone must be done by hand. Particular attention shall be given to underside of the pipe and fittings to provide a firm support along the full length of the pipe. The pipe zone shall be considered to extend 12 inches above the top of the pipe, and shall be compacted in the trench to a relative compaction of not less than 90 percent as herein after specified. Care shall be taken not to damage pipe or special coatings on the pipe.

1. Use of Material other than those specified shall be reviewed by the City prior to use. The Contractor shall bear all cost of removal of rejected material, its hauling to an authorized disposal site, and cost of providing required material to complete the bedding and backfilling.

B. BACKFILLING PIPE TRENCH: After the pipe has been laid in the trench and has been inspected and approved, and backfilling in the pipe zone is complete and compacted, the remainder of the trench may be backfilled. The backfill material shall be select backfill material as specified in paragraph 2.1.2. Care shall be taken to ensure that no voids remain under, around or near the pipe.

1. Whenever imported borrow for backfill is required, the Contractor shall furnish this borrow material and dispose of the excess trench excavation and shall include the expense of this work in his bid.

C. COMPACTION: The maximum dry density and optimum moisture content of each soil type used in the controlled compacted fill shall be determined by ASTM D-1557-91. Field density tests shall be determined in accordance with ASTM D1556-82, ASTM D2937-83, D2922-81.

D. PLACEMENT AND COMPACTION OF TRENCH BACKFILL: The placement and compaction of all trench backfill shall conform to one of the following methods subject to the qualification specified therein:

1. Mechanically Compacted Backfill: With review of City backfill shall be mechanically compacted by means of tamping rollers, sheepsfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers to 90 percent relative compaction except that backfill compaction for trenches above the pipe zone shall be to a minimum 95 percent in areas under buildings and pavements. Where the backfill soil has a clay-like behavior and has a plasticity index of at least 12, only the upper 3 feet of material placed shall require minimum compaction of 95 percent. Impact-type pavement breakers (stompers) shall not be permitted over any pipe. Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the Contract. The Contractor shall make his own determination in this regard. Mechanically compacted backfill shall be placed in horizontal layers not exceeding eight inches. Each layer shall be evenly spread, the moisture content brought to near optimum condition and then tamped or rolled until the specific relative compaction has been attained.

3.05 CENTRAL PIPELINE INSTALLATION REQUIREMENTS

A. DEPTH OF PIPE: Unless otherwise shown on the Plans, all pipelines shall have a coverage of at least 36 inches between the top of the pipe and the finished surface. All gravity line invert elevations and locations shown are intended to be exact and any change in alignment and grade may only be made with the review of the City. All force and gravity mains shall have 1 foot vertical clearance between themselves and all other utilities. At all water main crossings, both gravity and force mains shall have 20 linear feet of concrete encasement centered at the crossing.

B. CHANGES IN LINE AND GRADE: In the event obstructions not shown on the Plans are encountered during the progress of the Work which will

require alterations to the Plans, the City will issue the necessary changes to the Plans and order the necessary deviation from the line or grade. The Contractor shall not make any deviation from the specified line and grade without prior review by the City. Should any deviations in line and grade be permitted by the City in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, any additional costs for thrust blocks, valves, air and vacuum valve assemblies, blow-off assemblies, extra pipe footage, concrete, sewer structures, or other additional costs shall be borne by the Contractor.

1. Contractor shall include in his Bid provisions to cover any deviation from the invert grade shown on the Plans to facilitate extra depth required to eliminate possible conflicts between culverts and other utilities with the force and sewer mains.

C. INSTALLING PIPE: Contractor shall, after excavating the trench and preparing the proper bedding for the pipe, furnish all necessary facilities for properly lowering and placing sections of the pipe in the trench without damage and shall properly install the pipe. The section of pipe shall be fitted together correctly and shall be laid true to line and grade bedding material, but if the pipe has a projecting bell, suitable excavation shall be made to receive the bell which shall not bear on the subgrade. The requirements for closely fitting the bottom of the pipe to the bedding material for the width shown on the Drawings shall be strictly enforced.

1. Pipe shall be laid up grade. Any pipe which is not in true alignment, both vertical and horizontal, or shows any undue settlement after laying shall be replaced when so ordered by the City. No pipe shall be laid which is damaged, cracked, checked or spalled or has any other defect deemed by the City to make it unacceptable, and all such sections shall be permanently removed from the Work.
2. At all times when the Work of installing pipe is not in progress, all openings into the ends of the pipelines shall be kept tightly closed with suitable plywood or sheet metal bulkheads to prevent the entrance of animals and foreign materials and to prevent water from entering the pipe.
3. Keep the pipe trench free from water at all times and take all necessary precautions to prevent the pipe from floating due to water entering the trench from any sources. Any damage is the Contractor's full responsibility. Restore and replace the pipe to its specified conditions and grade if it is displaced due to floating.
4. All pipelines adjoining concrete structures (including manholes) shall have a flexible joint within 36 inches from the face of such concrete structures. Flexible joints shall be installed on all pipe 4" and larger whether a flexible joint is shown on the Drawings or not. Where the flexible joint is shown on the Drawings, install the joint at the location shown.

3.06 CLEANUP

Immediately upon completion of Work of this Section, all rubbish and debris shall be removed from the job site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat, clean and acceptable condition.

END OF SECTION 02221

SECTION 02415
SHEETING, WALING AND SHORING

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in the Conditions of the Contract and Division 1 form a part of this Section. Provide protective installation consisting of shores, wales, braces, posts, piling, sheeting, anchorages and fastenings, both temporary and permanent, for accomplishment and protection of Work.

A. WORK INCLUDED IN THIS SECTION: Principal items included:
   1. Shoring and sheeting for structure excavation.
   2. Temporary sheeting and bracing for pipeline work as required.
   3. Materials for permanent sheet and bracing.

1.02 QUALITY ASSURANCE

A. MATERIAL STANDARDS: Furnish lumber for shores, wales, and sheeting of grading required by the American Lumber Standards for the particular application.

1.03 SUBMITTALS

Contractor shall submit complete calculations of the sheeting system including sizing of sheeting wales, rakers, anchor system, struts, earth anchors, anchor piles, tie rods or any other components pertinent to the design prior to the start of any Work involving sheeting and bracing. All designs submitted shall be signed by an engineer duly registered in the State of California.

1.04 JOB CONDITIONS

Buried debris may be found at some locations. Federal and local requirements for safety of job personnel and public will apply to work under the Section.

1.05 ALTERNATIVES

The use of application of alternative methods and materials, and the employment of proprietary systems under lease or franchise in lieu of that specified herein, may be allowed. Demonstration of suitability and compliance with these Specifications will be required.

PART 2 - PRODUCTS

2.01 MATERIALS

A. LUMBER:

1. Temporary Shores, Wales and Sheeting: Furnish structural grade planks, beams, and posts as defined and specified for stress-grade lumber in the American Lumber Standards. Lumber may be rough, untreated, in random lengths, and shall be of standard dimensions.
2. Permanent Sheeting: When permanent sheeting is called for on the Drawings, provide and install planks, beams, posts and timbers of unseasoned, rough, new southern yellow pine or Douglas Fir meeting the requirements of ASTM Standard D25, Class "C". In lieu of the above, lumber dressed to standard dimensions, dried and treated in accordance with Standard T-3 of the American Wood Preservers' Association may be utilized.

B. FASTENINGS: Provide fastenings for permanent sheeting as recommended in the National Design Specification for stress-grade lumber and its fastening.

PART 3 - EXECUTION

3.01 INSTALLATION

Install sheeting and bracing for trench and structure excavation progressively as the removal of excavated material requires. Butt planks to exclude groundwater and fines, preventing the erosion of voids outside sheeting. In soft, wet ground drive sheeting to a lower level as excavation progresses to that sheeting is embedded in undisturbed earth. Bracing of sheet piling may be permitted to penetrate the structural concrete only as directed by the City. Refer to Section 03300. Install wales and struts at close intervals so as to prevent displacement of the surrounding earth and to maintain safe conditions in the Work area. Any damage proven to result from improper installations shall be the responsibility of the Contractor. Temporary sheeting for trench and structure excavation may be removed and reused. Withdraw individual planks alternately as the backfill is raised, maintaining sufficient sheeting and bracing to protect the Work and workmen. Remove bracing completely. Where unstable conditions occur in the underlying strata from any cause, and withdrawal of sheeting will endanger the Work, a portion of the sheeting, including bracing, may be left in place with approval of the City. Remove all wood within a zone extending four (4) feet below finished grade. Leaving such material in place shall not be cause for an increase in Contract price.

END OF SECTION 02415

SECTION 02610

BURIED PIPING INSTALLATION

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. INSTALLATION.

B. CONNECTION TO EXISTING WATER PIPELINES AND SHUT-DOWNS OF WATER MAINS.

C. CROSSING OF WATER AND SEWER MAINS.

D. INSULATION OF CONNECTIONS.

E. ABANDONMENT OF EXISTING PIPING AND APPURTENANCES.

F. PRODUCT DELIVERY, STORAGE, AND HANDLING.

G. MAINTAINING WATER SERVICE.

1.02 RELATED SECTIONS

A. SECTION 02221: Trenching, Backfilling, and Compacting.

B. SECTION 15064: Steel cylinder Water Pipe and Process Piping

C. SECTION 15000: Piping Components

1.03 REFERENCES

A. ASTM D2774: Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.

B. AWWA C105: Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.

C. AWWA C206: Field Welding of Steel Water Pipe.

D. AWWA C606: Grooved and Shouldered Joints.

E. AWWA M11: Steel Pipe – A Guide for Design and Installation.

F. AWWA M23: PVC – Design and Installation.

G. AWWA C900: Polyvinyl Chloride (PVC) Pressure Pipe, 4-in. through 12-in., for water.

H. ASCE MOP NO. 37: Design and Construction of Sanitary and Storm Sewers.

I. CONCRETE PIPE HANDBOOK, AMERICAN CONCRETE PIPE ASSOC.

1.05 CONTRACTOR SUBMITTALS

A. All pipe, fittings, valves, gaskets, and appurtenances shall be the product of a single manufacturer for that particular item (i.e., fittings by same manufacturer; valves by same manufacturer). Materials shall be compatible for the use intended and shall be in conformance with the appropriate sections of these specifications. Dissimilar materials shall be properly insulated to prevent galvanic action and so as to not cause any deterioration or failure of serve.

PART 2 – PRODUCTS

2.01 GENERAL

All piping, fittings, and appurtenances shall be of the types shown on the contract Documents and shall conform to the applicable sections of these specifications.

A. PIPE AND APPURTENANCES: Provide pipe materials, coatings and linings, and appurtenances of the sizes and types indicated on the Drawings.

B. WATER PIPE AND WATER LATERALS: Shall comply with Section 02646 – PVC Pressure Pipe, Section 02651 – Steel Pipe Cement Mortar-Lined and Coated, Section – 02653 Steel Pipe Fabricated Specials and Division 15.

2.02 WATER SERVICE TRANSFER MATERIAL

Water services shall be constructed as per City Standard Drawings W-1-E and W-2-E.

PART 3 – EXECUTION

3.01 INSTALLATION

Installation of buried piping shall conform to the provisions of the applicable sections of these Specifications.

All trench excavations shall be inspected by the Owner prior to laying of pipe. The Owner shall be notified in advance of excavation, bedding, and pipe laying operations.

All earth work and trenching shall conform to Section 02221 – Trenching, Backfilling and Compacting Earthwork of these Specifications.

Minimum depth of cover over piping shall be as indicated or as directed by the Owner.

Pipe, fittings, and appurtenances that are cracked, damaged, or in poor condition or have damaged linings or coatings will be rejected.

In order to prevent accumulations of air and to enable the pipeline to be drained, piping shall not have high or low points except where shown.

All non-metallic pipelines shall be provided with a No. 10 AWG base copper wire laid along the top of the pipe and held in place with ties or hitches. The ties or hitches shall be spaced not more than ten (10) feet apart. The copper wire is to be used in the future as a means of locating the pipe with an electronic-type locator.

A. LOCATOR TAPE: All non-metallic pipelines shall be provided with a 6-inch wide locator ribbon placed 24-inches above pipe. The locator ribbon shall be manufactured by Thor Enterprises, Inc., Calipco, Inc., Terra Tape, Inc. or approved equal. Contractor shall center pipe locator ribbon in trench and place over entire length of all sizes and locations of water main. Color and Text on tape as indicated below.

   1. Water Pipe: The identification tape shall be colored blue and have a continuous warning "CAUTION: WATER LINE BURIED BELOW."

B. INTERFERENCES: Contractor shall protect and maintain all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the Work. Where indicated that the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, or pipes, the obstruction shall be supported until it is relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, this work shall be performed at no additional cost to the Owner.

Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Owner may direct a change in the alignment or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and integrity of the finished joint.

C. LINE AND GRADE TOLERANCE: Each section of pipe shall be laid in the order and position shown on the laying schedule. Unless indicated otherwise, the pipe shall be laid to the design line and grade, within approximately one inch plus or minus. No tolerance is permitted on pipes designed for zero slope.

D. CURVED ALIGNMENTS: Where curved alignments are indicated, deflecting the joints will be allowed only in accordance with the written instructions of the pipe manufacturer and these specifications. Where a smaller radius of curvature is required than can be accommodated by deflecting the joints, sections of pipe with beveled ends may be laid unless fabricated bends are indicated. Maximum joint deflection and maximum level for different pipe sizes and joint designs shall be in accordance with the pipe manufacturer's recommendations and these specifications.

Cutting and machining of the pipe shall only be in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, or any other method that may fracture the pipe, produce ragged, uneven edges, or otherwise impair the condition of the pipe.

The Contractor shall install all pipe, fittings, closure pieces, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other steel plate specials, bolts, nuts, gaskets, jointing materials, and all other appurtenances as indicated and as required to provide a complete and workable installation. No pipe or appurtenance shall be installed when the interior or exterior surfaces show cracks or other defects that may be harmful as determined by the Owner. Damaged interior and exterior surfaces shall be repaired to the satisfaction of the Owner or a new undamaged pipe or appurtenance shall be provided.

Pipe laying operations shall be stopped and dewatering operations shall be adjusted to prevent the pipe from floating due to water entering the trench from any source. The Contractor shall reinstall all affected pipe to its specified condition and grade.

All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plus or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

Immediately before placing each section of pipe in final position for joining, the bedding shall be checked for firmness and uniformity of surface.

Pipe shall be laid directly on the bedding material. No blocking will be permitted and the bedding shall form a continuous, solid bearing for the full length of the pipe. Excavate to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings and to facilitate placement of grout bands. Excavation shall be adequate to permit access to the joints for bonding operations and for application of coating on field joints.

Lay section of pipe with the bell end upgrade.

Except for short runs which may be permitted by which may be permitted by the Owner Field Engineer Inspector, sections of pipe shall be laid in a sequence moving in an upgrade direction on grades exceeding ten percent (10%). Pipe which is laid in a downgrade direction shall be blocked and held in place until sufficient support is furnished by the following pipes to prevent movement.

Where indicated, concrete thrust blocks shall be provided per SDRSD WT-01.

3.02 WATER SERVICE TRANSFERS

The existing water services, where shown on the Contract Documents, shall be replaced with new water services for connection to the new water main. The locations shown are approximate only and the exact locations shall be determined in the field when the existing service is uncovered by the Contractor. All connections shall include complete replacement of copper tubing from the main to the meter. Water service transfers to existing meters shall be made after the new main and appurtenances has been tested, disinfected, and placed in service.

The size of piping and fittings for private water service transfers shall match the size of the existing water services, except that a minimum of 1-inch diameter copper tubing and

fittings shall e utilized. The size of existing water services to be transferred are 2-inch, 1-inch, or ¾-inch unless otherwise shown on the contract Documents. Contractor shall provide proper fittings to achieve the proper size connection to the existing service.

3.03 CONNECTION TO EXISTING WATER PIPELINES AND SHUT DOWNS OF WATER MAINS

A. GENERAL: At the locations shown on the Contract Documents, the Contractor shall make the required connections to existing pipelines. New pipelines shall not be connected to existing pipelines until the new pipeline has been successfully pressure tested, and has been disinfected and passed the bacteriological tests,

All shut downs of existing mains will be performed only by the Owner. The Contractor shall NOT shut down any exiting water main. Should the Contractor wish to have an existing water main shut down, a formal written request will be made to the Owner, two (2) weeks in advance of the time of the requested shut down. The Owner will allow a shut down only when such shot down will cause a minimum of disturbance to the normal delivery of water to customers. The Owner will have the sole discretion as to approval of schedules for requested shut downs and may require rescheduling if in the Owner's opinion the requested time for shut down will adversely affect the proper functioning of the water distribution system.

3.04 CROSSING OF WATER MAINS, SEWER MAINS, AND STORM DRAINS

A. CONSTRUCTION METHOD: A 12-inch minimum vertical separation is required on all new water and sewer mains crossing existing mains. Where a new water main crosses over an existing sewer main, the new water main shall be constructed of welded steel pipe or PVC water pipe, Class 200, with no joints allowed within four (4) feet of the outside diameter of the existing sewer. Where the new water main crosses under an existing sewer, the new water main shall be constructed of welded steel pipe or PVC water pipe, Class 200, with no joints allowed within ten (10) feet of the outside diameter of the existing sewer.

3.05 INSULATION OF CONNECTIONS

Insulating bushings, unions, couplings, and flanges, as appropriate, shall be used for joining pipes of dissimilar metals, and for piping systems where corrosion control and Cathodic protection are involved, or where shown.

3.06 ABANDONMENT OF EXISTING PIPING AND APPURTENANCES

Existing culverts and utility pipe lines, where shown on the Drawings to be abandoned, shall be abandoned in place or at the option of the contractor, the culverts and pipe lines shall be removed and disposed of. If the Contractor elects to remove and dispose of existing piping, the existing piping shall be handled, transported, and disposed o in accordance with all laws and regulations pertaining to the type of piping material in question. All resulting openings into existing structures that are to remain in place shall be plugged with concrete.

Abandonment of culverts and pipelines in place shall conform to the following:

Culverts and pipe lines that intersect side slopes shall be removed to a depth of not less than three (3) feet, measured normal to the plane of the finished side slope, before being abandoned.

Culverts, 18 inches in diameter and larger, shall be backfilled with a cement sand slurry mixture. Slurry mix shall conform to Section 02252 – control Density Fill (CDF).

A. WATER LINES: Abandonment of water lines in place shall conform to the following:

1. Water lines shall be abandoned by installing a plug or cap at all resulting openings, as described in Section 02252 – Control Density Fill (CDF).

2. When specified in the drawings, pipelines 10-inches and larger which are located beneath traffic bearing pavement shall be abandoned by injecting the pipe with sand slurry.

3. Where valves or blow-offs are to be abandoned, the valve well and cap shall be removed and returned to the Owner and the street is to be repaired.

Culverts and pipelines shall not be abandoned until their use is no longer required. The Contractor shall notify the Owner in advance of any intended culvert or pipe abandonment.

3.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site to ensure uninterrupted progress of the Work.

Handle all pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll, or skid

piping. Materials cracked, gouged, chipped, dented, or otherwise damaged will not be acceptable and shall be removed from the site immediately.

Unload pipe, fittings, and specials opposite to or as close to the place where they are to be installed as I practical to avoid unnecessary handling. Keep pipe interior completely free from dirt and foreign material.

3.08 MAINTAINING WATER SERVICES

While installing a new pipeline to replace an existing pipeline providing water service to users along the line, the service to a given user shall not be interrupted except for the required period to transfer that service from the old line to the new line. The service to a given user shall not be interrupted for more than 8 hours.

The Contractor shall make provisions necessary to keep the old main in service until the new main has been completed and is ready for service transfer. Transfers shall not be made until the new line has been installed, disinfected, tested and placed in service. Certain portions of the project will require the Contractor to install, maintain, and remove a potable "highline" to provide uninterrupted service to the users while the new pipeline is being constructed and the existing pipeline abandoned or removed. See Section 01510 – 1.09 for further details regarding potable "highlines".

END OF SECTION 02610

SECTION 02620
EXISTING UNDERGROUND UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in conditions of the Contract and Division 1, 2 and 15 form a part of this Section. Provide work related to existing underground utilities as set forth herein.

A. WORK INCLUDED IN THIS SECTION: Principal items are:
   1. Exposure of existing utilities.
   2. Advance notification of utility agencies.
   3. Crossing, protection and/or relocation of utilities.
   4. Protection of other existing facilities.

B. RELATED WORK NOT INCLUDED IN THIS SECTION: Site Utilities, Section 02610.

1.02 EXPOSURE OF UTILITIES IN ADVANCE OF WORK

A. DETERMINATION OF LOCATION AND DEPTH:
   1. Determine the true location and depth of all utilities and service connections; including the type, material, and condition of any utility which may be affected by or affect the work.
   2. Coordinate with all utility companies field locate all underground lines before start of construction.

B. EXPOSURE IN ADVANCE OF TRENCHING:
   1. Expose all utility mains that must be crossed or closely paralleled at least 1500' in advance of construction.
   2. Contractor shall immediately after field location, provide the location and depth of the "potholed" utilities to the Engineer.
   3. Expose all service connections before excavation in the area.
   4. All cost incurred in exposing utilities shall be borne by the Contractor.

C. RIGHTS TO MINOR ADJUSTMENTS IN DESIGN: The City reserves the right to make minor adjustments in pipeline alignment and grade, all at no additional cost to the City.

D. COMPLIANCE: Failure of the Contractor to comply with the provisions described herein will result in an order to suspend work until these provisions are complied with, and no additional compensation will be allowed as a result of such suspension.

1.03 ADVANCE NOTIFICATION OF UTILITY AGENCIES

1. Determine and notify those agencies requiring advance notification for inspection or other purposes before beginning construction in any area of concern to said agency.
2. Provide agencies with 48 hours minimum advance notice.

1.04 CROSSING PROTECTION AND/OR RELOCATION OF UTILITIES

A. GENERAL: Utilities for the purpose of these specifications shall be considered as including, but not limited to, and irrespective of ownership; Pipelines (including irrigation mains), conduits, transmission lines, and appurtenances of Public Utilities" (as defined in the Public Utilities Act of the State of California) and those of private industry, business, or individuals solely for their own use or for use of their tenants; and storm drains, sanitary sewer, street lighting, traffic signal systems, duct banks, telephone cable, transmission cables, and completely buried structures.

B. UTILITIES INDICATED ON DRAWINGS:

1. Indicated utilities are based upon the information provided by the utility company to the Engineer; and the accuracy and completeness of the utilities shown is not guaranteed.
2. The depth indicated in profile, unless a specific elevation is shown, is based on general practice and is not guaranteed at any specific location.
3. No service connections are shown on the Drawings. Contractor to determine the exact location of all utilities and their service connections. All costs to be included in bid items provided on Bidding Sheet, and no additional compaction will be made.

C. FIELD LOCATING:

1. Contractor shall have utility companies field locate their utilities prior to construction.
2. Where required, field location by Contractor forces shall be included in the contract price for which such work is appurtenant to and no additional allowance will be made therefor.
3. The Contractor shall make his own investigation as to the location and type of existing utilities and their appurtenances and service connections which may be affected by the contract work, and shall notify the City as to any utility located by him which has been incorrectly shown or omitted from the drawings.

D. UTILITIES ON PLANS AND NOT IN CONFLICT:

1. Where utilities cross or parallel the pipeline trench but do not conflict with the permanent work to be constructed, the Contractor shall protect the utility in place unless otherwise indicated on the plans.

2. Unless otherwise provided in the specifications, full compensation for crossing or paralleling of utilities shown on the plans shall be included in the contract unit price for which such work is appurtenant thereto and no additional allowance will be made therefor.

E. SPECIAL WATER/SEWER CROSSINGS:

1. At the locations shown on the plans or if the vertical separation between the outside of the sewer pipe and the outside of existing water pipes at crossings is less than one (1) foot, and when directed by the City, the Contractor shall provide the construction required per the detail shown on the plans and per the State Health Department Water/Sewer Special Construction Requirements. The special construction will be deleted at locations shown if the vertical separation is 1 foot or greater.
2. The City hereby reserves the right to increase or decrease this item from the quantity shown on the Proposal forms without altering the unit price bid per each. Payment will be made in accordance with the unit bid price provided on the Bidding Sheet; in the event no item for said special construction work is designated on the Bidding Sheet, Contractor shall be paid under the "Extra Work" provisions of the Contract Appendix.

F. RELOCATION OF UTILITIES BY THE CONTRACTOR FOR HIS OWN CONVENIENCE: The temporary relocation or the alteration of any utility desired by the Contractor solely for his own convenience in the performance of the contract work, to a position or condition other than that provided for in the specifications or shown on the drawings, shall be the Contractor's own responsibility, and he shall make all arrangements with the property owners regarding such work. Any costs of such work for the Contractor's own convenience shall be absorbed in the unit prices or included in the lump sum amounts bid for the various contract items.

G. UTILITY CONFLICTS WITH PROPOSED IMPROVEMENTS

1. If a utility, whether shown on the plans or not, should intersect the proposed improvement at grade anywhere along the line of the improvement, the Contractor shall immediately notify the City.
2. Contractor shall notify the City in writing, stating the nature of the conflict, location by schedule, sheet number, name of the street or location of easement and the station at which the conflict occurred. The City will, within a reasonable time, make the necessary arrangements to resolve the conflict.
3. Completion of any required "gap" after the resolution of a conflict shall not be just cause for additional compensation. Such completion of the "gap" shall be started within 72 hours after the Contractor has been notified of resolution of the conflict and

completed in a workmanlike manner within reasonable time thereafter.

4. When directed or approved by the City, changes in line or grade of any structure being built may be made in order to avoid utilities. Any additional costs because of such changes will be paid for as "Extra Work".
5. When a utility shown on the plans conflicts with the proposed improvements, the City will arrange for the relocation or alteration of said utility or require the Contractor to do same as 'Extra Work". Work required in connection with unknown utilities will be performed and paid for as specified in the following paragraphs.

H. UNKNOWN UTILITIES DISCLOSED DURING CONTRACT WORK: In the event that a utility is disclosed or installed subsequent to the award of contract, such utility not being indicated on the drawings, the alteration, relocation or proper support and protection shall be done and paid for as follows:

1. When said utility is found to occupy the space required to be occupied by a part of the permanent works to be constructed under the Contract, the City will arrange for the relocation or alteration of said utility, or require the Contractor to do same as "Extra Work".
2. When the said utility is found to lie parallel to the permanent work and within the trench prism defined by the minimum allowable trench excavation consistent with safety and the rules, orders and regulations of local, State and Federal agencies having jurisdiction; the City will arrange for the relocation, protection or alteration of said utility, or require the Contractor to do same as "Extra Work".
3. When said utility is more or less parallel with, and any portion of it does not lie within the trench prism specified hereinabove, the Contractor shall advise the City thereof, and in cooperation with the City of the utility, provide and place the necessary support, if any, for proper protection to ensure continuous and safe operation of the utility. All costs of such work shall be borne by the Contractor.
4. Utilities found to cross the excavation but not intercepting the permanent works to be constructed, then the Contractor will be required to protect the existing facility in place and construct the proposed facility under the unknown utility.

   Compensation for such crossings will be at a unit price per each in accordance with the proposal therefor. The number of such crossings is estimated and the City hereby expressly reserves the right to add to the number shown or decrease from the number shown or to totally delete the item for unknown utility crossings at no change in the unit price per each. The time extension for such crossings shall be determined by the City and shall be added t o the

total time for completion allowed and for which no liquidated damages will be assessed.

5. Upon disclosing a utility in the course of excavation that was not indicated on the drawings or marked in the field, the Contractor shall protect it in place. However, he shall immediately investigate if it is abandoned. The Contractor will be compensated at the bid unit price for unknown utility crossings only for the initial crossing of abandoned lines; and only if he did protect the abandoned utility in place.

I. RESPONSIBILITY OF THE CONTRACTOR:

1. The Contractor shall be responsible for all costs for the repair of any and all damage to the contract work or to any utility (whether previously known or disclosed during the work), as may be caused by his operations.
2. Utilities not shown on the drawings to be relocated or altered by others, shall be maintained in place by the Contractor.
3. At the completion of the contract work, the Contractor will leave all utilities and appurtenances in a condition satisfactory to the utility owners and the City.

1.05 PROTECTION OF FACILITIES OTHER THAN UTILITIES

Contractor shall protect in place or remove and replace to original condition all existing facilities.

It shall be the Contractor's responsibility to familiarize himself with the conditions of proposed work and to identify by field investigation those features, whether or not shown on the plans, which require removal and replacement or protection in place. These features include, but are not limited to, fences, cross gutters, roads, sidewalks, driveways, curbs and gutters, power poles, signs, drainage structures, trees, landscaping, etc.

END OF SECTION 02620

DIVISION 3

CONCRETE

DIVISION 3
TABLE OF CONTENTS

SECTION		PAGE
03110	Concrete Formwork	03110-1
03210	Concrete Reinforcement	03210-1
03300	Cast-in-Place Concrete	03300-1

SECTION 03110
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SCOPE
The work includes the furnishing and installing and removing of forms for all cast-in-place concrete work as shown and noted on the drawings and specified herein.

1.02 CODES AND STANDARDS
The American Concrete Institute's "Recommended Practice for Concrete Formwork", ACI 347-63, and the "Uniform Building Code", 1991 Edition, Section 2606, are hereby made a direct part of this specification, and all concrete formwork included in this contract shall conform with the applicable requirements therein except as specified otherwise herein.

1.03 RELATED SECTIONS
A. SECTION 02200: Earthwork and Site Preparation
B. SECTION 03210: Concrete Reinforcement
C. SECTION 03300: Cast-in-Place Concrete

1.04 SUBMITTALS
Information on the Contractor's proposed forming system shall be submitted in such detail as the Engineer may require to assure himself that the intent of the Specifications can be complied with by the use of the proposed system. Except as otherwise specified, or accepted in writing by the Engineer only forming systems by manufacturers with a minimum of five years' experience shall be considered.

1.05 ARRANGEMENT
Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

1.06 NOTIFICATION
Before placing concrete, and after placing reinforcing steel in forms, notify the Engineer and Inspector. Make notification at least two working days in advance of placing concrete to permit arrangements for site visit.

1.07 INSPECTION
Prior to placing of any concrete, and after placement of reinforcing steel in the forms, Contractor shall notify the City so that proper inspection may be made. Such notification shall be made at least 24 hours in advance of placing concrete to permit proper arrangements to be made for inspection.

1.08 TOLERANCES
Variation from plumb in lines and surfaces of columns, walls, and arises shall not exceed 1/8" in 10 feet.

Variation in linear building lines from established position in plan and related position of columns, piers, or walls shall not exceed 1/2" in any bay of 20 feet.

1.09 REJECTION OF DEFECTIVE WORK DUE TO IMPROPER FORMS

Any movement or bellying of forms during construction or variations in excess of the tolerances specified will be considered just cause for the removal of such forms and, in addition, the concrete work so affected. Reconstruction of forms and new concrete (including disposal of rejected materials) shall be furnished at no additional cost to the City.

PART 2 - PRODUCTS

2.01 MATERIALS

Earth forms may be used for footings only where the soil is firm and stable and the concrete will not be exposed. Where earth forms are to be used, excavations shall be cut neat and accurate to size for placing of concrete directly against the excavation.

Boards for unexposed concrete, not otherwise scheduled or specified, shall be Douglas Fir, conforming to the "Standard Grading and Dressing Rules No. 16", most current edition, of the West Coast Lumber Inspection Bureau. Boards shall be S4S. Contractor at his option, may use plywood for forms in lieu of boards. Plywood, if used, shall be "B-B Plyform Class I Exterior" grade, conforming to U.S. Product Standards PS 1-83, 5/8" minimum thickness. Plywood used for exposed concrete shall be a high density overlay type especially manufactured for form work.

A. FORM TIES AND SPREADERS: Standard metal form clamp assembly, of type acting as spreaders and leaving no metal within 1" of concrete face. Inner tie rod shall be left in concrete when forms are removed. Submit samples and manufacturer's specifications to Engineer for review and approval by the City before using. Wire ties or wood spreaders will not be permitted.

B. FORM COATING: Nongrain raising and nonstraining type that will not leave residual matter on surface of concrete or adversely affect proper bonding of subsequent application of other material applied to concrete surface. Coatings containing mineral oils or other nondrying ingredients are not be permitted. Acceptable products include, but are not limited to the following:

Non-Crete Company; Nox-Crete Form Coating
Arcal Chemical Corp.; Arcal 80
Industrial Synthetics Co.; Synthex

PART 3 - EXECUTION

3.01 GENERAL

The engineering and construction of all formwork, shoring and bracing shall be carried out by and under the direction of the Contractor, who shall be responsible for the engineering, construction, maintenance, and safety of all formwork during the entire construction period.

The design of all concrete forms, falsework, and shoring shall be the responsibility of the Contractor and the design and installation of these items shall comply with all local, State, and Federal regulations.

The formwork shall be designed for the loads and lateral pressure outlined in Part 3, Section 102, of ACI 347.

3.02 FORMS AND ACCESSORIES

A. GENERAL: Forms shall be so constructed that the finished concrete will conform to the shapes, lines, grades, and dimensions indicated on the Drawings. It is intended that the surface of the concrete after stripping shall present a smooth, hard, and dense finish that will require a minimum amount of finishing. Sufficient number of forms shall be provided so that the work may be prosecuted rapidly and present a uniform appearance in form patterns and finish. Forms shall be clean and free from all dirt, debris, concrete, etc. and shall be coated with an acceptable form release oil if required, prior to use of reuse.

B. BUILT-UP PLYWOOD FORMS:

1. Built-up plywood forms may be substituted for a prefabricated forming system subject to the following minimum requirements: full sized (4 foot by 8 foot) plywood sheets must be used except where smaller pieces will cover an entire area.
2. Plywood sheets shall be 5-ply, 3/4 inch nominal, made with 100 percent waterproof adhesive, and the finish surface shall be coated or overlaid with a surface which is impervious to water and the alkaline calcium and sodium hydroxide of cement.
3. Studding shall be not less than 2 inch by 4 inch lumber spaced at 16 inches or 24 inches on center.
    a. Closer spacing may be required depending upon the strength requirements of the forms, in order to prevent any bulging surfaces on the faces of finished concrete work.
    b. Studs shall be installed perpendicular to the grain of the exterior plys of the plywood sheets.
4. Wales shall be formed of double 2 inch by 4 inch lumber as a minimum.
5. Studding and wales shall contain no loose knots and shall be free of warps, cups, and bows.

6. The number of reuses of forms will depend upon the durability of the surface coating or overlay used, and the Contractor's ability to maintain the forms in a condition which will produce a flat, smooth, hard, dense finish on the concrete when stripped.
7. Alternate combination of plywood thickness and stud spacing may be submitted to the Engineer for review and acceptance.

C. STEEL OR STEEL FRAMED FORMS:
1. Steel forms shall be rigidly constructed and adequately braced for minimum deflection of the finish surface. The finish surface shall be flat without bows, cups, or dents.
2. Steel framed plywood forms shall be rigidly constructed and braced with joints fitting closely and smoothly.
   a. Plywood paneling shall be 5-ply, 5/8 inch nominal or 3/4 inch nominal, made with 100 percent waterproof adhesive, and the finish surface shall be coated or overlaid with a surface which is impervious to water and the alkaline calcium and sodium hydroxide of cement.
   b. The number of reuses will depend upon the durability of the surface coating or overlay used.
3. Built-up plywood forms, as specified herein, may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through the forms.

D. INCIDENTALS
1. Where not otherwise indicated on the Drawings, all external angles of walkways, slabs, walls, beams, columns, and openings shall have a 3/4 inch bevel formed by utilizing a true dimensioned wood or solid plastic chamfer strip and external angles of walkways, walls, and slabs at expansion, contraction, and construction joints shall be a 1/2 inch bevel formed by utilizing a true dimensioned wood or solid plastic chamfer strip.
   a. Reentrant angles may be left square.
   b. Level strips shall be installed at the top of all wall concrete placements to maintain a true line at all horizontal construction joints.
2. Keyways shall be constructed as indicated on the Drawings. Material for keyways shall be steel, plastic, or lumber treated with form coating, applied according to label directions.
3. Pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, shall be encased in the concrete. Dovetail anchors or ties shall be used in conjunction with the slots or inserts for the various materials as specified under their respective sections and as may be necessary for the required work.

4. All exposed corners shall be chamfered 3/4", unless shown otherwise on drawings. Provide molding in forms for all chamfering required.

E. BRACING AND ALIGNMENT OF FORMS
1. It shall be the Contractor's responsibility to limit deviations in line and grade to tolerances which will permit proper installation of all structural embedded items or mechanical and electrical equipment and piping.
2. All formwork shall be securely braced, supported, tied down, or otherwise held in place to prevent any movement of formwork. Adequate provisions shall be made for uplift pressure, lateral bulging of forms, and deflection of forms for slabs and beams.
3. When a second lift is placed on hardened concrete, special precautions shall be taken in the form work at the top of the old lift and bottom of the new lift to prevent spreading, vertical or horizontal displacement of forms; and to prevent grout "bleeding" on finished concrete surfaces. Pipe stubs, anchor bolts, and other embedded items shall be set in the forms where required.
4. No concrete shall be placed until all forms have been thoroughly checked by the Contractor for alignment, level, strength, and to assure accurate location of all mechanical and electrical inserts or other embedded items. All cracks, openings, or offsets at joints in the formwork which are 1/16 inch or larger shall be closed by tightening the forms of by filling with an acceptable crack filler.

F. FORM TIES
1. Form ties for the forming system selected shall be the cone-snap tie or flat bar type as manufactured by a recognized manufacturer of concrete forming equipment.
2. Forms shall be tied together at not less than 2 foot centers vertically and horizontally.
3. Wire ties or wood spreaders of any form shall not be used. Ties shall be of a type that will accurately tie, lock, and spread the forms.
4. Forms and ties shall be designed to withstand concrete pressures without building, spreading, or lifting of the forms.
5. The form tie shall be of such design that when the forms are removed, no metals shall be within 3/4 inch of any surface.

G. REMOVAL OF FORMS: Framing shall remain in place for the minimum time(s) indicated herein.
1. Vertical forms shall remain in place a minimum of 24 hours after the concrete is placed. If, after 24 hours, the concrete has sufficient strength and hardness to resist surface or other damage, the vertical forms may be removed.
2. Other forms supporting concrete and shoring shall remain in place as follows:

a. Sides of footings	24 h ours minimum
b. Vertical sides of beams, girders, and similar members	48 hours minimum
c. Slabs, beams, and girders	Until concrete strength reaches the specified strength or until shoring is installed
d. Shoring for slabs, beams, and girders	Until concrete strength reaches the specified strength
e. Wall bracing	Until concrete strength of the beams and slabs laterally supporting the wall reaches the specified strength.

3. Forms shall not be removed from concrete which has been placed with outside ambient air temperature below 50 degrees F until the concrete has attained the specified strength as determined by test cylinders stored in the field under equivalent conditions as the concrete structure. No heavy loading on green concrete will be permitted. Green concrete shall be defined as concrete with less than the specified strength. Immediately after forms are removed, the surface of the concrete shall be carefully examined, and any irregularities in the surface shall be repaired and finished as specified hereinafter.

END OF SECTION 03110

SECTION 03210
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SCOPE
The work includes the furnishing and installing of reinforcing steel for all cast-in-place concrete.

1.02 GENERAL
Contractor shall check project or contract architectural, structural, mechanical, and electrical drawings for anchors, inserts, conduits, sleeves, and any other items which are required to be cast in concrete, and shall make necessary provisions as required so that reinforcing steel will not interfere with the placement of such embedded items.

1.03 CODES AND STANDARDS
Except as modified by the requirements specified herein and/or the details on the drawings, all work included in this section shall conform to the applicable provisions of the following codes and standards:

1. "California Code of Regulations": 1997, Title 24, Chapter 19, Concrete.
2. Concrete Reinforcing Steel Institute (CRSI): "Recommended Practice for Placing Reinforcing Bars", latest edition.
3. American Concrete Institute (ACI): "Manual of Standard Practice for Detailing Reinforced Concrete Structures", ACI 315, latest edition.
4. American Society for Testing and Materials (ASTM): The specifications and standards hereinafter referred to, latest edition.

1.04 SUBMITTALS
Mill affidavits, stating the grades and physical and chemical properties of the reinforcing steel, and conformance with ASTM Specifications, shall be submitted to the Engineer for review and approval by the City before delivery of the steel to the job site.

1.05 STORAGE
Reinforcing steel shall be transported to the building site, stored and covered in a manner which will insure that no damage shall occur to it from moisture, dirt, grease, or any other cause that might impair bond to concrete.

A sufficient supply of approved reinforcing steel shall be stored on the building site at all times to insure that there will be no delay of the work. Identification of steel shall be maintained after bundles are broken.

PART 2 - PRODUCTS

2.01 MATERIALS

A. REINFORCING BARS: New, deformed, billet steel bars conforming to ASTM A615-84a Grade 40 unless otherwise indicated. Deliver bars new and free from rust and mill scale in original bundles with mill tags intact.

B. WELDED WIRE FABRIC: New, welded steel wire fabric, conforming to ASTM A185-73. Gauge and center-to-center spacing shall be as noted on drawings.

C. ACCESSORIES: Reinforcement accessories, consisting of spacers, chairs, ties, and similar items shall be provided as required for spacing, assembling, and supporting reinforcement in place. All metal accessories shall be galvanized steel or approved plastic accessories, conforming to the applicable requirements of the CRSI Standards specified herein.

D. TIE WIRE: Tie wire for reinforcement shall be 16 gauge or heavier, where indicated or specified, black or galvanized steel wire, conforming to ASTM A82-79.

PART 3 - EXECUTION

3.01 FABRICATION

Fabrication of steel reinforcement shall be in accordance with the details shown on the drawings. Where specific details are not shown or noted, comply with the applicable requirements of the "Codes and Standards" hereinbefore specified.

Bars shall be accurately bent, cut, and placed as indicated on the drawings. Bars shall be bent cold; heating of bars will not be permitted. Bars shall not be bent or straightened in any manner that will injure the material.

3.02 PLACING

A. GENERAL: Place reinforcing steel as indicated and in accordance with the applicable requirements of referenced specified. Install reinforcement accurately and secure against movement, particularly under the weight of workmen and placement of concrete.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials which may reduce or destroy bond with concrete.

B. REINFORCING SUPPORTS: Support reinforcing bars above earth and on forms by concrete blocks or other approved noncorrodible supports.

Support legs of accessories in forms without embedding in form surface. Space chairs and accessories to conform with CRSI's "Recommended Practice for Placing Bar Supports". No wood will be permitted inside forms.

C. PLACING AND TYING: Set reinforcing in place, and rigidly and securely tie or wire with 16 gauge steel tie wire in the position indicated, or as directed. Point ends of wire away from forms.

D. SPACING: Minimum center to center distance between parallel bars shall be in accordance with the details on the drawings or, where not shown, the clear spacing shall be 2 times the bar diameter but in no case less than 1-1/2" nor less than 1-1/3 times the maximum size aggregate.

E. SPLICES: Laps of splices, where shown or noted on drawings, shall be adequate to transfer stress by bond. Wherever possible, splices of adjacent bars shall be staggered. Reinforcing bars marked continuous shall be spliced with a minimum lap of (40) bar diameters in masonry and (30) bar diameters in concrete.

F. DOWELS: Dowels shall be tied securely in place before concrete is deposited. In the event there are no bars in position to which dowels may be tied, No. 3 minimum shall be added to provide proper support and anchorage. Bending of dowels after placement of concrete will not be permitted.

G. CLEANING: Reinforcement, at time of pour, shall be free of all coatings that would impair bond to concrete.

3.03 INSPECTION

A. Contractor shall notify Engineer at least 24 hours ahead of each concrete pour, and no concrete shall be placed until all reinforcing steel has been installed, inspected and approved by the Inspector.

B. The following reinforcing steel work will be considered defective and shall be removed and replaced at no additional cost to the City.
1. Bars with kinks or bends not shown on drawings.
2. Bars injured due to bending or straightening.
3. Bars heated for bending.
4. Reinforcement not placed in accordance with the drawings and/or specifications.

END OF SECTION 03210

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE

The work includes the furnishing and installing of cast-in-place concrete work as shown and noted on the drawings and specified herein.

Except as otherwise specified, concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce a plastic, workable mixture in accordance with all requirements of these Specifications and suitable to the specific conditions of placement. The portions of materials shall be such as to secure the lowest water-cement ratio which is consistent with good workability, a plastic, cohesive mixture, and one which is within the specified slump range. The proportion of fine and coarse aggregate shall be such as not to produce harshness in placing nor honeycombing in the structures.

1.02 RELATED SECTIONS

A. SECTION 02200: Earthwork and Site Preparation

B. SECTION 03110: Concrete Formwork

C. SECTION 03210: Concrete Reinforcement

1.03 CODES AND STANDARDS

Except as modified by the requirements specified herein and/or the details on the drawings, all work included in this section shall conform to the applicable provisions of the following codes and standards:

1. Uniform Building Code, Latest Edition, Chapter 26, "Concrete".

2. American Concrete Institute (ACI): "Building Code Requirements for Reinforced Concrete", ACI 318-71.

3. American Society for Testing and Materials (ASTM); The specifications and standards hereinafter referred to, latest edition.

1.04 MIX DESIGNS

Designs of concrete mixes, including recommended amounts of admixture and water to be used in the mixes, shall be obtained by the Contractor from a recognized independent testing laboratory. Costs of obtaining the mix designs shall be paid for by the Contractor. Contractor shall be responsible for incorporating into the structure, concrete of the minimum strengths specified. The Contractor shall submit designs for each class of

concrete for the Engineer's review. Concrete mix designs shall bear the signatures and seal of a California Registered Civil Engineer.

1.05 SUBMITTALS

Submit concrete mix designs, reinforcing steel, fibrous reinforcing, expansion joints, water stops and related product data to the Engineer for review and approved per Section 01340.

Certified copies in triplicate of mill tests representative of each shipment of cement shall be furnished to the Engineer for verification of compliance with these Specifications. Mill tests on cement shall include a report on alkali content.

1.06 CLASSES OF CONCRETE

Concrete shall be of five classes, herein referred to as Classes A, B, C, D, and CE which shall be as specified herein and which shall be used where specified or indicated on the Drawings. These classes of concrete shall have a minimum weight of 140 pounds per cubic foot. Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings. Class B concrete may be substituted for Class A concrete, if high-early strength concrete is desired by the Contractor, only in those areas specifically approved by the Engineer and which do not require a sulfate resistant concrete. Class D concrete shall be used for precast concrete items. Class CE shall be used for electrical encasements. All other concrete, unless specified or otherwise indicated on the Drawings, shall be Class A concrete.

TABLE B
CONCRETE
WITHOUT AIR ENTRAINMENT

Class	Specified Compressive Strength f'c At 28-Days (psi)	Max. Net Water To Cement Ratio By Weight	Min. Cement Per Cubic Yard Of Concrete (Pounds)	Slump Range (Inches)
A	3,500	0.53	564	2 to 4**
B Type III Cement	3,500	0.53	564	2 to 4**
C	2,500	0.71	423	3 to 6
D	4,500	0.45	658	2 to 4
CE	2,500	0.71	564	3 to 6

**NOTE: Slump for slabs, decks, walks, and beams shall be not more than 3-1/2 inches. Concrete that is pumped shall meet all the requirements of these Specifications. Concrete with a slump outside the limits indicated in the Table B shall not be placed.

Classes A, C, D, and CE concrete shall be made with Type II low alkali cement. Class B concrete shall be made with Type III low alkali cement. Admixtures shall be as specified hereinafter.

The exact proportions of the mix, including amounts of admixture (if any) and water, shall be determined by the Testing Laboratory or Mill, based cement and aggregate submitted by the Contractor.

1.07 TOLERANCES

It is the intent that the finished concrete conforms to the shapes, lines, grades, and dimensions indicated on the Drawings. It shall be the responsibility of the Contractor to comply with the intent of these Specifications, but it is also recognized that there will be occasions when some deviation will occur or be required. It shall therefore be agreed that the maximum deviation from true line and grade shall not exceed the tolerances listed below at the time of acceptance of the project.

A. In general, all tolerances shall comply with AC1 117-81, paragraphs 2.0 through 2.2 and paragraphs 4.0 through 4.5, except as modified in the following. All slabs shall be uniformly sloped to drain when a slope is indicated. Slabs which are indicated to be level shall have a maximum deviation of 1/8 inch in 10 feet without any apparent changes in grade.

B. On circular tank walls, the Contractor may deviate from the finish line indicated on the Drawings by the use of forms with chord lengths not to exceed 2 feet.

C. All inserts shall be set to the tolerances required for the proper installation and operation of the equipment or systems to which the insert pertains. The following shall be considered maximum tolerances.

Item	Maximum Tolerance, Inches
Sleeves and inserts	plus 1/8 minus 1/8
Projected ends of anchor bolts	plus 1/4 minus 0.0
Anchor bolt setting	plus 1/16 minus 1/16

1.08 WATERTIGHTNESS OF CONCRETE WORK

A. GENERAL: It is the intent of this Specification to secure for every part of the Work concrete and grout of homogeneous structure, which when hardened will have the required strength, watertightness, and resistance to weathering.

B. SURFACE HAIRLINE CRACKS: It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces. Construction, contraction, and expansion joints have been positioned in structures, and curing methods specified, for the purpose of reducing the number and size of these

expected cracks, due to the normal expansion and contraction expected from the specified concrete mixes. Class A and Class B concrete shall be watertight. Cracks which develop in walls or slabs shall be repaired. Cracks which show any signs of leakage shall be repaired until all leakage is stopped.

C. VISIBLE CRACKS: Visible cracks, other than hairline cracks and crazing, in the following areas shall be pressure grouted with low viscosity epoxy as specified herein as Epoxy Injection System: floors and walls of water bearing structures; walls and overhead slabs of passageways or occupied spaces, the outside of which are exposed to weather or may be washed down and are not specified to receive a separate waterproof membrane; slabs over water channels, wet wells, reservoirs, and other similar surfaces not specified to receive a separate waterproof membrane.

Walls or slabs, as above, that leak or sweat because of porosity or cracks too small for successful pressure grouting, shall be sealed on the water or weather side by coatings of a surface sealant system, as specified elsewhere herein.

Grouting or sealing as specified above shall be continued until the structure is watertight and shall remain watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.

1.09 TESTING OF CONCRETE

A. GENERAL: During the progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with the requirements specified herein. These tests shall be made in accordance with ASTM C 31, ASTM C 39, and ASTM C 172. Test cylinders will be made and delivered to the laboratory by the Engineer and the testing expense will be borne by the Owner.

Not less than three cylinder specimens, 6 inch diameter by 12 inch long, will be tested for each 150 cubic yards of each class of concrete with a minimum of three specimens for each class of concrete placed and not less than three specimens for each half day's placement. One cylinder will be broken at 7 days and two at 28 days.

The Contractor shall test the slump of concrete using a slump cone in accordance with the requirements of ASTM C 143. The Contractor shall provide the test equipment. Concrete that does not meet the Specification requirements as to slump shall not be used but shall be removed from the job. The Contractor shall test the slump at the beginning of each placement, as often as necessary to keep the slump within the specified range, and when requested to do so by the Engineer.

The Contractor shall make provisions for and furnish all concrete for the test specimens, and provide manual assistance to the Engineer in preparing said specimens. The Contractor shall be responsible for the care of and providing curing conditions for the test specimens in accordance with ASTM C 31.

PART 2 - PRODUCTS

2.01 MATERIALS

A. PORTLAND CEMENT: ASTM C150-85, Type I or II. Type II cement shall meet the strength requirements of Type I cement. Use only one brand of cement on the project.

B. FINE AGGREGATE: ASTM C33-85, graded from 1/4" to fine.

C. COARSE AGGREGATE: ASTM C33-85, graded from 1/4" to maximum sizes specified.

D. ADMIXTURE: ASTM C-494-90, of a type that increases workability and reduces water demand, but will not increase shrinkage. Admixture shall be submitted to Engineer for review and approval by the City. Admixtures shall be free of chlorides.

E. AIR ENTRAINING ADMIXTURE: All concrete shall contain 5 percent, plus or minus 1 percent, entrained air of evenly dispersed air bubbles at the time of placement. The air entraining agent shall conform to ASTM C 260. The air entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.

F. WATER: Clean and potable, free of impurities detrimental to concrete.

G. CURING-SEALER: Curing and sealing for floor shall be one of the following acrylate resin compounds or equal.

- AC Horn, Inc. "Horn Clear Seal 300"
- Sonneborn-Contech "Kure-N-Seal 0800"

H. EXPANSION JOINT FILLER: Premolded, of sizes and thicknesses shown on drawings, conforming to ASTM D1751-73.

I. EXPANSION JOINT SEALING COMPOUND: Joint sealant and backerod shall be a traffic grade polyurethane. Use submerged type sealant for water-carrying structures and related potentially west areas. Refer to Section 07900, Paragraph 2.1.3.

J. CLEAR SEALER HARDENER: Sonneborn "Lapidolith", Protex Industries "Lithoplate" or approved equal.

2.02 WATERSTOPS

A. GENERAL: Waterstops shall be installed in concrete joints where indicated on the Drawings and in all water bearing structures. Waterstop shall be rubber or polyvinyl chloride.

Waterstops in the walls shall be carried into lower slabs and shall join the waterstops in the slabs with appropriate types of fittings. All joints in water bearing structures shall have waterstops, whether indicated on the drawings or not. All waterstops shall be continuous. Waterstops shall be set accurately to the position and line indicated on the Drawings. Edges shall be held and securely fixed in position at intervals of not more than 12 inches so that they will not move during the placing of concrete. No nails shall be driven through waterstops in the vicinity of construction joints. Wires at not more than 12 inches on centers near the outer bulbs shall be used to tie the waterstops into position. Special clips may be used in lieu of wires, at the Contractor's option. Waterstops shall be terminated 3 inches from the top of finished surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.

Waterstops shall be manufactured by Burke Concrete Accessories Inc.; Greenstreak Plastic Products Division of Western Textile Products Company, Kirkhill Rubber Company; Williams Products Inc.; or equal.

Ribbed type waterstops will not be allowed.

B. RUBBER WATERSTOPS: Unless otherwise specified or indicated on the Drawings, rubber waterstops shall be 6 inch flat dumbbell type, centered, at construction and contraction joints, and 9 inch wide dumbbell type with 1 inch diameter hollow center bulb, centered, at expansion joints. Rubber waterstop shall meet the following requirements:

		Test Method
Hardness – Shore A durometer	60 to 70	ASTM D 2240
Elongation – not less than	450 percent	ASTM D 412
Tensile strength – not less than	3,000 psi	ASTM D 412
300 percent modulus – not less than	900 psi	ASTM D 1456
Water absorption after two days at 158 degrees F	5 percent	ASTM D 471
Tensile strength after aging 48 hours in	80 percent of	ASTM D 572

oxygen at 70 degrees C and 300 psi	origin	
Compression set, 22 hours at 158 degrees F	30 percent	
Specific Gravity	1.17 plus or Minus 0.03	ASTM D 395

The Contractor shall submit samples, prints, and complete physical property data covering the waterstop.

Rubber waterstop shall be manufactured to insure an integral cross section which will be dense, homogeneous, and free from porosity and other imperfections. Minor surface defects such as surface peel covering less than 1 square inch and surface cavities or bumps less than 1/4 inch in longest lateral dimension and less than 1/16 inch deep, will be acceptable.

All waterstops shall be installed so that all joints are watertight. All joints for rubber waterstops shall be made by the use of factory-made fittings and unions, some of which be special. Fittings and unions shall be cemented in place using clamps over the entire area of splice until the cement is bonded permanently. Welding of the waterstop without the use of factory-made unions and fittings, will not be permitted. Split type waterstop will not be permitted except where specifically indicated on the Drawings.

Cement shall be as recommended by the manufacturer of the waterstop, and field cementing or solvent welding shall be in accordance with the manufacturer's printed directions.

C. POLYVINYL CHLORIDE WATERSTOPS: Unless otherwise specified or indicated on the Drawings, polyvinyl chloride waterstop shall be 6 inch flat dumbbell type, centered, at construction and contraction joints, and 9 inch wide dumbbell type with a 1 inch diameter hollow center bulb centered at expansion joints. The waterstop shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material.

The Contractor shall submit samples, prints, and complete physical property data covering the waterstop. The Contractor shall submit written certifications that all of the material supplied on this project meets or exceeds the physical property requirements of the current U.S. Army Corps of Engineers Specification No. CRD-C572 and shall submit laboratory test reports indicating that the average properties of all the materials and finished waterstops conform to the following:

2.03 SYNTHETIC SPONGE RUBBER FILLER

A. Synthetic sponge rubber filler shall be an expanded closed-cell sponge rubber backer rod manufactured from a synthetic polymer neoprene base; or a resilient closed-cell polyethylene foam backer rod. The synthetic sponge rubber filler shall have characteristics suitable for the application intended, including the following:

1. Necessary strength for supporting the sealing compound during application.

2. Sufficient resiliency to prevent significant load transfer across the joint.

3. Resistance to the environmental conditions of the installation.

4. No bonding to the sealing compound.

5. A cellular structure that shall prevent wicking or absorption of water.

6. Compatibility with other materials in the joint, and acceptance by the manufacturer of the sealing compound.

B. The size of the synthetic sponge rubber filler shall be 25 percent greater than the nominal joint width.

C. Acceptable products include No. 750.3 Ropax Rod Stock manufactured by the Presstite Division of Interchemical Corporation; Rubatex-Cord manufactured by the Rubatex Corporation; or approved equal.

D. Surface preparation and installation of the synthetic sponge rubber filler shall be as recommended by the manufacturer in published instructions. The synthetic sponge rubber filler shall not be stretched beyond its normal length during installation.

PART 3 - EXECUTION

3.01 WORKMANSHIP AND METHODS

Concrete work, including detailing of reinforcing, shall be in accordance with the best standard practices and as set forth in the ACI Building Code, Manuals, and Recommended Practices.

All concrete materials shall be so delivered, stored, and handled as to prevent damage to the materials and the inclusion of foreign substances. Packaged materials shall be delivered and stored in original containers until ready for use. Material containers or materials showing evidence of water or other damage shall be rejected.

3.02 MIXING

Use ready-mixed concrete mixed and delivered in accordance with the requirements of ASTM C 94-84, and UBC Standard No. 26-13. In the event concrete is mixed at a central
batching plant, arrange delivery so intervals between batches are kept at a minimum, and in any event not more than 30 minutes. No water shall be added during transit or at the

Project site without the Inspector's approval. Place concrete within 90 minutes after cement has been mixed with aggregate or 45 minutes after addition of water and admixtures.

All concrete shall be ready-mixed concrete and shall be mixed and delivered in accordance with the requirements of "Specifications for Ready-Mixed Concrete", ASTM C94072, and U.B.C. Standard No. In the event concrete is mixed at a central batching plant, the delivery shall be arranged so that intervals between batches are kept at a minimum, and in any event not more than thirty (30) minutes. Trucks shall be in first-class condition and kept in constant rotation during delivery. No water shall be added during transit or at the job without specific approval of the Engineer. Concrete shall be placed within 90 minutes after cement has been mixed.

3.03 CONVEYING AND PLACING CONCRETE

A. GENERAL: The Contractor shall submit a proposed sequence of placing concrete showing proposed beginning and ending of individual placements. After acceptance, this sequence shall be adhered to except when specific changes are requested by the Contractor and accepted by the Engineer.

B. NOTIFICATION: Notify the City's Inspector at least two working days in advance of the placing of any concrete.

C. Obtain approval of soil bottoms for footings and slabs from the Soils Engineer before placing concrete.

D. FORMS: Before placing concrete, forms shall be thoroughly inspected. All wood chips, dirt, etc., shall be removed, all temporary bracing and cleats taken out, all openings for pipes, etc., properly boxed, all forms properly secured in their correct position and made tight, all reinforcement, anchors, and embedded items secured in their proper places. Concrete which may be on the forms or reinforcement and which is set and dry, shall be cleaned off and the forms and steel washed off before proceeding.

E. Sprinkle semiporous subgrades with water sufficiently to eliminate suction.

F. HANDLING AND DEPOSITING:

1. Complete concreting, once started, in continuous operations until the section of approved size and shape is completed.

2. Handle concrete as rapidly as practical from the mixer to place of final deposit by methods which prevent the separation or loss of ingredients. Deposit in its final position to avoid rehandling or flowing.

3. Do not drop concrete freely where reinforcing will cause segregation, nor more than 4 feet. Deposit concrete to maintain a plastic surface approximately horizontal.

4. Do not deposit concrete that has partially hardened.

G. VIBRATING AND COMPACTING:

1. Consolidate and compact concrete by suitable means during the operation of placing and depositing, and thoroughly work around reinforcement, embedded items, and into the corners of the forms. Spade concrete against forms. Use internal vibrators, and keep out of contact with reinforcement and wood forms. Do not use vibrators in a manner that forces mortar between individual form members.

2. Vibrate close to the forms but do not continue at one spot to the extent that large areas of grout are formed or heavier aggregates are caused to settle. Take care not to disturb concrete which has taken its initial set.

H. TEMPERATURE REQUIREMENTS: Maximum placing temperature of concrete, when deposited, shall be 80 degrees F. If the weather causes the placing temperature to exceed 80 degrees F, cool the mix by wetting aggregate or other appropriate methods specified in ACI 305-77, Hot Weather Concreting; a copy of which shall be kept at the job site at all times.

3.04 PATCHING

Immediately after stripping forms, patch minor defects, form tie holes, honeycombed areas, before concrete is thoroughly dry. Remove ledges and bulges. Repair gravel pockets by cutting out to solid surface, form key, and thoroughly wet before placing patching mortar. Use patching mortar consisting of one part cement to two parts fine sand; compact into place and neatly finish to match surface. Grind or fill surfaces to produce level, true planes.

3.05 CONCRETE SLAB FINISHES (AT GRADE OR ROOF)

A. STEEL TROWEL FINISH: Screed, wood float, and steel trowel surfaces. Provide a smooth, hard, dense, impervious surface, free of defects. Finishers shall work from knee boards laid flat upon the surface. Mechanical troweling machines may be used if the desired finish and level tolerances can be obtained by their use.

B. After concrete has been troweled and joints have been formed, use a soft bristled broom to provide a light, uniformly straight scored surface at right angles to the general flow of traffic.

C. SLAB LEVELS: Finish surfaces true to 1/8 inch in 10 feet on a straight-edge in any direction with maximum high and low variance occurring in not less than 20 feet and with 1/16 inch maximum tolerance in any one running foot. Take care to finish troweling around the edges of the slabs so finish surface edges will be at same elevations as the rest of the top surface of the slab. Use temporary screeds set level at the proper elevations.

D. MARK-OFF LINES: Form mark-off lines with curved edging tool, neat and true to line, uniform throughout. Conform to markings indicated.

E. WEAKENED PLANE JOINTS: Provide saw cut joints to the indicated depth after the surface has been finished. Sawed joints shall be completed within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.06 CURING AND SEALING

A. Protect concrete from injurious action of the elements and defacement of any nature during construction operations.

B. Keep concrete in a thoroughly moist condition from the time it is placed until it has cured for at least 7 days. Keep all forms sufficiently wet to prevent drying out of the concrete. Allow no slabs to become dry at any time until curing operations are complete.

C. Cure interior floor slabs with curing-sealing compound. Apply by method and at rates recommended by manufacturer.
   1. Just prior to completion of project, apply a second coat of curing-sealer to entire floor slab surface, at a rate recommended by manufacturer.

3.07 EXPANSION JOINTS

Provide premolded expansion joints to full depth of slabs, where indicated on the drawings. Install with top edge 1/2" below the surface and tool adjacent concrete edges to a 1/8" radius. Use steel pins to hold material in place during placing and floating of concrete. After a minimum of 28 days after slabs have been placed and finished, fill tops of expansion joints with sealer to 1/8" below surface of slabs. No traffic shall be permitted to travel over sealed joints until sealer is thoroughly dry.

3.08 WATER STOPS

Provide water stops for all potentially submerged construction joints in structures. Install per manufacturer’s recommendations.

3.09 DEFECTIVE WORK

Defective concrete work shall be removed and replaced at Contractor's expense.

END OF SECTION 03300

DIVISION 9

FINISHES

DIVISION 9
FINISHES
TABLE OF CONTENTS

SECTION		PAGE
09871	Painting and Protective Coatings	09871-1,-21
09873	Field Coating for Pressure Vessels	09873-1,-15

SECTION 09871

PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION

The work included in this section consists of the furnishing of all labor, materials, apparatus, scaffolding, and all appurtenant work in connection with painting.

A. WORK INCLUDED: In general, the following surfaces are to be painted or coated:

1. Exposed piping and other ferrous metal surfaces, interior and exterior. Not including architectural (Refer to Section 09900).

2. All structural and miscellaneous steel.

3. All specifically designated concrete surfaces.

4. Equipment furnished without factory finished surfaces.

5. Recoating equipment to a specific color assignment.

6. All pumps, piping, gear heads and motors.

7. All equipment furnished with a factory applied or specified fusion bonded epoxy and intended outdoor use, shall be prepared and overcoated with a U.V. resistant coating as specified herein (System P2) whether specifically indicated or not.

B. RELATED WORK NOT INCLUDED: In general, the following surfaces shall not be painted:

1. Non-ferrous metals and fiberglass unless otherwise noted or indicated. (Galvanized metal shall not be considered a non-ferrous metal.)

2. Concrete surfaces subject to pedestrian traffic (unless otherwise designated).

3. Electrical and mechanical equipment furnished with baked enamel surface and exempted by the Owner (unless otherwise designated).

C. PAINT REQUIRED: In no case shall any concrete, wood, metal, or any other surface requiring protection be left unpainted even though not specifically defined herein.

D. PROTECTION OF THE WORK:

1. The Contractor shall take the necessary steps to protect the work of others during the time his work is in progress. The Contractor shall be responsible for any and all damage to the work.

2. Motors, pumps, and other equipment that might be damaged by sandblasting and that are furnished with approved, factory-applied finish shall be solvent cleaned, lightly sanded to break the glaze, and given one (1) coat of painting System "P2" per Section 2.01 herein. The Owner shall be the final judge as to which equipment the above requirement applies. Color shall be as determined by the Owner. Paint shall not be applied while equipment is operating.

1.02 SUBMITTALS

A. PRODUCT DATA: Material Safety Data Sheets (MSDS) for each coating material, solvent, cleaning agent, or other potentially hazardous material to be used shall be submitted.

B. COLOR SELECTION: Submit manufacturer's brochure containing sample available colors. All color selections shall be subject to approval of submittals by the Owner.

C. PLANS AND PROCEDURES: Safety procedures and disposal methods associated with acid etching shall be submitted.

D. COATINGS SCHEDULE: At least thirty (30) calendar days prior to the start of coating work, the Contractor shall submit a schedule of coating products to be used. The list shall indicate the manufacturer's brand name of each material to be used and the surfaces to which each material is to be applied and the method of holiday testing.

E. ABRASIVE BLASTING PLAN: At least thirty (30) calendar days prior to the start of coating work, the Contractor shall submit a plan and detailed procedure for abrasive blasting, and containing and disposing of blasting products and debris.

F. CERTIFICATION LETTER: The Contractor shall submit a letter certifying that the coatings submitted for this project are approved by the coating manufacturer for inspection methods as outlined or referenced herein.

G. WORKERS QUALIFICATIONS:

1. At least thirty (30) calendar days prior to the start up of coating operations, the Contractor shall submit a list of names and qualifications (years of experience applying coating systems used in

this specific project) for each individual worker performing application and mixing.

2. The Contractor shall submit the experience and qualifications of employees assigned to perform DFT testing and porosity and holiday defect detection testing.

H. SHOP QUALITY CONTROL AND QUALITY ASSURANCE:

1. Submit detailed shop quality control and quality assurance procedures for approval.

2. Submit certified documentation of all shop testing results.

I. SAMPLES:

1. Identification: Label or tag each sample or set of samples identifying the manufacturer's name and address, brand name, catalog number, project title, and intended use.

2. Colors, Patterns, and Textures: For items required to be of selected and approved colors, patterns, textures, or other finish, submit sufficient samples to show the range of shades, tones, values, patterns, textures, or other features corresponding to the instructions and requirements specified.

3. Factory Finish Colors: Colors of material specified to be furnished with a factory finish are subject to approval. Submit duplicate samples of factory finishes showing the full range of available colors for selection and approval.

4. Piping and conduit identification and color coding samples shall be submitted.

J. MANUFACTURERS' INSTRUCTIONS: Current manufacturers' application instructions and recommendations for surface preparation, dry film thickness (DFT), drying time, time to recoat, and defect repair shall be submitted.

1.03 QUALITY ASSURANCE

A. GENERAL: Quality assurance procedures and practices shall be used to monitor all phases of surface preparation, application and inspection throughout the duration of the contract coating work. Procedures or practices not specifically defined herein may be used provided they meet recognized and acceptable professional standards and are approved in advance by the Owner.

B. QUALIFICATIONS:

1. The Contractor shall employ trained, experienced applicators, trained (NACE or SSPC) and certified quality control inspectors and trained coating mixer/helpers.

2. Workers shall work under the direction of qualified and experienced supervisors.

3. Supervisors shall have a minimum 2 years recent, continuous experience supervising industrial maintenance coating application operations similar to the operations required to complete this project.

4. Applicators and mixer/helpers shall be trained and certified by the coating manufacturer for all coating products used on this project.

5. Applicators shall have a minimum 2 years recent, continuous experience applying the industrial maintenance coatings products used on this project.

6. Contractor employees assigned to make DFT measurements and perform porosity and holiday defect tests shall possess the experience and qualification to accurately undertake these measurements and tests. If the equipment manufacturer has a certification program for operators of the equipment, the operators shall possess the certification. The Contractor shall submit the experience and qualifications of these employees.

C. SHOP COATING:

1. Adhere to the approved shop coating quality assurance and quality control procedures; and provide documentation to Owner prior to shipping and delivery of the specified equipment, materials or items to be shop coated.

2. Test on surfaces of abrasively blast cleaned steel shall be performed to detect oil and other contaminants which might be deposited on surfaces as a result of abrasive recycling or other shop operations. This will include chemical tests or ultra-violet (black light) tests as required. Provide documentation of test results to Owner.

D. FIELD SAMPLING AND TESTING: The Owner may require the Contractor to take pint samples of paint at random from the products delivered to the jobsite for testing by Owner or its representative to verify that the products conform to this specification. Products not in conformance shall be removed from the jobsite and replaced with products that conform to this specification.

1.04 SPECIAL CRITERIA FOR COATINGS

A. GENERAL: The coating criteria and conditions set forth herein shall apply to the coating materials listed in Paragraph 2.01 (“Protective Coating Materials”) and Section 09879 (“Surface Preparation for Steel and Concrete Substructures”).

B. P-1 EPOXY PRIMER, P-2 HYBRID POLYURETHANE COATING: All materials specified or selected for use under these specifications shall be delivered unopened at the job site in their original containers and shall not be opened until inspected by the Owner. No coating, paint, polyurethane, varnish, epoxy or stain shall be reduced or applied in any way, except as herein specifically called for or if not specifically called for, then it shall be applied in accordance with the manufacturer's published recommendations.

C. P-11 FUSION BONDED POWDER EPOXY: Epoxy powder shall be shop applied using the Electrostatic Method, as applied to preheated properly prepared metal as specified herein.

1. The fluidized bed or dipped method shall not be used.

2. Preparation: The surface shall be prepared to SSPC-SP10 (See Section 09879).

3. Fusion epoxy powder to be used in contact with potable water shall be in compliance with NSF-61.

4. Thickness of Coating: The minimum dry coating thickness shall be 12 to 14 mils provided, however, that the thickness of coating in the grooves for valves of fittings designed to receive a rubber gasket shall be approximately 5 mils.

5. Electrostatic Application Method: The powder shall be spray applied to the heated, grounded metal part which has been electrostatically charged by means of a current of approximately 1 1/2 amperes at 400 volts. After spray application of the epoxy powder, the part shall be reheated to the temperature and for the elapsed time specified by the coating manufacturer to ensure complete fusion and cure. Particular care shall be taken to protect non-ferrous masked parts. The finished product shall be carefully examined for epoxy interference on working parts and threaded holes or studs from receiving coating that will interfere with operation of the coated part.

6. Completed epoxy coated pieces shall, in no case be left exposed to sunlight for an extended period of time. Fusion bonded epoxy coated items which will be exposed to sunlight shall be brush-off blasted consistent with SSPC-SP-7 (See Section 09879) and over coated with

polyurethane (System P2) finish consistent with other finished exterior items.

D. LIQUID EPOXY COATING: Where the size of the valve, part or other item is too large to be coated by the powder epoxy method, with the written approval of the Owner, it shall be prepared in accordance with the requirements specified herein for System P12 and coatings shall conform to the following requirements.

1. Preparation: The surface shall be prepared per SSPC-10 (See Section 09879).

2. Thickness of Coating: The liquid epoxy shall be applied in multiple spray coats to a minimum total dry film thickness of 12 mils.

3. Application and Cure: The first coat of liquid epoxy shall be spray applied to the prepared surface within four (4) hours after completion of sandblasting. All items to be coated and the epoxy to be applied shall be at a minimum temperature of 50° F. and a maximum surface temperature of 100° F. at time of application. Subsequent coats shall be applied per the recoat specification of the manufacturer.

4. Liquid epoxy used for repair of damaged FBE shall have all loosely adhered coating removed and the FBE/Steel surface abraded with 80 grit sand paper or a rotary sander or blast cleaned. Remove all debris and oil and apply 2 part epoxy repair coating and allow to cure.

5. Liquid Epoxy to be used in contact with potable water shall be in compliance with NSF 61.

E. REJECTION: The completed coating will be inspected for quality, cure and mil thickness when received. Any color transfer, with or without acetone or MEK test, would consider the P11 coating improperly or incompletely cured. Any deficiency in these areas as outlined in this specification will be cause for rejection. Recoating over existing deficient coating in the P11 system is not permitted. Removal of deficient coating, re-prep and recoating is then required to meet the specification requirements and shall be at the Contractor's own expense with no additional cost to the Owner. ***No additional time extension will be granted for remedial work.***

F. PRIMER AND INTERMEDIATE COATS: Primer and intermediate coats of paint shall be unscarred and completely integral at the time of application of each succeeding coat. Each coat shall be subject to the inspection and approval of the Owner before the next succeeding coat is applied. Defective work of any kind shall be deemed sufficient cause for recoating the entire surface involved.

Sufficient time shall be allowed between coats to insure proper drying, unless these specifications or manufacturer's recommendations specifically state otherwise. Excessive time or exposure between coats shall not occur in cases where such excessive time or exposure will impair the bond between coats. Refer to manufacturer's product data sheets.

PART 2 - PRODUCTS AND MATERIALS

2.01 PROTECTIVE COATING MATERIALS

System		NSF Compliance	Product
P1	Epoxy Primer	☐	Tnemec, Series L69 Epoxoline II ICI-Devoe, BAR-RUST ® 231
P1A	Organic Zinc Primer	☐	Tnemec, Series 90-97 Tneme Zinc (Shop Primer) Tnemec, Series 94 H_20 Hydro Zinc (Field Applied)
P2	Hybrid Polyurethane Finish	☐	Tnemec, Series 750 UVX or Equal by ICI-Devoe
P3	Rubber Primer	☐	Polyken Denso Paste Priming Solution
P4	PVC 20-mil Tape	☐	Polyken Tape Denso Tape Systems
P5	Coal Tar Epoxy	☐	Rustoleum, HiPerform Industrial Coal Tar Epoxy

System		NSF Compliance	Product
P6	Coal Tar Mastic	☐	Carboline, Bitumastic 50 Christy's, HD 50
P7	Polyamidoamine Epoxy Primer For Marginally Prepared Steel	☐	Tnemec, Series 135 Chembuild ICI-Devoe, DEVRAN ® 203
P8	Grease	☐	Chevron, E.P. Roller Grease Texaco, Rust Inhibitive Grease
P9	Heat Resistant Silicone Aluminum	☐	Sherwin Williams, Silver-Brite,Hi-Heat Resisting Aluminum Paint, No. B59S3
P10	Chemical Etch	☐	See Tnemec Technical Memo #98-09 Great Lakes Laboratories, Clean 'n Etch Henkel, Galvaprep 5, No. 681-2802
P11	Epoxy Coating – Powder (FBEL/C)	☒	3M, Scotchkote 134
P11A	FBE Repair Coating (For Scotchkote 134)	☒	3M, Scotchkote 306, 314, 323 (Liquid Epoxy)
P12	Epoxy Coating – Liquid	☒	Keysite, 740 (White) Tnemec, Series L140F Pota Pox Plus
P12A	Epoxy Coating – Liquid (100% Solids)	☒	Tnemec, Series 22 Epoxoline
P13	Waterproofing (Concrete)	☐	OKON, W1 Chemprobe/ Tnemec, Prime-a-PELL H2O, Series 633
	Waterproofing (Masonry)	☐	OKON, Plugger Rainguard, Block-Lok Chemprobe/Tnemec, Prime-a-PELL H2O, Series 633
P14	Acrylic Latex	☐	ICI-Devoe, DEVFLEX™ 4216HP Tnemec, Series 1029, Enduratone

System		NSF Compliance	Product
P15	Epoxy (Concrete Floor Coating)	☐	Tnemec, Series 237, Power Tread
P16	Epoxy Mortar System Interior) (Waste Water Structures	☐	Tnemec – 3 stage 218 Mortar Clad 434 Perma Shield 435 Perma Glaze Raven, 404

2.02 SURFACE PREPARATION AND COATING THICKNESS

ITEM		SURFACE PREPARATION	FIRST COAT	SECOND COAT	THIRD COAT	MIN. TOTAL DRY FILM THICKNESS (MILS)
1.	Ferrous Metal Surfaces					
A.	Exposed	SP6	P1A	P1	P2	11.0
B.	Submerged	SP10	P1	P1	P1	15.0
C.	Underground	SP6	P1	P1	P1	15.0
D.	Subjected to High Temp. (300°+F.)	SP6	P9	P9	--	2.0
E.	Wearing Surfaces	None	P8	--	--	50.0
2.	Steel Pipe (N.S.F.)					
A.	Interior (if not CML)	SP10	P11	--	--	14.0
A1.	Interior (FBEL) Damaged P11 repair	SP10	P11A	--	--	16.0
B.	Exterior/Buried (if concrete encased)	SP6	P7A	--	--	5.0
C.	Exterior/Buried (if not CMC or concrete encased)		P3 (Coated and wrapped per current AWWA C-203)	P4	P4	30.0
D.	Exterior/Above Grade	SP6	P1A	P1	P2 [1]	11.0
3.	Ferrous Metal: Tanks and Vessels					
A.	Interior (N.S.F.)	SP10	P12A	P12A	--	21.0
B.	Exterior	SP10	P12A	P12A	P2 [5]	21.0
4.	Black Steel Pipe (Buried)	SP3	P3	P4	--	40.0
5.	Galvanized Surfaces					
A.	Coated in addition to galv. [4]	SP3	P10	P5	P1	9.0
B.	Buried	SP3	P3	P4	--	40.0
6.	Structural Steel					
A.	Shop Primed	SP6	P1A	P1	P2	10.0
B.	Not Shop Primed	SP6	P1A	P1	P2	10.0
7.	Mech. Equip. w/Factory Finish		Spot			
A.	Field Applied Touch-up [2]	SP2	P7	P2	--	5.0 [2]
8.	Concrete Surface					
A.	Structure Floor	SP13	P15	--	--	14.0
B.	Chemical Contact	SP13	(Coating system to be designated per exposure)			--
C.	H_2S exposed areas	SP13	P16	P16	P16	-- (Waste Water Structures-interior)

[1] Where required by manufacturer to meet minimum DFT requirement.
[2] Check for coating compatibility with existing factory finish.
[3] Only if necessitated by conditions or if specified.
[4] If required by coating manufacturer
[5] Finish coat per System P2 to be 3 mil. DFT.

2.03 COLOR AND PAINT SCHEDULE

PROCESS SYSTEM	DESCRIPTIVE COLOR CODING	MANUFACTURERS' COLOR DESIGNATION	PIPE LABEL
All exposed piping not within building or structures	Desert Sands	04BR	(as approp.)
Air, Low Pressure	Light Green	PPA30	Compressed Air (as approp.) psig
Air, High Pressure (over 50 psi)	Light Green w/Yellow Bands	PA30/ SC 01	Compressed Air (as approp.) psig
Gas & LPG	Light Yellow	SC 01	Gas
Wash Water	Red	06 SF	Wash Water
Potable Water	Pale Blue	25 BL	Water
Supply Oil Lines	Light Gray	10-1009	Supply Oil
Drain Oil Lines	Dark Gray	10-1092	Drain Oil
Engine Cooling Lines Water	Orange	04 SF	Engine Cooling
Sewage Pump Facility	Green	09 SF	All Piping
Raw/Recycled/Irrig. Water Facility	Purple	14 SF	Al Piping

The Owner reserves the right to make modifications to the color identifications schedule outlined above.

Color designations indicated are per Tnemec and may be cross referenced.

Contractor shall submit color charts to Owner for approval.

2.04 IDENTIFICATION OF PIPING

A. PIPING SYSTEMS: Identification of piping systems shall conform to the requirements of ANSI A13.1, "Scheme for the Identification of Piping System," unless otherwise specified herein.

B. COLOR IDENTIFICATION: All exterior exposed and/or unburied pipe outside of a structure, including tubing, galvanized pipe, polyvinyl

chloride pipe and fiberglass reinforced pipe, shall be painted "Desert Sands". Stainless steel pipe and all other pipe not readily receptive to a painted finish maybe left natural. Markers shall be adhesive type with extra strength and suitable for continuous duty at 250° and UV resistant. All markers shall have a protective silicone film. All pipes shall have markers whether painted or not.

All piping within a structure shall be coated in the color indicated in the table above.

Each utility shall be clearly labeled with 1" high lettering on piping 2" in diameter and larger; on pipes 1/2" to 2" in diameter the lettering height shall be 1/2 of the pipe diameter; on piping/tubing smaller than 1/2" diameter. A sheet metal band shall be formed around the pipe and extend 1" beyond on front and back to form a "Flag". The sheet metal "Flag Band" shall be 1" wide and made of a material that is not detrimental to the host piping. The front and back Flag shall be riveted together at each end to affix permanently to the host pipe. The lettering height on the "Flag" shall be 1/2".

C. The unit suction/discharge piping, pumps, discharge heads and electric motors shall be painted Pale Blue for potable water; Green for sewage and Purple for raw or recycled water (see "Color and Paint Schedule" in Section 2.03); and shall show flow arrows.

Contractor shall submit color charts to Owner for approval.

PART 3 - EXECUTION

3.01 PREPARATION

A. APPLICATION STANDARDS AND REQUIREMENTS: All surface preparation, coating and paint application shall conform to applicable standards of SSPC and the manufacturer's printed instructions. Material applied prior to approval of the surface by the Inspector shall be removed and reapplied to the satisfaction of the Inspector at the expense of the Contractor.

1. All work shall be performed by skilled craftsmen qualified to accomplish the required work in a manner comparable with the best standards of practice. Continuity of personnel shall be maintained and transfer of key personnel shall be coordinated with the Construction Manager.

B. COATING SUPERVISOR: The Contractor shall provide a supervisor to be at the work site during cleaning, application and disinfection operations. The supervisor shall have the authority to sign and change orders, coordinate work and make other decisions pertaining to the fulfillment of their contract.

C. SANITARY FACILITIES: Contractor shall provide approved sanitary facilities for all project personnel, as no existing facilities will be available to the Contractor. Facilities shall be maintained during the project to complete standards established by Owner, and shall be removed prior to Contractor's departure from the site at completion of the project.

D. WASHING REQUIREMENTS: Dust, dirt, oil, grease or any foreign matter which will affect the adhesion or durability of the finish must be removed by washing with clean rags dipped in an approved commercial cleaning solvent, rinsed with clean water and wiped dry with clean rags.

E. COATING AND PAINTING EQUIPMENT: The Contractor's coating and painting equipment shall be designed for application of materials specified and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. Blotter test shall be accomplished at each start-up period and as deemed necessary by the Inspector. Contractor's equipment shall be subject to approval of the Inspector.

1. Cleanliness of compressed air supply shall be verified daily, and as deemed necessary by Inspector, by directing a stream of air, without abrasive, from the blast nozzle onto a white blotter or cloth for twenty seconds in accordance with ASTM D4285. If air contamination is evident, change filters, clean traps, add moisture separators or filters, or make adjustments as necessary to achieve clean, dry air.

F. FIRST COAT APPLICATION: Application of the first coat shall follow immediately after surface preparation and cleaning within an eight-hour working day. Any cleaned areas not receiving first coat within an eight-hour period shall be re-cleaned prior to application of first coat.

G. PROTECTION OF PREVIOUSLY COATED SURFACES: Because of presence of moisture and possible contaminants in atmosphere, care shall be taken to insure previously coated or painted surfaces are protected or re-cleaned prior to application of subsequent coat(s). Methods of protection and recleaning shall be approved by the Inspector.

H. TEMPORARY POWER: The Contractor shall provide, at his own expense, all necessary power for his operations under the contract.

3.02 SURFACE PREPARATION, GENERAL

A. SEE SPECIFICATION SECTION 09879

3.03 SURFACE PREPARATION, SPECIFIC

A. SLAG AND WELD SPATTER REMOVAL: Slag, weld spatter, or sharp

edges such as those created by flame cutting and shearing not previously removed shall be removed by chipping and grinding. All sharp edges shall be peened, ground or otherwise blunted as required by the Engineer in accordance with NACE RP 0178. The rolled edges of angles, channels, and wide flange beams do not normally require further rounding unless specifically directed by the Engineer.

B. BLAST NOZZLE PRESSURE: Blast nozzle pressure shall be a minimum of 95 P.S.I. and shall be verified by using an approved nozzle pressure gage at each start-up period or as directed by the Inspector.

C. ABRASIVES: Particle size of abrasives used in blast cleaning shall be that which will produce a surface profile or anchor pattern specified herein, or in accordance with recommendations of the manufacturer of the specified coating or paint system to be applied, subject to approval of Inspector.

1. Abrasive used in blast cleaning operations shall be new, washed, graded and free of contaminants, which would interfere with adhesion of coatings and paints and shall not be reused unless specifically approved by the Inspector.

2. Abrasives shall be certified for unconfined dry blasting pursuant to the California Administrative Code, Section 92520 of Subchapter 6, title 17, and shall appear on the current listing of approved abrasives.

D. MAINTAINING WORK SITE AREA: The Contractor shall keep the area of his work in a clean condition and shall not permit blasting materials to accumulate as to constitute a nuisance or hazard to the prosecution of the work or the operation of the existing facilities. Spent abrasives and other debris shall be removed at the Contractor's expense as directed by the Inspector. If waste is determined to be hazardous, disposal by Contractor shall meet requirements of all regulatory agencies for handling such wastes.

E. CLEANING OF BLASTED SURFACES: Blast cleaned surfaces shall be cleaned prior to application of specified coatings or paints through a combination of blowing with clean dry air, brushing/brooming and/or vacuuming as directed by the Inspector.

F. SPECIAL SURFACES: The surfaces of any non-carbon steel substrates, or specialty items (i.e. galvanized, anodized, stainless steel, etc.) shall be properly treated and prepared prior to any coating operations in accordance with the coating manufacturer's written recommendations, subject to approval of the Inspector.

3.04 APPLICATION, GENERAL

A. SURFACE APPLICATION STANDARD: Coating and paint application shall conform to the requirements of the SSPC's Paint Application Specification No. 1 (SSPC-PA1), latest revision, for "Shop, Field and Maintenance Painting," the manufacturer of the coating and paint materials printed literature, and as specified herein.

B. THINNING: Thinning shall only be permitted as recommended by the manufacturer and approved by the Inspector, and shall not exceed limits set by applicable regulatory agencies.

1. If the Contractor applies any coatings which have been modified or thinned to such a degree as to cause them to exceed established VOC levels, Contractor shall be responsible for any fines, costs, remedies, or legal action and costs which may result.

C. COATING APPLICATION: Each application of coating and paint shall be applied evenly, free of brush marks, sags, runs and evidence of poor workmanship. Care should be exercised to avoid lapping on hardware. Coating and paint shall be sharply cut to lines. Finish surfaces shall be uniform in appearance and shall be free from defects or blemishes.

D. PROTECTIVE COVERINGS: Protective coverings or drop cloths shall be used to protect floors, concrete, fixtures, equipment, prepared surface and applied coatings. Personnel working in the vicinity of the coating equipment shall take precautions to prevent damage or contamination of coated or painted surfaces. Care shall be exercised to prevent coating or paint from being spattered onto surfaces, which are not to be coated or painted.

E. COATING SYSTEM: It is the intent of this specification to ensure the proper coating system is applied to all surfaces.

F. WELDS AND IRREGULAR SURFACES: All interior welds and irregular surfaces specified by the Engineer shall receive a brush coat of the specified product prior to application of each complete coat. Coating/paint shall be brushed in multiple directions to insure penetration and coverage, as directed by the Engineer. These areas include, but are not limited to welds, nuts, bolts, ends, and flanges, etc.

G. EXTENDED RECOAT CYCLE: Coating which has endured an excessive time element beyond manufacturer's recommended recoat cycle, shall be scarified by Brush-off Blast Cleaning (SSPC-SP7) or methods approved by the Engineer, prior to application of additional coating or paint. Scarified coating shall have sufficient depth to assure a mechanical bond of subsequent coat.

H. APPURTENANCES: All attachments, accessories, and appurtenances shall be prepared and finished in the same manner as specified for adjacent tank sections.

3.05 COATING APPLICATION

A. GENERAL: After completion of surface preparation as specified, all surfaces shall receive the prescribed number of coats to reach the specified DFT. Prime coat and topcoats shall not be the same exact color, but have a color variance to easily determine the coat visible. The total system shall be the system specified.

3.06 QUALITY CONTROL

A. MIXING: All coating components shall be mixed in exact proportions specified by the manufacturer. Care shall be exercised to insure all material is removed from containers during mixing and metering operations.

1. All coatings shall be thoroughly mixed utilizing an approved slow-speed power mixer until all components are thoroughly combined and are of a smooth consistency.
2. All catalyzed coatings shall not be applied beyond pot-life limits specified by manufacturer. Any required induction requirements shall be strictly followed.

B. USE OF THINNERS: Thinners shall be added to coating materials only as required in accordance with manufacturer's printed literature and in the presence of the Inspector. Quantities of thinner shall not exceed limits set by applicable regulatory agencies and manufacturer’s recommendations.

C. DRYING TIME: Drying time between coats shall be strictly observed as stated in the manufacturer's printed instructions.

D. COLOR OF COATS: Each coat shall be of contrasting color with the topcoat.

E. SPRAY OPERATIONS: Care shall be exercised during spray operations to hold the spray nozzle perpendicular and sufficiently close to surfaces being coated to avoid excessive evaporation of volatile constituents and loss of material into the air or the bridging of cracks and crevices. All dryspray or overspray shall be removed as directed by Inspector.

F. HOLIDAY DETECTION: Upon completion of the interior (linings) coating operations and after the required curing intervals, holiday detection shall be accomplished on all coated surfaces. Repairs shall be retested.

G. FIELD INSPECTION: All mixing, thinning, application and holiday detection of coatings shall be performed in the presence of the Inspector.

H. CURING CONDITIONS: A time element equivalent to 7 days curing time at 70 degrees and 50% relative humidity shall be allowed before placing the epoxy coating system into service, as determined in 3.08 "FINAL CURING OF EPOXY COATING."

3.07 FINAL CURING OF LIQUID EPOXY COATING

A. BLOWER FOR FINAL CURING: Upon completion and acceptance of applied coating system, Contractor shall furnish an approved exhaust fan or blower of sufficient capacity to insure removal of solvent vapors during curing process. The fan or blower, after approval by Engineer, shall be installed as directed by the Inspector and shall remain in continuous operation until coating is completely cured as determined by the manufacturer of the coating system.

B. TESTING: After completion of curing cycle as noted above, the Contractor shall test the applied coating with a solvent rub test performed in accordance with ASTM D 5402 to verify adequate curing has been attained.

1. If final cure has not been attained, ventilation shall be continued until applied lining passes the solvent wipe test.

2. After final cure is approved by Owner, Contractor shall remove fan or blower.

C. LIQUID EPOXY COATINGS: Shall be applied where required with the exception of system P11 A. Epoxy coatings shall be mixed only as needed and any material not used during manufacturer’s published “pot life” shall be discarded.

3.08 POWDER EPOXY (Fusion Bond Epoxy)

A. GENERAL: Above grade unit piping, air valves, gate and check valves shall be coated by the electrostatically sprayed power epoxy method.

B. COATING APPLICATOR QUALIFICATIONS: The Contractor shall specifically verify the coating applicator’s acceptable qualifications before subcontracting the work to him.

C. PREPARATION:

1. Prior to coating preparation, all oil and grease shall be removed from the metal by caustic degreasing or steam cleaning.

2. The surface shall be sandblasted to near-white metal in accordance

with SSPC-SP10 (See Section 09879). In order to obtain maximum adhesion of epoxy coating, the grit used for blasting shall be coarse enough to impact a tooth in the metal equal to 25 % of the thickness of the coating to be applied.

3. The metal shall be cleaned, after sandblasting, with clean, dry compressed air.

4. Use of rags to remove residual dust after sandblasting will not be permitted.

D. INSPECTION: Once the owner's inspector is satisfied with the surface preparation and/or appliances QA/QC inspector has accepted the preparation and provided documentation to that effect to the owner, the process of coating can commence.

E. PREHEATING: Areas that are not to be coated shall be masked using 500° F. masking tape, similar to Permacel, as manufactured by Minnesota Mining and Manufacturing Company (3M). The part to be coated shall be placed in an oven and preheated to the temperature specified by the epoxy manufacturer.

F. APPLICATION: The powder epoxy shall be electro statically spray applied to the full DFT in one coat. At which point the item being coated shall be placed back in the oven for the proper length of time at the proper temperature, as prescribed by the coating manufacturer, for final cure. Once the coating process is complete, the DFT will be verified by the coating applicator's quality control personnel and documented. The documentation shall be made available to the Owner. The coating quality and thickness will be verified by the Owner at the coating facility or at the site after delivery. Should the DFT be insufficient or substandard in any way, the original FBE coating will be completely removed and the part recoated to specifications at no additional cost to the Owner.

3.09 FIELD APPLICATION OF PAINT

A. QUALIFICATIONS OF APPLICATOR: The applicator of the paint shall be qualified and have had past experience in successfully applying the type or types of coatings and under similar conditions that he will be required to meet in this contract. The Contractor shall verify the paint applicator's qualifications and determine them acceptable before subcontracting the work to him.

B. APPLICATION CONDITIONS: No painting shall be done under windy or dusty conditions, during or immediately after a rain, during rainy weather, or when the temperature is less than 50° F.

C. APPLICATION: Except the prime coats shall be applied by brush and well worked into the surface, paint may be applied by brush, roller, or spray, unless the manufacturer's recommendations or these specifications call for some particular type of application.

1. Where spray application is used, each coat of paint shall be applied to a thickness equivalent to a brush coat application at coverage not greater than that specified by the manufacturer for a brush coat application.

2. All work shall be done in workmanlike manner, leaving the finished surfaces free from drops, runs, waves, holidays, laps, voids, or brush marks.

3. Drop cloths, masking and other coverings shall be so placed at all times as to protect floors and other surfaces from spatter and droppings.

4. Hardware, switch plates, lighting fixtures, nameplates, brass fittings and similar articles which are not to be painted shall be masked-off or removed completely.

5. After completion of painting, any spatter or droppings shall be removed.

D. COATING THICKNESS:

1. The number of coats specified is the minimum to be applied.

2. Any coating imperfections between coats shall be touched up, and additional coats shall be provided if required to produce a finished surface of solid, even color, free from defects.
3. The total thickness of the coating shall be as specified. Additional coats of paint shall be added if necessary to bring the total thickness up to not less than that specified, with holidays shall be left.

4. Particular care shall be used to assure that the specified coverage is secured on the edges and corners of all surfaces. Additional brush coats shall be applied if necessary to cover the edges and corners.

5. The Contractor shall control and check the dry film thickness of the coatings on metal surfaces with a correctly calibrated thickness meter and shall check for holidays with a low-voltage holiday detector. The Owner may use the Contractor's meter and detector for additional checking.

E. DAMAGED COATINGS:

1. Damaged paint or scratched painted surfaces shall be sanded smooth before repainting. Sanding areas to be repainted shall be done to such a degree and in such a manner that all evidence of the scratches or damages are obscured.

2. Any touch up or repair work shall be accomplished within the particular coating's "re- coat window" as determined by the manufacturer.

3.10 CLEAN-UP

Upon completion of his work, the painting contractor shall remove his surplus materials. All paint spills shall be removed and the entire premises shall be free from rubbish, debris, stains etc. caused by his work. He shall present the work clean and free from blemish so that it is acceptable in every way.

3.11 PAINT TO BE PROVIDED TO OWNER

At the end of the project, the Contractor shall turn over to the Owner a gallon can of each type and color of paint, primer, thinner, or other coating used in the field painting. If the manufacturer packages the material concerned in gallon cans, then it shall be delivered in unopened labeled cans as it comes from the factory. If the manufacturer does not package the material in gallon cans, and in the case of special colors, the materials shall be delivered in new gallon containers, properly closed with typed labels indicating brand, type, color, etc. The manufacturer's literature describing the materials and giving directions for their use shall be furnished in three (3) bound copies. A typewritten inventory list shall be furnished at the time of delivery.

3.12 WARRANTY INSPECTION

Warranty inspections shall be conducted during the eleventh (11th) month following completion of all coating work. All personnel present at the pre-job conference shall be present at this inspection. All defective work shall be repaired in strict accordance with this specification and to the satisfaction of the Owner.

END OF SECTION 09871

SECTION 09873

FIELD COATING FOR PRESSURE VESSELS

PART 1.0 - GENERAL

1.01 PURPOSE

The purpose of this specification is to establish the requirements for relining the interior surfaces and spot repairing and overcoating the exterior of a welded steel potable water surge tank.

1.02 SCOPE OF WORK

A. GENERAL: Provide and pay for all labor, equipment, materials, machinery, facilities, and services necessary to complete the work in accordance with these specifications.

B. WORK TO BE ACCOMPLISHED: Work to be accomplished includes the surface preparation, spot repair and overcoating of the exterior surfaces of the reservoir and the complete removal of all existing interior coatings and replacement of same with an ANSI/NSF Certified immersion grade epoxy liner, including all attachments, appurtenances, and accessories.

C. EXISTING EXTERIOR COATINGS: The Contractor is advised that the exterior coatings may contain heavy metals. As such the contractor shall conduct his own tests and work procedures to assure that his employees and the environment are properly protected as part of this Scope of Work.

1.03 REFERENCE SPECIFICATIONS AND STANDARDS

Without limiting the general aspects or other requirements of this specification, work and equipment shall conform to applicable requirements of municipal, state and federal codes, laws and ordinances governing the work, American Water Works Association, SSPC: The Society of Protective Coatings, and the manufacturer's printed instructions, subject to Engineer's approval.

The Engineer's decision shall be final as to interpretation and/or conflict between any of the referenced codes, laws, ordinances, specifications and standards.

1.04 SUBMITTALS

A. GENERAL: The successful Contractor must submit the following plans and programs for Engineer review and acceptance a minimum of 14 days

prior to project start-up, and 7 days prior to the Pre-Job Conference.

Acceptance of the programs does not relieve the Contractor from the responsibility to conduct the work in strict accordance with the requirements of this Specification, or to adequately protect the health and safety of all workers involved in the project including any members of the public who may be affected by the project.

B. DATA TO BE SUBMITTED: The Contractor shall submit at least Manufacturers' Product Data Sheets and Material Safety Data Sheets on all materials to be used including, but not limited to coatings and paints, thinners, solvents, and abrasive media. Contractor shall maintain copies of submittal data at jobsite at all times, and shall furnish a complete set of submittal data for use by the Inspector.

1.05 CONTRACTOR REQUIREMENTS

The Contractor (or Sub-Contractor) shall be a licensed Painting and Decorating Contractor in the State of California (C-33 Classification), and shall have a minimum of five (5) years practical experience and successful history in the application of specified products to surfaces of steel water storage tanks. Upon request, he shall substantiate this requirement by furnishing a written list of references.

1.06 DEFINITIONS

A. COATING: "Coating" refers to protective materials used or applied on interior surfaces, or any protective material in general.

B. ENGINEER: "Engineer" refers to the Owner’s Engineer or its designated representative.

C. PAINT: "Paint" refers to protective materials used or applied on exterior surfaces.

1.07 PRE-JOB CONFERENCE

A Pre-Job Conference shall be scheduled prior to start of project. The Owner, Contractor and Engineer shall be present. A schedule of work to be accomplished and a list of labor, material and equipment rates for additional work will be established and maintained throughout the project. Contractor shall furnish a complete set of submittal data for use by Inspector.

1.08 QUALITY ASSURANCE

A. GENERAL: Quality assurance procedures and practices shall be used to monitor all phases of surface preparation, application and inspection throughout the duration of the project. Procedures or practices not

specifically defined herein may be used provided they meet recognized and acceptable professional standards and are approved by the Engineer.

B. INSPECTION: All materials furnished and all work accomplished under the Contract shall be subject to inspection by the Engineer. The Contractor shall be held strictly to the true intent of the Specifications in regard to quality of materials, workmanship, and diligent execution of the Contract.

C. WORK PERFORMED WITHOUT INSPECTION: Work accomplished in the absence of prescribed inspection may be required to be removed and replaced under the proper inspection. The entire cost of removal and replacement, including the cost of all materials which may be furnished by the Owner and used in the work thus removed, shall be borne by the Contractor regardless of whether the work removed is found to be defective or not. Work covered up without the authority of the Engineer, shall, upon order of the Engineer, be uncovered to the extent required. The Contractor shall similarly bear the entire cost of performing all the work and furnishing all the materials necessary for the removal of the covering and its subsequent replacement, as directed and approved by the Engineer. Except as otherwise provided herein, the Owner will pay the cost of inspection.

D. TESTING: The Engineer will make, or have made, such tests as he deems necessary to assure the work is being accomplished in accordance with the requirements of the Contract. Unless otherwise specified, the cost of such testing will be borne by the Owner. In the event such tests reveal non-compliance with the requirements of the Contract, the Contractor shall bear the cost of such corrective measures deemed necessary by the Engineer, as well as the cost of subsequent retesting. It is understood and agreed the making of tests shall not constitute an acceptance of any portion of the work, nor relieve the Contractor from compliance with the terms of the Contract.

E. AMBIENT CONDITIONS: No coating shall be applied when the surrounding air temperature or the temperature of the surface to be coated or painted is below 50 degrees F. No coatings shall be applied at temperatures above 110 degrees F. No coatings shall be applied to wet or damp surfaces or in rain, snow, fog or mist, when the temperature is less than 5 degrees F. above the dewpoint, or when it is expected the air temperature will drop below 50 degrees F. Dewpoint shall be measured by the use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychrometer Tables or equivalent in accordance with ASTM D337. If unacceptable conditions are prevalent, coating or paint application shall be delayed or postponed until conditions are favorable. The day's coating or paint application shall be completed in time to permit the film sufficient drying time prior to

damage though atmospheric conditions.

F. SURFACE PREPARATION: Surface preparation will be based upon comparison with: "Pictorial Surface Preparation Standards for Painting Steel Surfaces," SSPC-Vis 1 and as described herein. Anchor profile for prepared surfaces shall be measured by using a nondestructive instrument such as a Keane-Tator Surface Profile Comparator or Testex Press-0-Film System in accordance with ASTM D4417. Temperature and dewpoint requirements noted in 1.08 E herein shall apply to all surface preparation operations, except low and high temperature limits.

The Contractor shall conduct all operations so as to confine abrasive blasting debris and paint overspray to within the bounds of the site. The Contractor shall take all precautions necessary to prevent adverse off-site consequences of painting operations. Any complaints received by the Owner relating to any such potential offsite problems will be immediately delivered to the Contractor. The Contractor shall immediately halt painting work and shall take whatever corrective action is required to mitigate any such problems. All costs associated with protection of off-site properties and/or correction of damage to property as a result of painting operations shall be borne directly by the Contractor at no additional expense to the Owner.

G. FILM THICKNESS TESTING: Thickness of coatings and paint shall be checked with a non-destructive film thickness gauge in accordance with ASTM D1186. An instrument such as Tooke Gage should be used in accordance with ASTM D4138 if a destructive tester is deemed necessary. The sampling of film thickness of flat (e.g. plate) surfaces shall be tested in accordance with SSPC-PA2. The sampling of structural members or irregular surfaces shall be tested in frequency and locations, as directed by the Engineer.

H. HOLIDAY DETECTION: Coating integrity of all interior coated surfaces shall be tested with an approved inspection device. All pinholes shall be marked, repaired in accordance with the manufacturer's printed recommendations and retested in accordance with NACE RP 0188. No pinholes or other irregularities will be permitted in the final coating.

I. WARRANTY INSPECTION: Warranty inspection shall be conducted between the eleventh and seventeenth months following completion of all coating and painting work. All personnel present at the Pre-Job Conference should be present at this inspection. All defective work shall be repaired in strict accordance with this specification and to the satisfaction of the Engineer.

1. Notification: The Owner shall establish the date for the inspection and shall notify the Contractor at least 30 days in advance. The

Owner will drain the tank and Contractor shall provide, at his own expense, suitable lighting and ventilation for the inspection.

2. Inspection: The entire interior coating systems shall be visually inspected. All defective coatings, as well as damage or rusting spots of the tank, shall be satisfactorily repaired by and at the sole expense of the Contractor. Defective coating shall be any of those defined by SSPC's Visual Comparison Manual. All repaired areas shall then be electrically tested. Testing procedures shall be repeated until surface is acceptable to the Engineer.

3. Inspection Report: The Engineer shall prepare and deliver to the Contractor an inspection report covering the warranty inspection. The report shall set forth the number and type of failures observed, the percentage of the surface area where failure has occurred, and the names of the persons making the inspection.

4. Schedule: Upon completion of the inspection and receipt of Inspection Report as noted herein, Owner shall establish a date for Contractor to proceed with remedial work. Any delay on part of Contractor to meet schedule established by Owner shall constitute breach of this Contract and Owner may proceed to have defects remedied through other means, and these costs may be charged to the Contractor.

5. Remedial Work: Any location where coating or paint has peeled, bubbled, blistered, cracked or any location where coating thru rust is evident shall be considered to be a failure of the system. The Contractor shall make repairs at all points where failures are observed by removing the deteriorated coating, cleaning the surface, and recoating or repainting with the same system. Any spot repairs to defective areas will require feathering at least 3 inches into sound adjacent coating. If the areas of failure exceeds 25 percent of the coated surface, the entire coating system will be required to be removed and recoated in accordance with the original specification.

6. Upon completion of remedial work, the Contractor shall disinfect the tank as specified herein.

PART 2 - COATING AND DISINFECTION MATERIALS

2.01 GENERAL

A. SPECIFIED MATERIALS: Materials specified are those which have been evaluated for the specific service. Products are listed to establish a standard of quality. No material substitutions shall be made. Contractor shall use products of the same manufacturer for all coats.

B. DELIVERY AND INSPECTION OF MATERIALS: All materials shall be brought to the jobsite in the original sealed containers. They shall not be opened or used until Engineer has physically inspected contents and obtained necessary data from information printed on containers or labels. Materials exceeding storage life recommended by the manufacturer shall be rejected.

C. MATERIAL CHARACTERISTICS: Flammability, toxicity, allergenic properties, and any other characteristic requiring field precautions shall be identified and specific safety practices shall be stipulated.

D. MATERIAL STORAGE: All coating, paint and disinfection materials shall be stored in enclosed structures to protect them from weather and excessive heat or cold. Flammable coatings and paints must be stored to conform with local, County, State and Federal safety codes for flammable coating and paint materials. At all time coatings and paint shall be protected from freezing.

2.02 INTERIOR COATING MATERIALS

A. APPLICABLE STANDARDS: Coating materials must appear on the current National Sanitation Foundation (ANSI/NSF) Standard 61-1999. They shall conform to the regulations and applicable requirements of local, State and Federal air pollution and health regulatory agencies.

1. Epoxy coatings shall be similar or equal to AWWA Standard D102-97 Inside Coating System No. 2. Materials supplied by Tnemec, ICI/Devoe and Sherwin-Williams have been listed herein as standards of quality.

2. Joint sealant shall be a flexible polyurethane or polysulfide product, similar or equal to Federal Specification TT-S-230.

2.03 EXTERIOR COATING MATERIALS

The exterior coating system shall consist of an epoxy primer for touching up bare steel, and epoxy tie coat and a polyurethane topcoat. Materials supplied by Tnemec, ICI/Devoe and Sherwin-Williams have been listed herein as standards of quality.

2.04 DISINFECTION MATERIALS

A. APPLICABLE STANDARD: Disinfection materials shall conform to all requirements of AWWA Standard C652-92.

PART 3 - EXECUTION

3.01 GENERAL

A. APPLICATION STANDARDS AND REQUIREMENTS: All surface preparation, coating and paint application shall conform to applicable standards of SSPC and the manufacturer's printed instructions. Material applied prior to approval of the surface by the Engineer shall be removed and reapplied to the satisfaction of the Engineer at the expense of the Contractor.

1. All work shall be performed by skilled craftsmen qualified to accomplish the required work in a manner comparable with the best standards of practice. Continuity of personnel shall be maintained and transfer of key personnel shall be coordinated with the Engineer.

B. COATING SUPERVISOR: The Contractor shall provide a supervisor to be at the work site during cleaning, application and disinfection operations. The supervisor shall have the authority to sign and change orders, coordinate work and make other decisions pertaining to the fulfillment of their contract.

C. SANITARY FACILITIES: Contractor shall provide approved sanitary facilities for all project personnel, as no existing facilities will be available to the Contractor. Facilities shall be maintained during the project to complete standards established by Owner, and shall be removed prior to Contractor's departure from the site at completion of the project.

D. WASHING REQUIREMENTS: Dust, dirt, oil, grease or any foreign matter which will affect the adhesion or durability of the finish must be removed by washing with clean rags dipped in an approved commercial cleaning solvent, rinsed with clean water and wiped dry with clean rags.

E. COATING AND PAINTING EQUIPMENT: The Contractor's coating and painting equipment shall be designed for application of materials specified and shall be maintained in first class working condition.

Compressors shall have suitable traps and filters to remove water and oils from the air. Blotter test shall be accomplished at each start-up period and as deemed necessary by the Engineer. Contractor's equipment shall be subject to approval of the Engineer.

1. Cleanliness of compressed air supply shall be verified daily, and as deemed necessary by Engineer, by directing a stream of air, without abrasive, from the blast nozzle onto a white blotter or cloth for twenty seconds in accordance with ASTM D4285. If air contamination is evident, change filters, clean traps, add moisture separators or filters, or make adjustments as necessary to achieve clean, dry air.

F. FIRST COAT APPLICATION: Application of the first coat shall follow immediately after surface preparation and cleaning within an eight-hour working day. Any cleaned areas not receiving first coat within an eight-hour period shall be recleaned prior to application of first coat.

G. PROTECTION OF PREVIOUSLY COATED SURFACES: Because of presence of moisture and possible contaminants in atmosphere, care shall be taken to insure previously coated or painted surfaces are protected or recleaned prior to application of subsequent coat(s). Methods of protection and recleaning shall be approved by the Engineer.

H. TEMPORARY POWER: The Contractor shall provide, at his own expense, all necessary power for his operations under the contract.

3.02 SURFACE PREPARATION, GENERAL

A. SURFACE PREPARATION STANDARD: The latest revision of the following surface preparation specifications of SSPC shall form a part of this specification. (Note: An element of surface area is defined as any given 9 square inches of surface).

1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods, which involve a solvent or cleaning action.

2. Brush-off Blast Cleaning (SSPC-SP7): Blast cleaning to remove loose rust, loose mill scale, and other detrimental foreign matter present to the degree specified.

3. Near-White Blast Cleaning (SSPC-SP10): Blast cleaning to near-white metal cleanliness, until at least ninety-five percent of each element of surface area is free of ail visible residues.

4. Power Tool Cleaning to Bare Metal (SSPC-SP11): Power tool

cleaning to bare with a minimum 1 mils profile.

5. Water Jetting (SSPC-SP12): Low Pressure Water Cleaning (LP WC) at pressures up to 5000 psi.

B. INTERIOR SURFACES: All interior surfaces of tank shall be abrasively blast cleaned to "Near-White Blast Cleaning" in conformance to SSPC's Surface Preparation Specification No. 10 (SSPC-SP10) and a surface profile or anchor pattern of 2 to 3 mils (.002" - .003").

C. EXTERIOR SURFACES: All exterior surfaces of tank and appurtenances shall be pressure water cleaned in accordance with SSPC-SP12, LP WC (2500 to 3500 psi) to remove all dirt, dust, grease, chalk and other foreign materials detrimental to adhesion of new coatings. Active rust sites shall be power tool cleaned to bare metal in accordance with SSPC-SP 11 to provide a minimum surface profile of 1 mils (.001"). Each area shall be feathered back to sound coatings a minimum distance of 2" in all directions.

3.04 SURFACE PREPARATION, SPECIFIC

A. SLAG AND WELD SPATTER REMOVAL: Slag, weld spatter, or sharp edges such as those created by flame cutting and shearing not previously removed shall be removed by chipping and grinding. All sharp edges shall be peened, ground or otherwise blunted as required by the Engineer in accordance with NACE RP 0178. The rolled edges of angles, channels, and wide flange beams do not normally require further rounding unless specifically directed by the Engineer.

B. BLAST NOZZLE PRESSURE: Blast nozzle pressure shall be a minimum of 95 P.S.I. and shall be verified by using an approved nozzle pressure gage at each start-up period or as directed by the Engineer.

C. ABRASIVES: Particle size of abrasives used in blast cleaning shall be that which will produce a surface profile or anchor pattern specified herein, or in accordance with recommendations of the manufacturer of the specified coating or paint system to be applied, subject to approval of Engineer.

1. Abrasive used in blast cleaning operations shall be new, washed, graded and free of contaminants, which would interfere with adhesion of coatings and paints and shall not be reused unless specifically approved by the Engineer.

2. Abrasives shall be certified for unconfined dry blasting pursuant to the California Administrative Code, Section 92520 of Subchapter 6, title 17, and shall appear on the current listing of approved

abrasives.

D. MAINTAINING WORK SITE AREA: The Contractor shall keep the area of his work in a clean condition and shall not permit blasting materials to accumulate as to constitute a nuisance or hazard to the prosecution of the work or the operation of the existing facilities. Spent abrasives and other debris shall be removed at the Contractor's expense as directed by the Engineer. If waste is determined to be hazardous, disposal by Contractor shall meet requirements of all regulatory agencies for handling such wastes.

F. CLEANING OF BLASTED SURFACES: Blast cleaned surfaces shall be cleaned prior to application of specified coatings or paints through a combination of blowing with clean dry air, brushing/brooming and/or vacuuming as directed by the Engineer.

F. SPECIAL SURFACES: The surfaces of any non-carbon steel substrates, or specialty items (i.e. galvanized, anodized, stainless steel, etc.) shall be properly treated and prepared prior to any coating operations in accordance with the coating manufacturer's written recommendations, subject to approval of the engineer.

3.05 APPLICATION, GENERAL

A. SURFACE APPLICATION STANDARD: Coating and paint application shall conform to the requirements of the SSPC's Paint Application Specification No. 1 (SSPC-PA1), latest revision, for "Shop, Field and Maintenance Painting," the manufacturer of the coating and paint materials printed literature, and as specified herein.

B. THINNING: Thinning shall only be permitted as recommended by the manufacturer and approved by the Engineer, and shall not exceed limits set by applicable regulatory agencies.

1. If the Contractor applies any coatings which have been modified or thinned to such a degree as to cause them to exceed established VOC levels, Contractor shall be responsible for any fines, costs, remedies, or legal action and costs which may result.

C. COATING APPLICATION: Each application of coating and paint shall be applied evenly, free of brush marks, sags, runs and evidence of poor workmanship. Care should be exercised to avoid lapping on hardware. Coating and paint shall be sharply cut to lines. Finish surfaces shall be uniform in appearance and shall be free from defects or blemishes.

D. PROTECTIVE COVERINGS: Protective coverings or drop cloths shall be used to protect floors, concrete, fixtures, equipment, prepared surface and applied coatings. Personnel entering tank or walking on exterior roof of tank shall take precautions to prevent damage or contamination of coated or painted surfaces. Care shall be exercised to prevent coating or paint from being spattered onto surfaces, which are not to be coated or painted.

E. THREE-COAT SYSTEM: It is the intent of this specification to ensure a three coat system is applied to all interior surfaces.

F. WELDS AND IRREGULAR SURFACES: All interior welds and irregular surfaces specified by the Engineer shall receive a brush coat of the specified product prior to application of each complete coat. Coating/paint shall be brushed in multiple directions to insure penetration and coverage, as directed by the Engineer. These areas include, but are not limited to welds, nuts, bolts, ends, and flanges, etc.

G. EXTENDED RECOAT CYCLE: Coating which has endured an excessive time element beyond manufacturer's recommended recoat cycle, shall be scarified by Brush-off Blast Cleaning (SSPC-SP7) or methods approved by the Engineer, prior to application of additional coating or paint. Scarified coating shall have sufficient depth to assure a mechanical bond of subsequent coat.

H. APPURTENANCES: All attachments, accessories, and appurtenances shall be prepared and finished in the same manner as specified for adjacent tank sections.

3.06 COATING APPLICATION

A. GENERAL: After completion of surface preparation as specified, all interior surfaces shall receive three coats of one of the coatings specified under 2.02 "INTERIOR COATING MATERIALS." Prime coat and topcoats shall be white. The total system shall include one of the following systems:

1. Tnemec Company Series N140F (V)
   a. 4-6 mils Prime Coat
   b. 4-6 mils Intermediate Coat
   c. 4-6 mils Topcoat
   d. 15 mils (.015") shall be the nominal dry film thickness of the completed system

2. ICI/Devoe Bar Rust 233H
   a. 4-6 mils Prime Coat
   b. 4-6 mils Intermediate Coat
   c. 4-6 mils Topcoat

d. 15 mils (.015") shall be the nominal dry film thickness of the completed system

3. Sherwin Williams Company Macropoxy 646NSF
   a. 4-6 mils Prime Coat
   b. 4-6 mils Intermediate Coat
   c. 4-6 mils Topcoat
   d. 15 mils (.015") shall be the nominal dry film thickness of the completed system

B. TIME BETWEEN RE-COATS: A minimum of 24 hours time or until the previous coat has dried firm is required before additional coats may be applied.

C. SPOT PRIMING: After completion of surface preparation as specified, all bare steel surfaces shall be spot primed. Then all surfaces shall be coated with one of the coatings specified under 2.03 "COATING MATERIALS –Exterior". The total system shall include one of the following systems:

1. ICI/Devoe Company
   a. 4-6 mils Bar Rust 231 Spot Prime Coat
   b. 2-3 mils Pre-prime 167 Tie Coat
   c. 2-3 mils Devthane 379 Finish Coat
   d. 9 mils (.009") shall be the nominal dry film thickness of the completed system

2. Tnemec Company Series 76
   a. 4-6 mils Series 135 Spot Prime Coat
   b. 2-3 mils Series 135 Prime Coat
   c. 2-3 mils Series 75 Finish Coat
   d. 9 mils (.009") shall be the nominal dry film thickness of the completed system

3. Sherwin Williams Company
   a. 4-6 mils Macropoxy 646 Spit Prime Coat
   b. 2-3 mils Macropoxy 646 Prime Coat
   c. 2-3 mils HS Polyurethane B65-300 Finish Coat
   d. 9 mils (.009") shall be the nominal dry film thickness of the completed system

4. It is the intent of this specification to apply one of the above complete systems.

D. TEST PATCH: Prior to the full application of the epoxy tie-coat, a test patch shall be applied and allowed to reach full cure in accordance with these specifications. The test patch shall then be evaluated for lifting,

adhesion, softening of the existing film, or other defects. If the test patch determines that the epoxy is incompatible with the existing paint system, the contractor shall submit proposed alternative materials for review and approval of the engineer. If the test patch is found to be compatible, then one the total system shall be applied.

E. COATING SYSTEM IDENTIFICATION: Unless otherwise directed by the Engineer, stencil the following information. Location will be selected by the Engineer. Use a black urethane coating and provide lettering that is 2 to 3 inches in height.

1. Month and Year of Completion
2. Identification of Cleaning Method
3. Identification of Coating System

3.07 QUALITY CONTROL

A. MIXING: All coating components shall be mixed in exact proportions specified by the manufacturer. Care shall be exercised to insure all material is removed from containers during mixing and metering operations.

1. All coatings shall be thoroughly mixed utilizing an approved slow-speed power mixer until all components are thoroughly combined and are of a smooth consistency.

2. Epoxy coatings shall not be applied beyond pot-life limits specified by manufacturer. Any required induction requirements shall be strictly followed.

B. USE OF THINNERS: Thinners shall be added to coating materials only as required in accordance with manufacturer's printed literature and in the presence of the Engineer. Quantities of thinner shall not exceed limits set by applicable regulatory agencies.

C. DRYING TIME: Drying time between coats shall be strictly observed as stated in the manufacturer's printed instructions.

D. COLOR OF COATS: Each coat shall be of contrasting color with the topcoat being white.

E. SPRAY OPERATIONS: Care shall be exercised during spray operations to hold the spray nozzle perpendicular and sufficiently close to surfaces being coated to avoid excessive evaporation of volatile constituents and loss of material into the air or the bridging of cracks and crevices. All dryspray or overspray shall be removed as directed by Engineer.

F. HOLIDAY DETECTION: Upon completion of the interior coating operations and after the required curing intervals, holiday detection shall be accomplished on all coated surfaces. Repairs shall be retested.

G. FIELD INSPECTION: All mixing, thinning, application and holiday detection of coatings shall be performed in the presence of the Engineer.

H. CURING CONDITIONS: A time element equivalent to 7 days curing time at 70 degrees and 50% relative humidity shall be allowed before placing the epoxy coating system into service, as determined in 3.08 "FINAL CURING OF EPOXY COATING."

3.08 FINAL CURING OF EPOXY COATING

A. BLOWER FOR FINAL CURING: Upon completion and acceptance of applied coating system, Contractor shall furnish an approved exhaust fan or blower of sufficient capacity to insure removal of solvent vapors during curing process. The fan or blower, after approval by Engineer, shall be installed as directed by the Engineer and shall remain in continuous operation until coating is completely cured as determined by the manufacturer of the coating system.

B. TESTING: After completion of curing cycle as noted above, the Contractor shall test the applied coating with a solvent rub test performed in accordance with ASTM D 5402 to verify adequate curing has been attained.

1. If final cure has not been attained, ventilation shall be continued until applied lining passes the solvent wipe test.

2. After final cure is approved by Owner, Contractor shall remove fan or blower.

3.09 DISINFECTION

Disinfecting of interior surfaces of the tank shall be accomplished in the presence of the Engineer, in conformance to AWWA Standard C652 Section 4.2 Chlorination Method 2.

3.10 TESTING FOR VOLATILE ORGANIC COMPOUNDS (VOC's)

A. VOC TESTING AND MONITORING PROCEDURE: In order to monitor the presence of excessive levels of VOC's leached into the water from the coating process, the following procedure shall be utilized:

1. After satisfactory curing and disinfection, the Owner in accordance with standard filling procedures shall fill the tank. Water shall then be retained for a period of 5 days.

2. On the sixth day following completion of filling of tank, samples of the water shall be removed by Owner in accordance with latest Health Department memoranda. Samples shall then be forwarded, by Owner, to an approved test laboratory for testing to determine presence of VOC'S.

3. After testing of samples, results must show levels of leached organics to be in accordance with levels established by the Health Department for various VOC'S. Health Department will verify results and tank will be then placed into operating service.

4. If levels of leached organics exceed those acceptable to the Health Department, the tank shall be drained, flushed, refilled and retested; all at the Contractor's expense. Failure of the tank to attain levels acceptable to the Health Department shall be the responsibility of the Contractor and remedial measures to attain such levels shall be at his sole expense.

3.11 CLEAN-UP

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. Coating or paint spots upon adjacent surfaces shall be removed and the entire jobsite cleaned. All damage to surfaces resulting from the work of this section shall be cleaned, repaired, or refinished to the complete satisfaction of the Engineer at no cost to the Owner.

3.12 OMISSIONS

Care has been taken to delineate herein those surfaces to be coated. However, if coating or painting requirements have been inadvertently omitted from this section or any other section of the specifications, it is intended that all metal surfaces, unless specifically exempted herein, shall receive a first-class protective coating or paint equal to that given the same type surface pursuant to these specifications.

END OF SECTION 09873

DIVISION 11

EQUIPMENT

DIVISION 11

EQUIPMENT

Table of Contents

Section	Title	Page
11300	GAC Adsorption System	11300-1

SECTION 11300

GAC ADSORPTION SYSTEM

PART 1 – GENERAL

1.01 Section Includes
- A. Adsorption System Description
- B. Adsorption System Specifications
- C. Installation and Start-up Services

1.02 References
- A. ASME Section VIII, Division 1 – American Society of Mechanical Engineers Boiler and Pressure Vessel Code
- B. ASME/ANSI B16.5 – American Society of Mechanical Engineers/American National Standard Institute
- C. U.S. Food and Drug Administration, 21 CFR 175.300 and 177.2420
- D. Steel Structures Painting Council Surface preparation Specifications and National Association of Corrosion Engineers
- E. ASME Section II, American Society of Mechanical Engineers – Materials, Parts A, B & C
- F. American Society of Testing Materials (ASTM)
- G. American Water Works Association (AWWA) – B604, Standard for Granular Activated Carbon
- H. ANSI/NSF Standard Drinking Water System Components – Health Effects

1.03 System Description
- A. The complete adsorption system includes the following.
  - a. Carbon adsorbers with internals for carbon retention
  - b. Activated carbon
  - c. Influent, effluent and backwash piping with valves
  - d. Carbon fill and discharge piping with valves
  - e. Vent and pressure relief piping
  - f. Water piping and utility connections
  - g. Accessories as shown below
  - h. Manufacturer’s services

- B. The vessels, piping, valves, and carbon function as a system in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s services.

1.04 Manufacturers

A. Basis of design for the GAC System is model HP-1020ST by Evoqua Water Technologies as the existing GAC system was provided by Evoqua Water Technologies. The GAC System shall be HP-1020ST by Evoqua Water Technologies, or approved equal. Companies requesting to be considered an approved equal shall submit their qualifications and a submittal package at the time of the bid. Supplier of the adsorption system will have the following minimum qualifications and will submit affidavits attesting to these facts:
   a. At least 20 years of experience successfully supplying both adsorption systems and GAC to treat water with flow rates greater than 300 gpm average daily flow.

1.05 Submittals

A. One submittal package with the following information will be provided for approval by the Owner. Fabrication will begin upon receipt of Owner's approval.
   a. Adsorber vessel specifications and drawing including design pressure, dimensions, and capacity.
   b. System flow diagram showing all valves, components, instrumentation and utilities.
   c. System general arrangement showing dimensions, weights, and elevations including influent, effluent, backwash, and carbon exchange pipe connection locations.
   d. Pressure drop information across the system.
   e. Specification of the granular activated carbon to be utilized in the system.
   f. Material specifications for pipe, fittings and instrumentation.
   g. Specifications for vessel lining.
   h. Specifications for vessel painting.

B. The system Operating & Maintenance Manual will be provided upon completion of the project/shipment of the system.

PART 2 – PRODUCTS

2.01 General

A. The Contract Documents indicate specific required features of the equipment, but do not purport to cover all details of design and construction.

2.02 Carbon Adsorber Vessels

A. The carbon adsorber vessels shall be fabricated of carbon steel, conforming to ASTM A516 grade 70, 10'-0" diameter by 12'-0" straight side height with 2:1 elliptical top and bottom heads. Each vessel will be sized to contain 20,000 pounds of GAC and to accommodate approximately 30% bed expansion within the straight side of the vessel. The vessels shall be designed, constructed and stamped in accordance with

ASME Section VIII, Division 1 and registered with the National Board for a design pressure rating of 125 psig at 140°F. Each vessel will be provided with one (1) 20" diameter round manway located on the lower straight side portion of the vessel and one (1) 14" x18" elliptical manway located on the bottom head. The vessels will be free standing utilizing four (4) structural steel support legs.

B. The structural aspects of the vessel shall be sufficient to meet the California Building Code - IBC 2013 requirements of PGA_M =0.75, Site Class D, I=1.5. Vendor shall submit detailed calculations on request illustrating the seismic characteristics of the proposed vessel.

C. Each vessel shall be designed with an internal cone underdrain system that provides uniform distribution of the treated water using a minimum of one (1) septa nozzle for every nominal square foot of vessel cross section, facilitates GAC removal without the need to open the manway to manually hose out the remaining spent GAC, and allows replacement of the septa without the need to remove external piping. The septa shall be designed to contain the GAC within the adsorber and be constructed of polypropylene (ppl) material.

D. All surfaces shall be degreased prior to sandblasting. The adsorber internal surface shall be blasted to a white metal finish (SSPC-SP5) to provide a 3 to 4 mil anchor pattern. The exterior surfaces of the adsorber shall be prepared by blasting per SSPC-SP7.

E. The interior surfaces of the vessel shall be lined. The surfaces above the internal cone with a nominal lining thickness of 35 to 45 mil dry film (dft) and the surfaces under the internal cone bottom a nominal lining thickness of 10 to 12 mil dft. The lining material shall be a vinyl ester combined with a special curing system and inert flake pigment that meets the requirements of the U. S. Federal Register, Food and Drug Regulations Title 21, Paragraphs 175.300 and 177.2420 and the requirements of ANSI 61 when applied and cured per the manufacturer's requirements.

F. The exterior surface of the adsorbers shall be painted to a dry film thickness of 5 to 7 mil with a high solids epoxy (gray color) paint material.

2.03 Process and Utility Piping

A. The process and utility piping on the adsorption system shall include influent water to the system, treated water (effluent), backwash water supply and discharge, adsorber vent lines and granular activated carbon fill and discharge piping. The GAC piping shall be designed for downward flow. A flow meter shall be provided at the adsorber vessel for flow measurement during normal operation and during backwashing. An air valve shall installed at the highest point of the inlet piping.

1. Carbon Backwashing – The GAC shall be capable of operating in a backwash mode where the vessel is isolated from the raw waterline and treated water flows upward through the bed and out to the backwash waste. The system shall be designed with a backwash flow capacity

sufficient to expand the GAC bed up to at least 25 percent. The GAC Supplier shall submit calculations that identify the necessary backwash flow rate to accomplish this with the submitted bid. In any case, the system shall be designed to permit backwashing with a flow of not more than 1500 gpm. Headloss shall not exceed 8 psig during backwashing. Water temperature used in calculations shall be 60 deg. F.

2. GAC Removal and Replacement – System shall be designed and constructed to allow the adsorber vessel to be isolated for removal of spent GAC. Removal shall be accomplished by pressurizing the vessel with compressed air to displace the spent GAC into an empty shipping container or trailer. The bottom of the adsorber vessel and GAC slurry piping shall be designed to allow complete removal of spent GAC from the adsorber vessel and piping, using manual hosing from the access manholes if necessary.

   The Plant does not have compressed air available at the GAC facility. Manufacturer/Supplier of GAC shall provide his own mobile compressor necessary for GAC loading and removal operations.

B. The influent and effluent pipe network shall allow series (lead/lag) and parallel operating modes. Lead/lag operation allows either; a) flow from the influent flange, to Adsorber A, to the pipe module, to Adsorber B, to the pipe module then to the effluent flange, or b) flow from the influent flange, to Adsorber B, to the pipe module, to Adsorber A, to the pipe module then to the effluent flange. The change in flow pattern shall be accomplished with a change of valve positions. The purpose of lead/lag operation allows an adsorber to act as an on-line backup and/or provides for sufficient contact time to allow adsorption of the contaminants of concern.

C. Process piping (influent, effluent and backwash) shall be 8” diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials with 125# ASTM A126 Class B cast iron flanged fittings cement mortar lined per AWWA C205 with ANSI 61 approved materials.

D. Vent piping shall be 3” diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials.

E. Carbon fill and discharge piping shall be 4” diameter, constructed of Schedule 10 304 stainless steel, ASTM A-312, Grade TP 304/304L.

F. Utility piping shall be constructed of threaded schedule 80 carbon steel, ASTM 53 Grade B materials.

G. All piping surfaces shall be prepared by blasting per SSPC-SP7.

H. The exterior surface of the piping shall be painted to a dry film thickness of 5 to 7 mil with a high solids epoxy (gray color) paint material prior to assembly to ensure minimum oxidation at flanged connections.

I. The piping network shall be provided with a structural steel support frame for support of the piping module.

2.04 Process and Utility Valves (Per GAC System)

A. The process and utility piping; excluding GAC fill and discharge piping shall be equipped with butterfly valves for flow control. A total of ten (10) 8" diameter butterfly valves shall be supplied to accommodate the process and backwash control functions for each GAC system. Two (2) valves are needed for backwash control, two (2) valves are needed for influent isolation, two (2) valves for effluent isolation, two (2) valve for staging of the vessels and two (2) valves for the vent function.

B. The influent, effluent, and backwash valves shall be 8" AWWA butterfly valves, having an ANSI 125# wafer cast iron body, a cast iron disc with a polished 316SS edge, SS shaft, and an EPDM one-piece bonded seat that provides a flange face gasket surface. Valves conform to NSF-61, AWWA Class 150B, and 150 psig working pressure. Valves supplied complete with a mounted manual gear operator with handwheel.

C. The carbon fill and discharge valves shall be 4" diameter full port ball valves, 316 stainless steel construction with TFE seats and seals. A total of four (4) valves shall be supplied, two (2) for carbon fill and two (2) for carbon discharge.

D. Utility valves for the compressed air supply will be bronze or brass or barstock brass body regular port ball valves.

2.05 Instrumentation

A. Instrumentation will be accessible from grade.

B. Pressure relief will be provided by a 3" rupture disk constructed of impervious graphite and designed to relieve pressure at the design pressure of the vessel and at the maximum flow to the system. The rupture disks shall be mounted off the vessel vent line and vent to atmosphere. A total of two (2) will be provided for the system.

C. Each vessel shall be provided with an indicating differential pressure switch, 4" diameter dial, scaled for 20-0-20psi. The switch is rated at 1.0 amps @ 115 volts AC for remote indication. A total of two (2) shall be provided for the system.

D. The process piping shall be equipped with pressure gauges to indicate the pressure entering and exiting each adsorber and to provide information on pressure drop across each adsorber and the system. The pressure gauges will have 4 ½" face diameter with a stainless steel bourdon tube in a phenolic case housing (1 to 100 psig range). A total of three (3) will be provided for the system.

E. The process piping will be equipped with sample taps to enable sampling of the water entering and exiting each adsorber. A total of three (3) will be provided for the system.

F. An outdoor rated panel will be provided for the flow meter displays with enough room for each vessel flow meter (4 total), single master flow meter provided by General Contractor, and future flow meters (4 total), for a total of nine (9) flow meter displays.

2.06 Miscellaneous

A. The carbon fill and discharge shall be fitted with hose connections, such that carbon transfer to and from the adsorbers can be facilitated using carbon transfer hoses. These connectors will be 4" Quick Disconnect Adaptors constructed of aluminum as manufactured by Dover Corp. as Kamlock connectors or equal.

B. Two (2) flush connections shall be provided on each GAC fill line, one upstream and one downstream of the valve. One (1) flush connection will be provided on each GAC discharge line, downstream of the valve. The connections will be welded into the steel or stainless steel pipe or screwed into solid propylene "spacers" for the lined pipe. Flush connections will consist of a short section of ¾" pipe, a ¾" full port ball valve and a ¾" quick disconnect adaptor to match with water hose fittings.

C. Each vessel shall be provided with one (1) 8" stainless steel effluent strainer basket mounted in the effluent line from the vessel. The basket strainer shall be constructed of 316 stainless 14 gage plate with 1/8" diameter holes drilled on 3/16" centers, covered with 40 mesh 316 stainless steel screen and topped by a 4 mesh 316 stainless steel support screen (0.063" wire diameter). A total of two (2) will be provided for the system.

D. The influent and effluent pipe for each vessel shall be provided with a molded rubber double arch type expansion joint, with cover and tube constructed of EPDM. Expansion joints are ANSI/NSF 61 certified. Joints allow for axial compression and extension, lateral deflection and minimum 18 degrees angular misalignment. Steel backing flanges, 150 # drilling, to be galvanized or zinc plated. The expansions joints are rated at 190 psi at 170°F. A total of four (4) will be provided for the system.

E. Gaskets will be 1/8" thick, 85 durometer EPDM with a temperature range of -40°F to 275°F and a pressure rating of 175 psig. Gaskets will meet the requirements of ANSI/NSF Standard 61.

2.07 Granular Activated Carbon

Approved GAC suppliers are Evoqua Water Technologies or CalgonCarbon. The GAC supplier will provide activated carbon that will meet or exceed the following specifications:

ANSI/NSF Standard 61 Classified

ANALYSIS	SPECIFICATIONS
	ANSI/NSF Standard 61 Classified
Type	Bituminous coal
PSD, U.S. Standard Mesh Size	12 x 40 mesh, 5% max over, 4% max under

Iodine Number, mgI_2/g	1000 min
Abrasion Number	75 min
Hardness Number, wt. %	90 min
Mean Particle Diameter, mm	0.8 – 1.1
Effective Size, mm	0.55 – 0.75
Uniformity Coefficient	1.9 max
Moisture as Packed, wt. %	2% max
Apparent Density, g/cc	0.47 - 0.54
Total Ash Content, wt. %	11% max
Water Soluble Ash, wt. %	0.5% max

The activated carbon shall be bituminous coal based and the supplier of the activated carbon being proposed comply with the following requirements:

- The carbon is ANSI/NSF Standard 61 classified and meets all the physical, performance and leachability requirements established by ANSI/AWWA B604 and the Food Chemical Codex
- The carbon shall be pre-washed to reduce the amount of fines in the water and duration of the initial backwash.
- The carbon has been shown through prior experience to be effective in removing TOC and DBPs from drinking water.
- The supplier must operate a quality control laboratory within the United States that uses fully documented QA/QC procedures. These QA/QC procedures must be based on ASTM and AWWA testing protocols and be used to establish and guarantee the quality of the activated carbon being supplied.

1. Material Quality and Testing

The quality of the GAC shall be determined by testing in accordance with the following standards:

Particle Size Distribution Sieve Analysis	AWWA B604
Effective Size	AWWA B604
Uniformity Coefficient	AWWA B604
Moisture	AWWA B604
Bulk Density	AWWA B604
Abrasion Number	AWWA B604
Iodine Number	ASTM D4607-86

Butane Number	ASTM D5742
Total Ash	ASTM D2866-83
Water Soluble Ash and Water Extractable Phosphate Water Extractables Test	Food Chemical Codex, Third Edition Activated Carbon Specifications,

All tests required shall be performed on a representative sample of the lot (or lots) of the carbon to be supplied at the bidders expense by a qualified testing Laboratory. Certified test results and a 50 lb. representative sample (if requested) of the GAC media shall be submitted to the system owner a minimum of 3 weeks prior to delivery along with a written statement certifying that the sample of the GAC material is representative of the GAC media that is ready for shipment and installation under this contract.

The system owner will have 2 weeks from the date of delivery of the 50 lb. representative sample of the GAC media, corresponding test results, and certifications as outlined above to notify the supplier in writing of shipment quality acceptance.

PART 3 – ADDITIONAL

3.01 GAC Supplier

A. GAC Supplier shall assign a Project Manager (PM) to facilitate the execution of the project. The PM will interface with the customer for both the technical and commercial aspects of the project.

B. GAC Supplier shall provide an Engineering Submittal Package as outlined in paragraph 1.05A.

C. GAC Supplier shall supply Operation and Maintenance Instructions upon completion of the project/shipment of the system.

D. A manufacturer's trained specialists, experienced in the installation of the GAC Adsorption Systems, and with at least five (5) years of field experience will be present at the job site and/or classroom designated by the Owner/Contractor to provide the following services:

- Inspection of the installed equipment
- Supervision of carbon loading
- Start-up assistance
- Troubleshooting
- Operator training

E. GAC Supplier shall retain design and fabrication documentation for a minimum period of seven (7) years following completion of the project.

3.02 Installation of GAC Material

Following testing, inspection, and disinfection of the system, the adsorber vessel shall be filled with a minimum 20,000 pounds of virgin GAC in accordance with the specifications.

GAC Supplier shall deliver GAC in company owned and maintained trailers or approved subcontractors owned and maintained trailers used solely for the transport of Potable Water GAC. Trailers shall be thoroughly cleaned prior to filling with GAC and shall be lined or constructed with materials suitable for transporting GAC that will be in contact with potable water. Weight tickets for all carbon shall be provided to the Owner for the actual carbon delivered.

Makeup or rinse water needed for the transfer shall be potable water provided by the Owner. The GAC Supplier and the Contractor shall provide any necessary hoses, site glasses, piping, and appurtenances for using this water. The compressed air supply required for transfer of carbon shall be provided by the GAC Supplier or Contractor.

All water used in the transfer process shall be discharged to the point on site designated by the Owner; no discharges will be permitted without the Owner's permission.

GAC shall be transferred as water slurry only, using air pressure on the trailer as the motive force. Use of a pump or eductor to transfer the carbon from the trailer into the adsorber vessel will not be allowed. Bag loading or dry loading of the GAC into the adsorber vessel is prohibited. The GAC shall be loaded into the trailers before the units are driven on to the site.

The GAC Supplier and the Contractor will be responsible for cleanup of all GAC and slurry spills that may occur during the GAC transfer operation.

Following installation of the GAC in all adsorber vessels, the GAC Supplier and the Contractor shall assist the Owner's operating personnel in placing the system in initial operation in the filter-to-waste and backwashing modes, in accordance with the GAC Supplier's recommendations, for removal of fines from the newly installed GAC beds. When the beds have been adequately rinsed and are ready for normal operation, the Supplier shall so advise the Owner and assist with placing the system in operation.

3.03 Material Testing and Start-up

The surface water provided by the Owner meets all the maximum contaminant levels (MCLs) for secondary inorganic contaminants. The quality of the virgin carbon will be reflected by the quantity of inorganics leached into the effluent in terms of secondary inorganic contaminations of phosphates, ash, etc. The effluent shall be sampled (after the washing is considered complete) and tested by an independent laboratory. The GAC Supplier shall arrange and pay for all testing described herein. The treatment system must provide water that does not exceed the MCLs for secondary contaminants. GAC Suppliers' representatives shall be present to oversee the start-up procedure and instruct the Owner.

3.04 Services By Others

A. The designated general contractor will be responsible for installation and site services, typically including:

1. Site preparation, foundation design and foundation installation
2. Receipt, off-loading (and storage) of adsorption system equipment
3. Installation of adsorption system equipment
4. Provision of a means to keep the vessel flooded in all operating modes
5. Any hydrostatic test of the installed system at the site
6. System connection to existing infrastructure
7. System disinfection prior to initial fill of carbon
8. Utilities for bulk loading of GAC (clean water source, backwash water disposal)
9. Operation of the system during carbon fill operation
10. Mechanical startup of the system

END OF SECTION 11300

DIVISION 13

METAL BUILDING

DIVISION 13
TABLE OF CONTENTS

SECTION		PAGE
13120	Metal Building	13120-1

SECTION 13120

METAL BUILDING

PART 1 - GENERAL

1.01 SUMMARY OF WORK

The work included under this specification section consists in general of the provision of all labor, materials, equipment and services required for the furnishing and installing of a rigid frame, insulated steel building with all doors, roof skylights, ventilators, etc., as shown on the Drawings and specified herein to effect a complete and finished job under the design criteria and guidelines provided; all in accordance with the terms of the Special Requirements, Basic Specifications, and Drawings.

1.02 SUBMITTALS

The Metal Building Manufacturer shall submit to the Engineer for approval: complete shop drawings showing scope of work, slab and footing plan, anchor bolt setting plan, erection information, skylight/roof hatch details, insulation panel specifications and complete structural analysis including mansard design and seismic design calculations per Section 15010. The submitted shop drawings and structural calculations shall be signed by a Civil or Structural Engineer registered in the State of California.

1.03 GENERAL DESCRIPTION OF BUILDING

The building shall include all columns, rafter beams, endwall columns, roof and wall panels, mansard, skylights/roof hatches, anchor bolts, leveling plates, erection bolts, nuts and washers, purlins, girts, bracing, flashing, closures, fasteners, and other miscellaneous items shown on the Drawings, specified herein or required to complete the work. All material shall be new, unused, and free from defects.

1.04 BUILDING DIMENSIONS

The Drawings have anticipated certain basic building dimensions. The building manufacturer may vary these dimensions to best accommodate his standard procedure, under the following conditions:

Building Dimensions:

31' - 4" outside width
65' - 0" outside length
12' - 0" eave height
1:12 roof slope

1.05 BUILDING DESIGN

The building manufacturer shall be responsible for the structural designs of the building, enclosing material, and support of all related structural items, electrical items, architectural items, mechanical items, and plumbing items, including lighting, etc. The building shall be the design of a manufacturer regularly engaged in the fabrication of pre-engineered structures conforming in whole or in part as specified in the Metal Building Manufacturer's Associates "Code of Standard Practices". The building manufacturer shall submit all applicable guarantees and/or certificates to the City.

All structural or built-up sections shall comply with the applicable requirements of the A.I.S.C. "Specifications for the Design, Fabrication and Erection of the Structural Steel for Building", and all light gauge steel structural members shall comply with the A.I.S.C. "Specifications for the Design of Light Gauge Cold-Formed Steel Structural Members", and the Uniform Building Code, all as interpreted and administered by the Department of Building and Safety, Riverside County, California.

1.06 DESIGN CRITERIA

Buildings shall be designed to the following criteria:

Roof Live Load:	25 psf	Wind Speed:	100.00 mph
Seismic Zone:	4	Wind Exposure:	C

1.07 MANUFACTURERS

Manufacturer of the Metal Building shall be MWC Group, Inc. out of Phelan, CA. or approved equal. Companies requesting to be considered an approved equal shall submit their qualifications and a submittal package at the time of the bid. Supplier of the metal building will have the following minimum qualifications and will submit affidavits attesting to these facts:

a. At least 10 years of experience successfully supplying metal buildings.

1.08 RELATED WORK

Related work to be performed by the Contractor or by his subcontractors consists of, but is not limited to, the following:

1. Provide adequate concrete foundations and floor slabs designed according to load reactions supplied by the building manufacturer.

2. Set all anchor bolts and leveling plates. Anchor bolts, bolt setting plan, and leveling plates to be supplied by the building manufacturer.

1.09 BASIS OF QUALITY AND WORKMANSHIP

The Specifications outlined under this Section intend to establish a minimum of quality for materials to be used in this project and for the type of workmanship employed in the erection of all materials.

Where the building manufacturer's standards dictate deviations from these specifications, such deviations shall be outlined by each bidder in his proposal, and only those deviations which exceed the requirements of these specifications in quality and/or performance will be accepted.

PART 2 - PRODUCTS

2.01 STRUCTURAL MATERIALS

A. STEEL: The steel for main rigid frames and all primary structural framing members (other than cold formed, light gauge sections) shall be of 42,000 psi minimum yield strength.

B. LIGHT GAUGE STEEL: Cold formed light gauge sections shall conform to the physical requirements of A.S.T.M. specifications as follows:

(1) Hi-tensile: A-375 with a minimum yield strength of 50,000 psi.

(2) Grade "C" A-245 with a minimum yield strength of 36,000 psi.

C. FRAMING MEMBERS: All framing members shall be shop punched for bolted field assembly.

D. BOLTS: High strength bolts shall be bearing type with threads excluded from shear planes and shall conform to A.S.T.M. Specification A-325, and are bearing type connections with heavy hex heads. Installation shall conform to A.S.T.M. Specification A-325.

(1) 3/4" Dia. H.S.B. have a minimum tension of 28,000 lbs. and applied torque shall be 355 ft. lbs.

(2) 7/8" Dia. H.S.B. have a minimum tension of 36,000 lbs. and applied torque shall be 523 ft. lbs.

(3) All other frame connectors to be A.S.T.M. A-305 machine bolts of 3/4" diameter, cadmium plated.

E. CONNECTORS: All connectors for secondary members shall be 1/2" cadmium plated machine bolts unless otherwise noted.

2.02 ROOF AND WALL COVER

A. GENERAL: All roof and wall coverings shall be made from prime, hot-dipped galvanized steel not less than #26 U.S. Gauge, having a minimum of 1.25 oz. of zinc; roll formed into panels of required length to minimize end laps. Primary ribs shall be in pairs not less than 1" deep and shall be spaced not more than 12" on center, with a secondary rib not less than 3/16" deep between pairs. Flat areas shall not exceed 2-3/4" between any rib. Roof and wall panels shall provide a minimum of 36" wide coverages and shall be insulated per this Section.

B. SIDE LAPS: Side laps shall have a siphon break gutter for positive mechanical water seal.

C. WALL PANELS: Wall panels shall be 26 gauge panel rib type and continuous where possible from base to eave and shall have a siphon break and gutter for positive mechanical water seal. The sheet base shall have a crimp bottom.

INTERIOR WALL PANELS: Interior steel facings shall be not less than 26 gauge and shall be full wall height. All trims for interior liner panels shall be 26 gauge.

EXTERIOR WALL PANELS: Exterior steel facings shall be not less than 26 gauge and shall be full wall height.

ROOF PANELS: Roof panels shall be 2-1/2" thick rigid insulated panel by API model 9025 with a minimum R value of 22.

D. COLOR COATING OF PANELS: All panels shall be shop coated in accordance with the following:

(1) The exterior finish coating of all panels shall be KXL Kynar 500. Color to be Desert Tan.

(2) The interior finish coating of all panels shall be KXL Kynar 500. Color shall be Arctic White.

(3) Color coating shall be applied to both sides of hot-dipped galvanized steel panels with 1-1/4 oz. coating (A.S.T.M. Specification A-446). The metal shall be chemically pretreated and conversion coated. After thorough drying, a zinc-chromate epoxy primer shall be applied and based on the metal after which the finish coating shall be applied and baked on the surface.

E. INSULATION: Roof Insulation shall consist of 2-1/2" rigid insulated panel by API Model 9025 providing a minimum resistance of R-22. Walls

shall consist of blanket insulation providing a minimum resistance of R-11. Liner panel shall cover all interior surfaces, both interior and exterior steel facings shall be not less than 26 gauge. Contractor shall submit specifications for metal building insulation to the Engineer for approval.

2.03 TRIM

All metal trim be #26 U.S. Gauge galvanized steel sheets with the same type coating as the panels. Trim is to be formed and lapped to provide a complete weather-tight installation.

Eave and rake trims shall be shop coated with exterior color selected by the City from manufacturer's standard colors. All trim shall be held to the roof panels by fasteners not to exceed 12" on center.

2.04 FASTENERS

A. WALL: Wall fasteners shall be in accordance with the following:

(1) Wall fasteners shall be #14 x required length hex head sheet metal screws with steel backed neoprene washer, cadmium plated. These fasteners shall also be installed at roof panel side laps.

(2) Or: #14 x required length hex head Type 305 stainless steel sheet metal screws with stainless steel backed neoprene washer cadmium plated.

(3) Or: #12 x 14 x required length hex head self-drilling screws with steel backed neoprene washer, cadmium plated.

(4) Or: #14 x required length round head sheet metal screws with #3 Pozi-Drive socket assembled with a plain neoprene washer, cadmium plated.

(5) Or: #14 x required length hex head integral color nylon head with flared flange, steel cadmium plated shank screws. Head color shall be selected by The City from the building manufacturer's standard colors.

B. ROOF: Roof fasteners shall be in accordance with the following:

(1) Roof Fasteners shall be #14 x required length head self-tapping screws with steel backed neoprene washer, cadmium plated.

(2) Or: #14 x required length hex head Type 305 stainless steel self-tapping screws with stainless steel backed neoprene washer, cadmium plated.

(3) Or: #12 x required length hex head self-drilling screws with steel backed neoprene washer, cadmium plated.

C. CLOSURES: All closure strips shall be of preformed neoprene material and shall conform to the contour of the roof and wall covering panels.

2.05 ACCESSORIES

A. PEDESTRIAN DOORS: Pedestrian doors shall be in accordance with the following:

(1) The standard of quality adopted for swing doors and frames shall be that established by the Steel Door Institute and that set forth as a minimum by the U.S. Department of Commerce Standard PS 4-66, relative to the manufacturer of 1 3/4" thick flush steel doors. Doors shall be per Steelcraft L-16 or approved equal.

(2) All door sizes, swing and hands, shall be as shown on the drawings.

(3) There shall be included all required hardware and accessories conforming to the schedule shown on the drawings in addition to the necessary framing and fasteners required to properly install and to replace structurally the wall panels and/or framing displaced.

(4) All door leaves, frames, astragals and louvers specified shall be manufactured from zinc-coated steel. The door leaves, frames, louvers and astragals shall be bonderized and given a baked on prime coat of paint, shop applied.

(5) Locksets, deadbolts, and cylinders shall be keyed, masterkeyed, and grand master keyed at the factory where records shall be established and maintained as directed. Lockset to be keyed per Owner's instruction to match existing buildings. Except where otherwise specified, locksets, and cylinders and component parts, as specified hereinafter shall be by Schlage.

1. Locksets and deadbolts shall be Schlage.
2. Locksets and cylinders shall have a minimum of six pins.
3. Lock strikes shall be boxed, and shall have a curved lip of sufficient length to protect the trim and jamb.

(6) Master keys and grand master keys shall be identified with a registry number, NOT stamped with MASTER or letter "M".

(7) Furnish 2 change keys per lockset. Furnish master keys as directed.

(8) Coordinate all keying requirements with the City prior to purchasing of hardware.

B. COILING DOORS: Provide spring counterbalanced, insulated overhead coiling type door designed for application specified below. Door shall be complete with guides, hardware, fastenings, operating mechanism, and accessories. Door, hardware, and anchors shall be designed to withstand a wind pressure of 20 pounds per square foot of door area without damage. Approved Coiling Door Manufacturer:

"Thermal Guard" chain operated, insulated roll-up coiling door assembly by "R & S manufacturing" or approved equal.

1. CURTAIN: Interlocking type 25 flat slats roll formed from galvanized steel coil. Gage of slats shall be as required to meet wind loads of 20 pounds per square foot. Polyurethane foam, 3/4" thick, is to be laid in place for complete coverage and concealed by a 24 gage back slat. Windlocks are to riveted to slats to maintain curtain alignment. Bottom of curtain shall be reinforced by a double steel footpiece with astrigal.

2. GUIDES: Structural steel angles shall form curtain guides and shall be bolted to structural steel wall angles. Size of guides shall be as required to retain curtain under wind loads. Windlock bars shall be provided when windlocks are specified. Provide vinyl guide weather-stripping against the flat faced side of slats.

3. BRACKETS: Brackets are to be constructed of steel plate not less than 1/4" thick and shall be bolted to the wall angle with 1/2 inch diameter fasteners.

4. GEARS: All gears shall be cast iron with cast from machine cut patterns. The pinion gear shall not be less than 3 inch pitch diameter, The gear ratio shall be designed for a maximum manual effort of not more than 30 pounds.

5. BARREL: The barrel shall be steel tubing of not less than 6 inches in diameter. Oil tempered torsion springs shall be capable of correctly counter balancing the weight of the curtain. The barrel shall be designed to limit deflection to .03 inch per foot of opening width.

6. HOOD: Hoods shall be fabricated from 24 gauge galvanized steel sheet, reinforced with top and bottom flanges to limit deflection. Provide intermediate support as required.

C. FRAMED LOUVERS: All framed louvers for wall and/or gable installation shall be of type and size shown on the Drawings. There shall be included all necessary framing, hardware and fasteners to properly

install and to replace structurally the wall and/or gable panels and/or framing displaced.

The louver components shall be zinc-coated steel with a 1.25 oz. (ordered weight) zinc coating.

All applicable components of the basic louver shall be cleaned, phosphate treated, given one shop coat of metal primer and adequately oven or air dried under proper controls.

D. ROOF SKYLIGHTS: Roof skylights shall be translucent white plastic "skylight panels", factory assembled and designed to fit in the roof system without additional flashing. Skylights shall be weather tight, as manufactured by Bristolite, or equal.

E. EXHAUST FAN: Exhaust fan shall be the size and type shown on the Drawings. There shall be included all required hardware and accessories conforming to the manufacturer's standards in addition to necessary framing and fasteners required to properly install and to replace structurally the wall panels displaced.

PART 3 - EXECUTION

3.01 GENERAL

All field erection and construction shall be performed in a neat and workmanlike manner per the applicable ASIC and Uniform Building Code requirements, manufacturer's recommendations and these Specifications.

3.02 WELDING

All welding operators shall be qualified under the Standard Qualification procedure of the American Welding Society (AWS). All welding shall conform to the latest specification of the "Code of Arc and Gas Welding Society".

The City shall have the right at any time to call for and witness the making of test specimens by any welder in accordance with these Specifications, and the expense of such tests shall be borne by the contractor.

Welds considered by the City to be deficient quality, or made contrary to any mandatory provision of these Specifications, shall be removed throughout its depth to expose clean base metal, but in case of a strictly local deficiency, the weld need not be removed throughout its entire length, provided that sufficient amount shall be removed to ensure that sound weld metal, only, remains. A cracked weld shall be removed throughout its length.

Certification of the welder's qualifications shall be submitted at the City's request.

3.03 INSTALLATION

A. GENERAL: The following requirements apply to the installation/erection of the metal building. Field cutting or burning of openings and/or wall framing shall not be permitted.

B. INSTALLATION OF STRUCTURAL MATERIALS: Purlins shall be connected directly to the rafter flanges. Field riveting or welding will not be permitted. Flanges and webs of built-up welded members shall be joined by a continuous automatic submerged arc welding process.

All steel members except bolts and fasteners shall be thoroughly cleaned of all loose mill scale, rust, oil, dirt and other foreign matter and given one shop coat of zinc chromate primer with a pigment content of 50% and shall meet Federal Specification TTP-636; and finish coated (shop or field applied) to match interior color with type of paint as recommended by Metal Building Manufacturer.

All building parts shall carry an identifying mark for easy field erection.

C. INSTALLATION OF ROOF AND WALL COVER: Side laps shall be secured by locating one stitch screw midway between supporting members in the crown of the panels.

Roof sheet fasteners shall be applied at every purlin. Holes will be field drilled in the crown of the sheets and supporting structural member to insure perfectly matched holes. They shall not exceed 12" center to center at intermediate bearings.

Ridge flashing for buildings having a 1:12 or flatter slope shall be formed by a method recommended by the Metal Building Manufacturer.

D. TRIM: At corners of the building where eave trim meets gable trim, tabs shall be field formed.

E. CLOSURES AND MASTIC: Closure strips shall be installed at the bottom edge of wall panels, at the intersection of the roof panel and the eave trim and between the gable trim and the endwall panels. Closure strips shall be "inside type" or "outside type" as appropriate for the location.

Closer strips shall be installed before panel or trim fasteners are applied to firmly hold the strips in place.

1/4" extruded single bead butyl rubber mastic shall be installed at all roof panels side and/or end laps.

F. FASTENERS: All fasteners protruding more than one eighth (1/8) of an inch beyond the inside of the building walls shall be neatly field trimmed as approved by the Engineer.

G. FRAMED LOUVERS: All framed louvers shall receive a field painted finish coat with automotive acrylic enamel to match building color.

H. ROOF SKYLIGHTS: The skylight/roof hatch assemblies shall be installed in such a manner as to facilitate drainage by a method recommended by Metal Building Manufacturer and approved by the Engineer. The skylight assembly shall be located as shown on the plans.

END OF SECTION 13120

DIVISION 15

MECHANICAL

DIVISION 15
TABLE OF CONTENTS

SECTION		PAGE
15010	General Mechanical & Equipment Provisions	15010-1
15041	Disinfection of Piping	15041-1
15044	Pressure Testing of Piping	15044-1
15060	Process Piping and Appurtenances	15060-1
15064	Water Pipe and Process Piping	15064-1
15081	Gaskets	15081-1
15089	Nuts and Bolts	15089-1
15099	Process Valves Regulators and Miscellaneous Components	15099-1
15101	Butterfly Valves	15101-1
15102	Resilient Seat Gate Valves	15102-1
15103	Actuators for Process Valves and Gates	15103-1
15105	Air Valves	15105-1
15107	Resilient Seat Ball Valves	15107-1
15112	Double-Door Check Valves	15112-1
15161	Vertical Turbine Pumps	15161-1
15170	Induction Motors	15170-1
15171	Vertical Hollowshaft (VHS) Electric Motors	15171-1

SECTION 15010

GENERAL MECHANICAL AND EQUIPMENT PROVISIONS

PART 1 - GENERAL

1.01 DESCRIPTION

These General Mechanical and Equipment Provisions, which apply to all systems and equipment, are hereby made a part of each and all of the separate Sections of this Specification. Contractor shall direct the attention of all Subcontractors and suppliers of mechanical and related appurtenances for the Work to the provisions of the Contract Documents and this Section.

1.02 MANUFACTURER'S EXPERIENCE

Unless specifically named in the detailed Specifications, a manufacturer shall have furnished equipment of the type and size specified which as demonstrated successful operation and is in regular use.

1.03 FACTORY INSPECTION

The Owner or its representative may inspect fabricated equipment at the factory without cost to Contractor. The Contractor shall notify the Owner in sufficient time so that factory inspection can be arranged. Factory inspection will be made after manufacturer has performed satisfactory checks, adjustments, tests and operations Approval of equipment at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute final acceptance by the Owner.

1.04 STANDARD OF QUALITY

Items of equipment are specified by the name of a manufacturer for the purpose of establishing a standard of quality and acceptable experience. Substitute equipment will be acceptable if it can be demonstrated to the Owner that the substitute is in strict accordance with the Specifications and equal in quality to those models specifically named. Manufacturers specified have been determined by the Owner to meet or exceed the minimum acceptable standard for the designated equipment style and model. Refer to the General Provisions for requirements pertaining to substitutions and equals. All mechanical equipment furnished under this Specification shall be new and of current design.

1.05 ADAPTATION OF EQUIPMENT

No responsibility for alteration of a planned structure to accommodate substitute equipment will be assumed by the Owner. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All revisions to structures, mechanical, electrical, or other work made necessary by such substitution shall be approved by the Owner and the cost of said revisions, including cost of redesign, shall be made at the Contractor's expense. Refer to General Provisions.

A. HORSEPOWER RATINGS. Horsepower ratings specified and/or shown for the proposed equipment are in accordance with the best information available to the Owner. In the event any equipment item proposed by the Contractor should require motors with larger horsepower rating than indicated on Drawings, it shall be the Contractor's responsibility to provide the proper control equipment, required modifications to motor control centers, starting equipment, feeder and branch circuit, and accessories as required to make the installation comply with the electrical code and to prevent excessive voltage drop without added cost to the Owner.

B. EQUIPMENT: Where equipment to be furnished is installed in an existing enclosure or adjacent to existing equipment, the Contractor shall field check the dimensions of existing equipment, location of conduits, etc., and shall familiarize himself with all existing conditions and difficulties to be encountered in performing such work.

1.06 GUARANTEE AND WARRANTIES

The Contractor shall guarantee all equipment in accordance with the Conditions of the Contract. In addition to the general guarantee requirements, equipment guarantee shall cover (1) faulty or inadequate design; (2) improper assembly or erection; (3) defective workmanship or materials; and (4) leakage, breakage, or other failure. For equipment bearing a manufacturer's warranty in excess of one (1) year, furnish a copy of the warranty to Owner with the Owner named as beneficiary. The period of all guarantees shall be initiated from the date of the Owner’s written acceptance of the Work.

1.07 SUBMITTALS

Refer to Special Requirements and specific Divisions and Sections for additional submittal requirements.

A. SHOP DRAWINGS: Shop drawings shall be submitted to the Owner in complete sets indexed by Specification paragraph and Drawing number describing the various equipment items or systems. Unless otherwise

specified or directed, submit shop drawings for all mechanical equipment specified herein.

B. EARTHQUAKE DESIGN DATA: Submit with the shop drawings complete calculations or test results, details of constructions, and method of attachment for all manufactured products showing compliance with Paragraph 3.11, "Earthquake Design and Restraint". The calculations and details shall be signed by a Professional Engineer who has demonstrated proficiency in Structural Engineering or Civil Engineering and is registered in the State of California.

C. INSTRUCTION MANUALS: Prepare and submit instruction manuals covering all mechanical equipment and machinery specified herein.

D. MANUFACTURERS' CERTIFIED REPORTS: Each equipment manufacturer, or his authorized representative, shall submit a notarized written report with respect to his equipment certifying that (1) the equipment has been properly installed and lubricated under his supervision, (2) the equipment is in accurate alignment, (3) he was present when the equipment was placed in operation, (4) he has checked, inspected, and adjusted the equipment as necessary, (5) the equipment is free from any undue stress imposed by connecting piping or anchor bolts, (6) has been satisfactorily operated under full load conditions, (7) he has inspected his equipment during the operational demonstrations and system validation tests to the extent specified, and (8) is fully covered under the terms of the guarantee. Form is included in Appendix F.

E. SUBMITTALS FOR OPERATIONAL DEMONSTRATION AND SYSTEM VALIDATION TESTS:

1. Operational Demonstration: When the Contractor's application for a progress payment equals or exceeds 75% of the Contract value for the first time, submit a detailed and comprehensive procedure plan for performance of each operational demonstration required. Identical equipment items may be covered under one plan. Include an estimated date and duration for each procedure and the personnel required.

2. System Validation Tests: When the Contractor's application for a progress payment equals or exceeds 75% of the Contract value for the first time, submit a detailed and comprehensive procedure plan for performance of each separate validation test and for each validation test that covers two or more systems. Each procedure plan shall describe and itemize the involved system, including associated electrical equipment and instrumentation and control systems, and shall include evidence of an organized step-by-step

procedure properly coordinating the efforts of the various trades and manufacturers' representatives involved and of the operations of the facilities. Procedures shall include an estimated duration and date for each procedure and the personnel required.

3. Procedure Plan Information: In addition to the information specified above, each procedure plan shall include the following information as applicable:

   a. Description of temporary procedure facilities, including Drawings and sketches as required to fully illustrate the facilities.
   b. List of test materials and estimated quantities.
   c. List of instruments, measuring and recording devices, and other test equipment, whether a part of the plant or furnished separately for temporary use.
   d. Names of supervising and inspecting manufacturers.
   e. Complete listing of all functional parameters to be observed and recorded.
   f. Recording intervals.

4. Records Materials: Submit samples of the forms, charts, and other materials to be used in recording demonstration and validation test results.

5. Results: Within 10 days after completion of each procedure plan submit 3 copies of all recordings and results of all operational demonstrations and system validation tests.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

Box, crate, or otherwise enclose and protect equipment during shipment, handling, storage, and following installation until final acceptance of the project. Keep equipment dry and covered from exposure to weather. Store pumps, motors, electrical equipment, and equipment having anti-friction or sleeve bearings in weathertight storage facilities. Lift large equipment items only at the points designated by manufacturer.

A. FACTORY PAINTED SURFACES: Protect against impact, abrasion, discoloration, and other damage. Repair damage as directed and approved (Refer to Section 9871).

B. ELECTRICAL EQUIPMENT: Maintain electrical equipment, controls, and keep insulation dry at all times. Keep heaters in equipment connected and operating until equipment is placed in operation.

1.09 JOB CONDITIONS

Drawings are diagrammatic and show the intended arrangement of principal apparatus, piping, and appurtenances. Conform to Drawings as closely as possible and exercise care to secure approved headroom and space conditions, neat arrangement of piping, valves, hangers, and like items, and to overcome structural interferences. Verify dimensions and conditions at the place of installation, and install materials and equipment in the available spaces. Submit written details and reasons for proposed deviations from Drawings and Specifications, and do not deviate therefrom unless authorized by Field Order or Change Order. If approved changes require alteration of structures or related work, make such alterations as approved in advance by the Owner at no additional cost to Owner.

1.10 EQUIPMENT

All equipment furnished shall be complete, ready for installation and operation. All bolts, nuts, washers, mounting plates, bed plates, bases, anchor bolts and other miscellaneous items necessary to form a complete, installed, operational system shall be furnished weather specifically specified or not.

PART 2 - PRODUCTS

2.01 MATERIALS AND WORKMANSHIP

All equipment furnished shall be new and guaranteed free from defects in materials, design, of workmanship. It shall be the manufacturer's responsibility to ascertain the conditions and service under which the equipment will operate and to warrant that operation under those conditions shall be successful. All parts of the equipment shall be amply proportioned for all stresses that may occur during fabrication, erection, and intermittent or continuous operation.

All equipment shall be designed, fabricated, and assembled in accordance with the best modern 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. Materials shall be suitable for service conditions. Iron castings shall be tough, close-grained gray iron free from blowholes, flaws, or excessive shrinkage and shall conform to ASTM A48. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall have a minimum nominal thickness of 1/4-inch. Provide equipment and materials suitable for the service conditions and meeting standard specifications such as ANSI, ASME, AWWA, ASTM, NEMB, UBC, and UL. The location of the fabricator and his shop schedule shall be furnished to the

Owner prior to the beginning of fabrication so that the Owner can schedule shop inspection.

2.02 LUBRICATION

A. LUBRICANTS: Provide lubricants of types recommended by equipment manufacturers, quantities sufficient for consumption prior to completion, testing, and final acceptance.

B. LUBRICATION SYSTEMS: Lubrication of equipment shall ensure constant presence of lubricant on all wearing surfaces. Lubricant fill and drain openings shall be readily accessible. Easy means for checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer. Equipment lubrication systems shall be systems that require attention no more often than weekly during continuous operation, shall not require attention during start up or shut down, and shall not waste lubricants.

2.03 STRUCTURAL STEEL FABRICATIONS

Conform to "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" of the AISC unless otherwise indicated or specified. Design all fabrications for dynamic and vibratory loadings. Use structural steel shapes conforming to ASTM A36, A440, A500, A501, A570, A618, or equal, as applicable. Conform welding to AWS D1.1 Structural Welding Code. Galvanized specified items in accordance with ASTM A123, A153, or A386 as applicable; use galvanized bolts and fasteners with galvanized assemblies.

2.04 EQUIPMENT BASES AND BEDPLATES

Mount equipment assemblies on a single heavy cast iron or welded steel bedplate unless otherwise shown or specified. Provide bases and bedplates with machined support pads, tapered dowels for alignment or mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. Continuously weld seams and contact edges between steel plates and shapes, and grind welds smooth. Do not support machinery or piping on bedplates other than that which is factory installed. Provide jacking screws in equipment bases and bedplates to aid in leveling prior to grouting. Provide plates of minimum thickness of 1/4-inch. Pump bedplates shall include a drip lip and provisions for directing gland leakage to a single disposal point.

2.05 ANCHORS AND SLEEVES

Each equipment manufacturer shall furnish the required anchor bolts, nuts, washers, and sleeves of adequate design for securing bases and bedplates to concrete bases. Provide

sleeves of at least 1-1/2 times anchor bolt diameter. Anchor bolts shall be Type 316 stainless steel. Provide anchor bolts of length to allow for 1-1/2 inch of grout under baseplates and adequate anchorage into structural concrete unless otherwise shown or specified. Conform to designs for attachments to resist seismic forces, as applicable.

2.06 SAFETY GUARDS

Cover belt or chain drives, fan blades, couplings, exposed shafts and other moving or rotating parts on all sides with safety guards conforming to all Federal, state, and local codes and regulations pertaining; conform to the most restrictive requirements. Safety guards shall be free of all sharp edges and corners. Use corrosion-resistant materials at least equivalent to hot-dip galvanized steel. Safety guards shall be fabricated from 16 USS gage, or heavier, galvanized or aluminum-clad steel or 1/2-inch mesh galvanized expanded metal. Design guards for easy installation and removal. Provide necessary supports, accessories, and fasteners, of hot-dip galvanized steel or stainless steel. Design guards in outdoor locations to prevent entrance of rain and dripping water.

2.07 DRIVE UNITS

Provide drive units designed with a AGMA rating and service factor suitable for 24 hour continuous duty service under operating load, constructed to preclude oil leakage around shafts. Drive unit housings shall be constructed of high grade cast iron, welded steel, or other suitable material. Thermal rating of each unit shall exceed the design load or proper cooling devices shall be provided. All drives shall be designed especially for the service for which they are to operate.

A. MOTOR RATINGS: Provide drive motors having nameplate horsepower rating at least equal to the theoretical brake horsepower required to drive equipment under full load for conditions specified, including all losses in speed reducers and power transmission.

B. V-BELT DRIVES: Equip each V-belt with a sliding base or other suitable tension adjustment. Where motors are mounted above the driven machine on a pedestal, the belt tensioning shall be accomplished by four studs which are double nutted to the motor plate to raise and lower the motor plate. Hinges with a jacking screw to tension the belts shall not be used. Provide drives having a service factor of at least 1.6 at maximum torque using nameplate rating of driving motor.

2.08 GEARS

Provide oil-lubricated totally-enclosed gear reducers and increases.

A. SERVICE RATINGS: Each gear shall have a nameplate service horsepower rating equal to the nameplate rating of the driving motor. Each gear shall have mechanical and thermal capacity equal to, or greater

than an equivalent horsepower determined by multiplying the service horsepower rating by the specified service factor recommended by AGMA for heavy duty service, except each set of worm gears shall have a minimum service factor of 1.20 and all other gears shall have a minimum service factor of 1.50.

B. THERMAL RATING: Obtain thermal rating for the equivalent horsepower without auxiliary cooling equipment such as heat exchangers. Design units to operate continuously for the conditions specified in a location where ambient temperatures vary from 30 to 130°F. If a cooling coil is required, provide minimum 1-inch diameter tubing and a 1-inch solenoid supply water valve with the gear.

C. BEARINGS: Provide anti-friction bearings throughout, designed to give 20,000 hours B100 life for the specified horsepower in continuous operation, of proportions, mounting, and adjustment consistent with acceptable modern practice for applied radial and thrust loads at speeds involved. Provide thrust bearing rates at 1-1/2 times the maximum thrust loadings involved.

D. GEAR NAMEPLATES: Equip each gear with an AGMA nameplate which shows service horsepower, actual service factor for actual mechanical or thermal rating as applicable, and AGMA gear Class I rating.

2.09 ELECTRICAL MOTORS FOR MECHANICAL EQUIPMENT

Conform with applicable requirements of Division 15.

2.10 CONTACTS

For interlock or failure indicating contacts specified to be supplied as part of equipment, provide SPDT switches rated for 120 VAC, 60 Hz at 5 amperes resistive or 3 amperes inductive loading, terminated at screw-type barrier strips in a NEMA 4 enclosure, unless otherwise shown or specified.

2.11 GAUGES

Gauges shall be installed in the suction (where applicable) and discharge piping of each pump. The gauges shall be 3 inch diameter, liquid filled and in accordance with Division 15, Section 15131 and shall include a petcock (Corp stop) between the pump piping and the gauge. For solids bearing or corrosive fluids, a diaphragm gage isolator shall be provided. Suction gauges shall be of the compound type and shall have a range as shown on the Drawings. Discharge gauge ranges shall be a standard commercially available range as shown on the Drawings.

2.12 NAMEPLATES AND DATA PLATES

Provide Type 302, 304, or 316 stainless steel nameplates of ample size with embossed or preprinted lettering, fastened to the equipment in a prominent place with corrosion-resisting pins. On nameplates, display manufacturer, serial number, date of manufacture, model number and essential operating characteristics. Inscribe data plates with specific or directed information.

2.13 PAINTING

Conform to applicable requirements of Section 09871 "Painting and Protective Coatings" and following requirements unless modified or superseded under other Sections.

A. FACTORY PAINTING: On mechanical equipment, drives, starters, control panels and other similar self-contained or enclosed components, apply a factory primer and high-quality oil-resistant baked industrial enamel finish. Paint or otherwise protect surfaces that are inaccessible after assembly by a method which provides protection for the life of the equipment.

B. SHOP PRIMING: Apply one or more shop coats of metal primer on surfaces to be finish painted at the site, coating thickness to protect surfaces until finished. Use primers specified for the required paint system in Section 09871.

C. RUST PREVENTIVE: Coat machined, polished, other ferrous surfaces, and non-ferrous surfaces, which are not to be painted, with rust preventive compound, Dearborn Chemical No-Ox-Id 2W, Houghton Rust Veto 344, Rust-Oleum 4-9, or approved equal.

PART 3 - EXECUTION

3.01 COORDINATION

The Drawings show in a diagrammatic form the arrangements desired for the principle apparatus, piping, and similar appurtenances, and shall be followed as closely as possible. Proper judgment must be exercised in carrying out the Work to secure the best possible headroom and space conditions throughout, to secure neat arrangement of piping, valves, fixtures, hangers, and similar appurtenances, and to overcome local difficulties and interferences of structural conditions wherever encountered.

The Contractor shall take all measurements for his Work at the installation sites, verify all subcontractor drawings and be responsible for the proper installation, within the available space of the apparatus specified and shown on the Drawings, and must secure the approval of the Owner for any variations before making any changes.

Refer to pertinent Sections for items of equipment to be assembled of several components under the unit responsibility of one manufacturer. To coordinate this requirement, the Contractor shall monitor and verify the unit responsibility processes and submit the following information to the Owner in writing on a monthly basis:

1. Shipment dates of the various components to the unit responsibility manufacturers.
2. Scheduled dates of factory tests by unit responsibility manufacturers.
3. Schedule shipment dates to site of unit responsibility items.
4. Scheduled arrival date, installation date and start-up date.

3.02 INSPECTION

Inspect each item of equipment for damage, defects, completeness, and correct operation before installing. Inspect previously installed related Work and verify that it is ready for installation of equipment.

3.03 PREPARATION

Prior to installing equipment, ensure that installation areas are clean and that concrete or masonry operations are completed. Maintain the areas in a broom-clean condition during installation operations. Clean, condition, and service equipment in accordance with the reviewed Instruction Manuals and requirements in other Sections of these Specifications before installing.

3.04 MANUFACTURERS' SUPERVISION AND INSTALLATION CHECK

Each equipment manufacturer shall furnish the services of an authorized representative especially trained and experienced in the installation of his equipment to (1) supervise the equipment installation in accordance with the reviewed Instruction Manual, (2) be present when the equipment is first put into operation, (3) inspect, check, adjust as necessary, and approve the installation, (4) repeat the inspection, checking, and adjusting until all trouble or defects are corrected and the equipment installation and operation are acceptable, (5) witness and supervise operational demonstrations and system validation tests to the extent specified, and (6) prepare and submit the specified Manufacturers' Certified Report. Include all costs for representatives service in the Contract Price.

3.05 INSTALLATION

A. STRUCTURAL FABRICATIONS: Conform to the AISC Code and Specification references in Article "Structural Steel Fabrications".

B. EQUIPMENT: Conform to reviewed Instruction Manuals. Employ skilled craftsmen experienced in installation of the types of equipment specified. Use specialized tools and equipment, such as precision

machinist levels, dial indicators, gages, and micrometers, as applicable. Produce acceptable installations free of vibration or other defects.

C. ANCHOR BOLTS: Deliver bolts with templates or setting drawings and verify that bolts are correctly located before structural concrete is placed.

D. BASE AND BEDPLATE GROUTING: Do not place grout until initial fitting and alignment of connected piping is completed. Level and align equipment on the concrete foundations, then entirely fill the space under base or bedplates with grout. Bevel exposed grout at 45 degree angle, except round exposed grout at horizontal surfaces for drainage. Trowel or point exposed grout to a smooth dense finish and damp cure with burlap for three days. When grout is fully hardened, remove jacking screws and tighten nuts on anchor bolts. Check the installation for alignment and level, and perform approved corrective work as required to conform to the tolerances given in the applicable Instruction Manual.

3.06 FIELD QUALITY CONTROL

A. GENERAL: All costs for performing operational demonstrations and system validation tests shall be included in the Contract Price, and no extra payment will be made to the Contractor due to overtime, weekend, or holiday labor costs required to perform and complete the demonstrations and validation tests. Requirements specified in this Article are in addition to the demonstration and test requirements specified under other Sections of these Specifications.

1. Operational Demonstration and Systems Validation Testing shall be performed by the Contractor in accordance with the approved procedure plans to demonstrate to the Owner's satisfaction that:

   a. All components of the process systems defined herein, the complete systems, and the new plant systems are fully completed and operable.
   b. All units, components, system, and the entire plant systems operate with the efficiency, repeatability, and accuracy indicated and specified.
   c. All components, systems and the entire plant conform to the Contract Documents and the reviewed shop drawings, samples, construction manuals, materials lists, and other reviewed submittals.

2. Scope of Demonstrations and Validation Testing: Operational demonstrations and system validation tests are required for all Work, equipment, and systems specified in these Specifications including all associated and related electrical systems and control devices.

a. Equipment and work to be operationally demonstrated are defined as individual equipment items such as pumps, compressors, mixers, sludge collecting mechanisms, belt press and like equipment items. Demonstrations shall be performed simultaneously on groups of identical equipment items and groups of items supplied by one manufacturer to the extent feasible.
b. Systems to be validation tested are defined as complete systems that perform a discrete process function of the pump station such as chemical systems, pumps, and similar systems. Each system shall include associated structures, tanks, piping, utilities, instrumentation and controls, and like related items. Two or more separate systems shall be validation tested simultaneously when necessary to validate an entire discrete plant function.

3. Prerequisite Conditions: Operational demonstrations and validation testing shall not commence for any equipment item or system until all related structures, piping, electrical, instrumentation, control, and like Work has been installed, tested, and connected in compliance with the pertaining requirements specified elsewhere in the Specifications.

4. Demonstration and Testing Materials: Furnish materials, natural gas and/or electrical power for operational demonstrations and validation tests. Use fresh water to fill tanks, wells, piping, and systems that contain water or wastewater in normal operation. Use the specified chemicals for chemical systems but do not exceed "in service" concentrations. Furnish temporary facilities as required such as by-pass or re-circulation piping, diversions, storage, and similar facilities. Use procedures that conserve testing materials and avoid wastage, especially with respect to large quantities of fresh water and electrical power.

5. Inspection and Supervision by Manufacturers: Perform operational demonstrations and system validation testing under continuous inspection by the Owner. Technical representatives of the various equipment manufacturers shall be present at the start of the operational demonstrations, shall examine their equipment at least twice near the beginning and end of the validation tests, shall supervise the start up and adjustment procedures, and shall perform all other services necessary for the manufacturer's certified reports required herein.

6. Correction of Defects: Immediately correct all defects and malfunctions disclosed by demonstrations and validation tests using approved methods and new materials for repairs as required. Interruption time necessary for corrective work shall be added to the specified total demonstration and validation test periods.

7. Acceptance: Satisfactory completion and approval of required operational demonstrations and system validation testing is one of the conditions precedent to the Owner's acceptance of the Work and does not constitute final acceptance. Refer to the Conditions of the Contract.

B. OPERATIONAL DEMONSTRATIONS: Demonstrate that the performance of installed equipment complies with all requirements indicated and specified. Operate each item through entire no-load to full-load range in accordance with the approved procedure plan for not less than 24 consecutive hours, unless a longer period is specified under other Sections.

C. SYSTEM VALIDATION TESTS: All equipment components of each system shall have successfully completed the required operational demonstration before the system is validation tested. Perform validation testing in accordance with the approved procedure plan.

1. Test Period: Test each system, including standby systems, by continuous operation in "in-service" condition for not less than 48 consecutive hours, with no interruptions except for normal maintenance of corrective Work.

2. Testing Methods: Operate systems continuously 24 hours a day under constant inspection of trained operators. Cycle system operation from full load to light load and back to full load each 24 hours; cause variable speed equipment to cycle through the applicable speed range at a steady rate of change. Induce simulated alarm and distressed operating conditions, and test controls and protective devices for correct operation in adjusting system functions or causing system shutdown.

3. Simulation of Conditions: Subject to Contractor's request and Owner's review in each case, the Contractor may simulate certain operating conditions relating to flow rates, water levels, and malfunctions. Permission for simulations will be granted only where it is unwise or impossible to obtain the conditions covered by the capability of ranges or equipment. The simulation methods shall reflect reasonable anticipated operating conditions.

4. Ranges for Testing:

a. Flow metering Systems shall be tested at not less than 3 values corresponding approximately to a minimum, average and maximum capacity, respectively.
b. Liquid Level Indicating Systems shall be tested at not less than 5 levels corresponding approximately to low, average, normal, maximum and high alarm levels, respectively. Low-low and high-high level alarms and system reaction shall also be tested where equipment or instruments are required to react to such conditions.
c. Remotely Controlled Valves shall demonstrate suitable operation both from local controls and remote controls. As a minimum, these procedures shall include full-open and full-close positioning. Each test shall be repeated not less than 3 times for non-throttling and non-modulating valves. In addition to these minimum requirements, and subject to approval, all throttling valves and modulating valves shall be operated at not less than 3 intermediate positions and shall demonstrate the ability of each valve to hold the set position under operating conditions.
d. Variable Speed Equipment shall demonstrate accurate response to speed controlling devices and controls within the required operating ranges. Actual output shaft speeds of manually adjustable speed equipment shall be validated by measurement of shaft speeds versus speeds shown by equipment instruments.

5. Automatic Response of Equipment: Response of equipment to appropriate manual or automatic controls, or combinations of both automatic and manual controls, shall be demonstrated to be correct and accurate. Where applicable, all components shall be tested for both manual and automatic operation. Where a component performs more than one function, every function shall be validated.

a. Pumping Equipment shall respond accurately and reliably to liquid level and flow rate signals from appurtenant reservoirs, or wet wells. Automatic alternation and back-up pump functions shall also be validated.
b. Auxiliary Equipment Items such as automatic samplers, enunciators, alarms, and like items shall respond accurately and reliably to every condition for which they are programmed, in the manner specified.

D. RECORDING OF DATA: Neat and comprehensive records of each operational demonstration and system validation test shall be maintained by the Contractor. Each portion of the demonstration or validation procedure shall be described with all components itemized. Records shall

be prepared on forms in a step-by-step fashion paralleling the approved plans. Forms shall list for each condition:

a. Step taken;
b. Result anticipated;
c. Result obtained
d. If incorrect, corrective action taken; and
e. Retest result.
f. Steps (d) and (e) shall be repeated until all systems operate as required.

1. Recording Devices: Instruments, gages, and other sensor and display devices forming a part of the various systems shall be employed for data acquisition to the extent applicable. The Contractor shall furnish all other instruments, gages, recorders, and test devices as required, types conforming to the approved procedure plans.
2. Information and Intervals: All applicable data such as, but not limited to, water and other liquid levels, flows, pressures, head differentials, duration of runs, instrument readings, chemical feed rates, voltage settings, drive speeds, motor running currents, torque, voltage, gpm, pressures, clarity, residual chlorine and related information, as applicable, and in accordance with the approved procedure plans, shall be recorded at the start and finish of every operational demonstration and at maximum 8-hour intervals during system validation tests, unless shorter intervals are specified elsewhere.
3. Repetitions: When a repeat of the same demonstration or validation test is required to verify the results, the repeat procedure shall be indicated on the recorded data by numerical indication, date, and time.

3.07 CONSOLIDATION OF DEMONSTRATION, TESTING, AND INSTRUCTION REQUIREMENTS

Operational demonstrations, system validation testing, and instruction of the Owner's personnel may be performed simultaneously, subject to prior approval of the extent of consolidation in each case.

3.08 SOUND LEVEL TESTING AND WORKER PROTECTION

Measure the sound level developed by all mechanical and electrical equipment provided under the Contract Documents. Perform testing in all rooms and spaces containing such equipment during the final operation test program with all equipment operating. Use an OSHA approved instrument and record the highest sound level developed when

measured according to OSHA standards in each room and space. Deliver a copy of records to the Owner.

3.09 IN-SERVICE CHECKS

Refer to Section 01820.

3.10 PUMPS

This article covers general stipulations applicable to the booster pumps. All applicable parts of this Section shall also apply.

A. SHOP TESTING: All shop testing shall be performed by the equipment supplier prior to shipment and the results furnished to the Owner and Owner.

B. FIELD TESTING: Following completion of the installation and satisfactory start-up of the equipment, the Contractor shall provide the services of the pump manufacturer's representative to operate each pumping unit over the entire specified range. The operation, over the entire specified range, shall be free of vibration, noise, or cavitation.

Vibration shall be checked and recorded. The full speed vibration of all pumps shall be equal to or less than the amplitude limits recommended in the Hydraulic Institute Standards.

Each pump performance shall be documented by obtaining concurrent readings showing motor voltage and amperage, pump suction head and pump discharge head. Readings shall be documented for at least three pumping conditions to ascertain the actual pumping curve. One test shall be at shutoff head. Each power lead to the motor shall be checked for proper current balance.

Bearing temperatures shall be determined by a contact type thermometer. A running time of at least two hours shall be maintained at the maximum specified operating head.

In the event any of the pumping equipment fails to meet the above test requirements, it shall be modified and retested in accordance with the requirements of these Specifications.

3.11 EARTHQUAKE DESIGN AND RESTRAINT

All manufacturer equipment supplied under this Contract shall be designed, constructed and attached to resist stresses produced by seismic forces specified in this Section. Equipment that does not vibrate during normal operation shall be rigidly attached.

Equipment that vibrates during normal operation shall be attached by means of isolators with mechanical stops that limit movement in all directions unless it can be demonstrated by calculations that such stops are not required. Equipment or portions of equipment that move during normal operation shall be restrained with mechanical devices that prevent displacement unless it can be demonstrated by calculations that such restraints are not required.

A. WORK INCLUDED: The Work included in this Paragraph includes, but is not limited to, the following equipment items:

1. All pumps and motors
2. Pipe supports and hangers
3. Electrical Control Panels

B. MINIMUM EARTHQUAKE FORCES: The minimum earthquake forces shall be those prescribed for Essential Facilities by the Uniform Building Code and applicable supplements as published by the International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601 or as specified in the "Soil Investigation Report", whichever is greater.

Contractor shall make submittals of shop drawings, details and data hereinbefore specified in the Special Requirements.

END OF SECTION 15010

SECTION 15041

DISINFECTION OF PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

This section includes materials and procedures for disinfection of water mains by the continuous feed method and by the swabbing method. Disinfect piping in accordance with AWWA C651 as modified below.

1.02 RELATED WORK DESCRIBED ELSEWHERE

A. Section 15044 Pressure Testing of Piping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. American Water Works Association (AWWA).
   1. AWWA B301 Standard for Liquid Chlorine.
   2. AWWA C651 Disinfecting Water Mains.

1.04 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01340.

B. Submit plan for disinfection method and procedure, including equipment to be used, gauges and/or scales to measure the rate at which chlorine is injected, qualifications of the personnel performing the disinfection, chlorine injection, testing locations, testing schedule, source of potable water, and water disposal locations. Personnel performing the disinfection shall demonstrate a minimum of five (5) years experience in the chlorine and dechlorination of water pipelines of the size and type specified, or comparable.

C. Qualifications of organization performing the disinfection.

1.05 JOB CONDITIONS

A. Discharge of chlorinated water into watercourses or surface waters is regulated by the California Regional Water Quality Control Board, San Diego Region, under the National Pollutant Discharge Elimination System (NPDES). Schedule and coordinate rates of flow and locations of discharge of disinfection and flushing water with the Engineer and cognizant state and local regulatory agencies to ensure compliance with all applicable rules and regulations.

B. Use potable water for chlorination.

C. Submit request for use of water from waterlines of City two (2) working days in advance.

PART 2 - MATERIALS

2.01 LIQUID CHLORINE
Liquid chlorine shall conform to AWWA B301.

2.02 CHLORINE RESIDUAL TEST KIT
For measuring chlorine concentration, supply and use a medium range, drop count, titration kit or an orthotolidine indicator comparator with wide range color discs. Range to match chlorine concentration limits. products: Hach Chemical or Hellige. Maintain kits in good working order available for immediate test of residuals at point of sampling. At its option, City may elect to take chlorine residual samples using its own test kits.

PART 3 - EXECUTION

3.01 DISINFECTION
Disinfect the new pipeline coincident with refilling by the continuous feed method, applying a chlorine gas-water mixture with a solution-feed chlorinating device. Disinfect the connections to the existing facilities by the swabbing method prior to refilling the pipeline.

3.02 CONTINUOUS FEED METHOD FOR PIPELINES
Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a maximum concentration of 50 mg/l. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

3.03 DISINFECTION OF VALVES AND APPURTENANCES
During the period that the chlorine solution is in the section of pipeline, open and close valves to obtain a chlorine residual at pipeline appurtenances.

3.04 CONFIRMATION OF RESIDUAL
After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of not less than 25 mg/l exists along the pipeline by sampling at air valves and other points of access.

3.05 BACTERIOLOGIC TESTS
City will collect two samples, deliver to a certified laboratory within six hours of obtaining the samples, and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline after chlorination and refilling.

3.06 REPETITION OF PROCEDURE

If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

3.07 PIPELINE FLUSHING

After confirming the chlorine residual, flush the excess chlorine solution from the pipeline until the chlorine concentration in the water leaving the pipe is within 2.0 mg/l of the replacement water.

3.08 TEST FACILITY REMOVAL

After satisfactory disinfection, replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

END OF SECTION 15041

SECTION 15044

PRESSURE TESTING OF PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

This section specifies the hydrostatic and leakage testing of pressure piping.

A. RELATED WORK NOT INCLUDED IN THIS SECTION:

1. Process Piping and Appurtenances, Section 15060.

1.02 SUBMITTALS

A. Submit Shop Drawings in accordance with Special Requirements.

B. Submit test bulkhead locations and design calculations, pipe attachment details such as temporary vents, valves and drains, and methods to prevent excessive pipe wall stresses.

C. Submit six copies of the test records to the Engineer upon completion of the testing.

1.03 TESTING RECORDS

A. Provide records of each piping installation during the testing. Test records shall include:

1. Date of test.
2. Identification of pipeline, or pipeline section, tested or retested.
3. Identification of pipeline material.
4. Identification of pipe specification.
5. Test fluid.
6. Test pressure.
7. Remarks: Leaks identified (type and location), types of repairs, or corrections made.
8. Certification by Contractor that the leakage rate measured conformed to the specifications.
9. Test duration
10. Allowable losses.
11. Actual losses.

PART 2 - MATERIALS

2.01 VENTS AND DRAINS FOR ABOVE GROUND PIPING

Install vents on the high points of above ground piping, whether shown on the Plans or not. Install drains on low points of above ground piping, whether shown on the Plans or not. Provide a valve at each vent or drain point. Valves shall be 3/4 inch for piping 3 inches and larger and 1/2 inch for piping smaller than 3 inches. Valves shall be all-bronze ball valves, unless otherwise shown on the Plans.

2.02 MANUAL AIR-RELEASE VALVES FOR BURIED PIPING (Not Applicable)

2.03 TEST BULKHEADS (Not Applicable)

2.04 TESTING FLUID

For potable water pipelines, obtain and use only potable water for hydrostatic testing.

2.05 TESTING EQUIPMENT

Provide new, calibrated, 4 inch diameter face pressure gauges and a chart recorder, pipes, bulkheads, pumps, and calibrated meters to perform the hydrostatic testing. Use laboratory calibrated test gauges and meters, which shall be calibrated by a certified laboratory prior to the test. Submit proof of calibration.

PART 3 - EXECUTION

3.01 TESTING PREPARATION

A. Place and anchor pipes before commencing pressure testing.

B. Conduct pressure tests on exposed and above ground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

C. Conduct pressure tests on buried piping after the trench has been completely backfilled.

D. Provide any temporary piping needed to carry the test fluid to the piping that is to be tested. Water shall not be obtained directly through in-line valves---an air gap or approved RP backflow device must be utilized. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping.

E. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing.

3.02 CLEANING

A. In pipelines less than 24 inches in diameter, before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. Maintain a flushing velocity of at least 3 fps for water testing. Flush pipes for the minimum time period as given by the formula below and as required to thoroughly clear the pipeline of dirt and debris.

$$T = \frac{2L}{3}$$

in which:

T = flushing time (seconds)
L = pipe length (feet)

B. In pipes 24 inches or larger in diameter, clear the pipe using high-pressure water jet, sweeping, scrubbing, or equally effective means. All water, sediment, dirt, and foreign material accumulated during this cleaning operation shall be discharged, vacuumed, or otherwise removed from the pipe.

3.03 TESTING AND DISINFECTION SEQUENCE OF POTABLE WATER PIPING

A. Perform required chlorination subsequent to hydrostatic testing, except when pipeline being tested is connected to a potable waterline.

B. Locate and install test bulkheads, valves, connections to existing pipelines, and other appurtenances in a manner to provide an air gap separation between existing potable water pipelines and the pipeline being tested, or provide approved RP backflow device.

3.04 LENGTH OF TEST SECTION FOR BURIED PIPING

3.05 INITIAL PIPELINE FILLING FOR HYDROSTATIC TESTING

Control maximum rate of filling to prevent water velocity in pipeline from exceeding 1 fps. Filling may be facilitated by removing automatic air valves and releasing air manually.

3.06 HYDROSTATIC TESTING OF ABOVE GROUND OR EXPOSED PIPING

Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges. Subject the piping system to the test pressure specified herein. Maintain the test pressure for a minimum of 24 hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained. Air and vacuum valves shall be in place and working in case of pipe failure during testing.

3.07 HYDROSTATIC TESTING OF PIPING

A. Apply and maintain the test pressure by means of a hydraulic force pump.

B. Maintain the test pressure for the following duration by restoring the pressure whenever it falls an amount of 5 psi:

Pipe Diameter (inches)	Hours
30” and less	4

C. Repair and retest any pipes showing leakage.

3.08 TEST PRESSURE

The field hydrostatic test pressure in pounds per square inch shall be 150 psi.

3.09 REPETITION OF TEST

If the actual leakage exceeds the allowable, locate and correct the faulty work and repeat the test at the Contractor's expense. Restore the work and all damage resulting from the leak and its repair. Eliminate visible leakage.

END OF SECTION 15044

SECTION 15060

PROCESS PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

Contractor shall furnish all tools, equipment, materials and supplies, including all labor required for complete installation, testing, and flushing of piping and appurtenances, all as shown on the Drawings and specified herein.

1.02 SCOPE OF WORK

A. WORK INCLUDED IN THIS SECTION: The Work of this Section shall include the furnishing, installation, and testing of pipe, fittings, specials, thrust restraint, and all required appurtenances as shown on the Drawings and as required to make the entire piping system operable.

1.03 CONTRACTOR SUBMITTALS

A. GENERAL: It is the responsibility of the Contractor to route all piping in such a way so as not to interfere with other piping, equipment, instrumentation, electrical work or structures. Pipeline routing shall be in accordance with the Drawings. Minor changes due to differences in equipment size or configuration will be permitted, provided that such changes do not interfere with other work. Any major deviations from the layouts shown on the Drawings shall require review and approval by the Owner.

Shop and erection drawings, together with other required information specified, shall be submitted in accordance with the requirements of Section 01340.

B. CATALOG DATA: Submit manufacturers' catalog data showing material, grade and class for all pipe, fittings, joints and couplings. Detailed catalog and engineering data sheets shall be submitted for all components such as flexible couplings, rubber gaskets and insulating joints. Submit affidavit of compliance for all referenced Standard Specifications.

C. LAYOUT DRAWINGS: Piping shall be installed to adhere to the Contract Drawings. The Contractor shall submit pipe layout drawings for approval by the Engineer.

1. Process Piping Installation Procedures: Installation drawings shall be supplemented with a set of written procedures for performing the field piping installation. The procedures shall cover in detail

the preparation and making of the push-on, mechanical, flanged, welded, caulked, flared, hard-soldered, chemically-welded and screwed joints and couplings; measures to ensure integrity of interior pipe lining and exterior protective coating at all joints and couplings; the method of backing up and sealing the annular spaces in pipe sleeves; and the installation and adjustment of pipe hangers and other supports.

D. TESTING AND DISINFECTION PROCEDURES: Procedures for hydrostatically testing and disinfecting (where specified) the piping, and arrangements for obtaining and disposing of water for the tests, shall be fully described. The equipment for testing shall be itemized. Details of bulkheads, flanges or caps for the hydrostatic testing of the pipe shall be included with the Submittal. The Contractor shall provide all fittings and piping necessary for testing and disinfection. Contractor shall be responsible for obtaining and legally disposing of all test water after completion of testing.

1.04 QUALITY

All piping systems shall be in accordance with these specifications and with the codes and standards specified herein. The codes and standards shall be the latest edition unless a specific year is designated. The completed systems shall meet all requirements of the California Division of Occupational Health and Safety.

1.05 PRODUCT HANDLING, DELIVERY AND STORAGE

A. GENERAL: Pipe shall at all times be handled with equipment designed to prevent damage to the interior or exterior coating of the pipeline. Steel pipe with cement mortar lining or having any other special coating or lining shall only be handled with wide canvas or rubber covered slings. Bare cables, chains hooks, or metal bars shall not be allowed to come in contact with the coating.

B. SHIPPING: When making shipments, all chains, cables and hold-down equipment shall be carefully padded where in contact with the pipe. For steel pipe, when the deformation exceeds one percent of the diameter, each end of the pipe shall be properly braced with approved interior supports or spiders.

C. UNLOADING: Unloading from the trucks shall be done with care using slings as indicated above for steel pipe or appropriate slings and cables for ductile iron pipe. No pipe shall be allowed to fall from trucks. Pipe shall only be unloaded using a crane or forklift.

D. GASKETS: Gaskets shall be stored in containers or wrappers which shall protect the gaskets from ozone and other atmospheric deterioration.

PART 2 - PRODUCTS

2.01 GENERAL

A. GENERAL REQUIREMENTS: All pipe fittings, couplings and appurtenant items shall be new, free from defects or contamination and be the standard product of the manufacturer. They shall be furnished in pressure classes as specified or shown. All valves shall be provided as shown on the Drawings, schedules and as specified herein. Where not otherwise designated, the valves shall have pressure rating not less than the adjacent piping. All assemblies of valves, operators and accessories shall be complete and adequate for the intended purpose and shall include all essential components of equipment together with all mountings and other appurtenances normal and necessary for proper installation whether shown or not.

B. PIPE SCHEDULE: Pipe materials shall conform to the type and class as shown on the Contract Drawings.

2.02 POLYVINYL CHLORIDE PIPE (PVC)

A. GENERAL: Compounds for pipe and fittings shall conform to Cell Class 12454-A or 12454-B as defined by ASTM D-1784 unless otherwise noted.

B. SCHEDULE RATED PIPE:

1. Pipe: PVC pipe shall be of unplasticized compounds suitable for use with chemicals and potable water as shown on the Drawings. Pipe shall conform to ASTM D01785. Refer to Pipe Material Schedule herein for pipe schedule.
2. Fittings: Fittings shall be socket type or Schedule 80 threaded type. Conform to ASTM D-2466 (Schedule 40) or D-2467 (Schedule 80) for socket type fittings or to ASTM D02464 for threaded fittings.
3. Flanges: Flanges, where shown, shall be 150 pound, flat-face. The outside diameter and drilling shall match ANSI B 16.5, Class 150.
4. Solvent Cement: Conform to ASTM D-2564.
5. Gaskets: Neoprene full-faced gaskets 1/8 inch thick of 45 to 60 durometer ("A" scale) hardness; excepting that for chlorine solution service use natural rubber 1/8 inch thick of 75 $\pm$ 5) durometer ("A" scale) hardness.
6. Bolts: Bolts for use with flanges shall be corrosion-resisting steel conforming to ASTM A-276, Type 316.

2.03 DUCTILE IRON PIPE (DIP)

A. PIPE AND SPECIALS: Unless otherwise specified elsewhere, ductile iron pipe shall be minimum thickness Class 53 and shall conform to the requirements of AWWA C150 and C151. Unless otherwise shown on the Drawings, the pipe shall be of a restrained, rubber gasketed push-on joint design per AWWA C111 with the rubber gasket forming the sole element relied upon to form a watertight seal.

B. FITTINGS: Fittings shall conform to the requirements of AWWA C110 and C153.

C. PIPE JOINTS: Pipe joints shall be as specified in the pipe schedule except that joints shall be flanged at valves, appurtenances with flanged bodies and at dead ends.

1. Rubber Gasket Push On Joint shall conform to AWWA C111.
2. Mechanical Joints shall conform to AWWA C111.
3. Flange Joints shall conform to AWWA C110.
4. Restrained Joints shall be the same as U.S. Pipe and Foundry - LOK-type, American Cast Iron Pipe - LOK-FAST or approved equal.

D. PIPE LINING AND COATING: All ductile iron pipe and fitting shall be cement mortar lined with a minimum thickness of 1/8” with Type V cement per ANSI A21.4. Pipe shall be encased in polyethylene meeting the requirements of AWWA C105. Contractor to provide polyethylene wrap.

2.04 MILL STEEL PIPE (MSP)

A. GENERAL: The Contractor shall furnish and install mill type carbon steel pipe and fittings as shown on the Drawings and as specified herein. Refer to the Pipe Schedule for pipe diameter, pipe schedule, lining and coating.

B. PIPE MATERIALS:

1. All mill steel pipe shall conform to ASTM A-53, type S or E, grade B.
2. All pipe and fitting connections 4 inches and larger shall be flanged, welded or mechanically coupled as shown on the Drawings, unless otherwise specified in the Pipe Schedule.
3. All pipe 3" and smaller shall have screwed fittings and connections.

C. FITTINGS:

1. All pipe fittings shall be the same schedule weight as the adjoining pipe. Where two adjoining pipes are of a different schedule, the fitting shall have the same schedule as the highest adjoining pipe schedule.
2. All pipe fittings 4 inches and larger shall conform to ASTM A234, grade WPB.
3. All pipe fittings 3 inches and smaller shall be class 150 malleable iron fittings per ANSI B16.3.
4. Small branch outlet connections on piping 4" and larger shall be made by Thred-O-lets. Fittings shall comply with ANSI B16.9.

D. CONNECTIONS AND JOINTS:

1. Mechanical Couplings: Pipe ends for mechanical couplings shall be square cut or beveled with all burrs removed. All outside surfaces of the pipe ends shall be free of indentations, projections or roll marks. Pipe ends for mechanical couplings shall have tolerances within the limits required by the coupling manufacturer.
2. Field Welded Joints: Both ends of the pipe section shall be plain, square cut and edge burrs shall be removed. Pipe with a wall thickness 15/64 inch and greater shall have both ends of the pipe beveled. Bevels shall have an angle of 30 degrees, with a maximum plus tolerance of 5 degrees and no minus tolerance. The width of the throat face at the end of the pipe shall be 1/16 inch plus/minus 1/32 inch.
3. Joint Compound (screwed joints) shall be Teflon ribbon dope thread sealant, Anchor Style 1175, Permacel, Rectorseal 5, or approved equal.
4. Screwed connection threads shall conform to ANSI B2.1.
5. Flange Connections:
    a. Steel pipe flanges shall conform to ASTM A105. Flanges shall be either weld neck or slip-on type. Slip-on type flanges shall be attached to the pipe or fitting by the means of two fillet welds in accordance with Section 4 of AWWA C207. Flange diameters and drillings shall match the adjoining flange of the valve or equipment. Flange faces shall be machined flat and shall have a serrated finish at connections to valves and equipment. Refer to General Requirements 2.01.B for instrumentation flanges.
    b. Gaskets for flanged joints shall be 1/16-inch thick compressed non-asbestos sheet, and shall be of a quality equal to Garlock Blue-Gard 3000 or Anchor Green Klinger C4401. (Refer to Section 15081)

c. Bolts and nuts for non-buried service shall be carbon steel conforming to ASTM A307 Grade B. Bolts and nuts for buried SERICE SHALL BE COATED PER Section 09871 using protective coating system P6. Bolts and nuts for immersed or intermittently immersed shall be 316 stainless steel conforming to ASTM A276.
d. Flat face flanges shall not mate with raised face flanges. The Contractor shall be responsible for ensuring flange faces are compatible (ie. Flat face/Flat face or raised face/raised face)

E. INTERIOR COATINGS: Pipe and fittings shall be lined as specified below and as indicated in the Pipe Schedule.

1. Type III lining shall be epoxy lined per system P11 or P12, Section 09871.

F. EXTERIOR COATINGS:

1. Non Buried Pipe: All non-buried, immersed or intermittently immersed pipe and fittings shall be coated in accordance with Section 09871, "Coating Systems for Water Pumping Plants".
2. Buried Pipe:

a. Type A coating shall be a coal tar enamel with a fibrous glass mat felt wrap in accordance with AWWA C203. The coal tar enamel shall be Type II with a Type B primer. The finish coat shall be a white wash layer of Kraft paper. All joints, flanges and couplings shall be coated in accordance with AWWA C203.

2.05 MECHANICAL COUPLINGS

A. GROOVED END COUPLINGS: Mechanical couplings shall be shouldered type conforming to AWWA C606. Coupling shall engage and lock the shouldered pipe ends allowing some degree of contraction, expansion, and angular deflection. Coupling housing shall be of ductile iron or malleable iron and shall consist of two or more segments held securely together by at least two steel bolts. Sealing gasket shall be of such design that internal pressure in the pipe increases the tightness of the seal and shall be of materials suitable for the intended service. The coupling shall have a rated working pressure not less than the pressure rating of the pipe. Gaskets shall be as recommended by the manufacturer for the temperature and service. The couplings shall be Victaulic, Gustin-Bacon or approved equal.

B. FLEXIBLE COUPLINGS: Flexible (sleeve) couplings shall be of the full sleeve type, split sleeve type, or flange adapter type, as shown on the Drawings, specified herein, or as otherwise permitted by the Owner. They shall provide the requisite pipe flexibility without jeopardizing pipe joint integrity due to hydraulic thrust, and shall have the same pressure-rating as the pipe. Couplings shall have all-metal bearing surfaces and shall be provided with appropriate bolts and nuts. Flexible couplings shall be restrained per AWWA M11 unless otherwise indicated.

1. Full Sleeve Type Couplings shall be gasketed, suitable to service temperatures up to 212°F, and for service temperatures greater than 212°F shall be as recommended by the manufacturer, and shall be of a diameter to fit the pipe. Each coupling shall consist of a steel middle ring, 2 steel followers, 2 gaskets, and the necessary steel bolts and nuts to compress the gaskets. The couplings shall be Dresser Style 38, Smith Blair 400 series, or approved equal.
2. Split Sleeve Type Couplings shall consist of one gasket, 2 housing clamps, and 2 bolts and nuts to obtain the flexibility for connecting the piping. Steel shoulders shall be provided and welded to the pipe ends to accommodate the couplings. The couplings shall be Smith Blair, Baker; or approved equal.
3. Flexible Flanged Coupling Adapters shall be of the sleeve type, consisting of steel middle ring, steel followers, gaskets, and steel bolts and nuts to compress the gaskets and restraining rods and collars per AWWA M11. Gaskets shall be suitable for temperatures up to 212°F, and for service temperatures greater than 212° F shall be as recommended by the manufacturer. The couplings shall contain anchor studs or restraining rods (as recommended by the manufacturer) of strength adequate to hold the pipe together under a pull equal to the longitudinal strength of the pipe at a tensile stress of 20,000 psi, and used only when specifically indicated. The flanged coupling adapters shall be Dresser Style 128, Smith Blair 913 series, or approved equal. If restraining rods are used, ease of removal and installation shall be considered and coordinated with the Owner.

2.06 EXPANSION JOINTS

Expansion joints for cast iron, ductile iron, and steel pipe shall be provided as shown on Drawings and in accordance with the manufacturer's recommendation. The expansion joints shall be Dresser Style 63 Type 2, double-end expansion joint, Smith Blair 612 series, or approved equal. The expansion joints shall have a deep packing chamber to provide for full and ample packing space. The followers shall be three-fourths as long as the packing chamber to afford a wide margin of take-up should future re-tightening of the expansion joint be necessary. The expansion joint packing chamber shall be accessible at all times with sufficient room available to pull out the followers and repack the joint.

Standard packing shall consist of alternate split rubber-compound rings for sealing purposes and split jute rings for lubrication and shall be designed to operate at temperatures up to 212 degrees F. Special asbestos-type packings shall be furnished where temperatures exceed 212 degrees F. Expansion joints shall be of welded steel construction.

2.07 PIPE HANGERS AND SUPPORTS

The Contractor shall provide pipe hangers, brackets, saddles, clamps, and other supports as necessary to support all dead load, live load, and dynamic load experienced by the piping and appurtenances. Pipe supports conforming to these requirements shall be supplied whether or not shown on the Drawings. Supports shall be provided at, but not limited to, points of change in direction, both sides of flexible joints, dead ends and maximum spacing as defined by this specification. Pipe hangers, brackets, saddles, clamps, and other supports shall be adjustable type conforming to the requirements of ANSI B31.1, Section 6; and shall be shop primed, including all bolts, nuts, and threaded parts. Where not specifically identified or called out on the Drawings, computations showing adequacy of Contractor selected hangers and supports to meet these requirements shall be submitted. The Contractor shall determine the required number and location of hangers before the support or roof system is installed. Hangers and supports so identified on the Drawings do not relieve the Contractor from meeting all requirements specified herein. Wherever possible, brackets shall be used in lieu of hangers.

A. GENERAL: Hangers and supports shall include all hanging and supporting devices of metallic construction shown, specified, or required for pipe lines, apparatus, and equipment other than electrical equipment. The contractor's working drawings, as required herein, shall show quantity, type, design, and location of all hangers and supports required under the various Contract items. Hangers and supports shall be painted the same as required for the supported piping.

   1. Where specified or shown, bolts, stud bolts, rods, yokes, and nuts of hangers and supports shall be of steel. Bolts shall not be less than 1/2 inch diameter unless otherwise called for on the Drawings.
   2. Except where otherwise shown, specified, or required, hangers, supports, anchors and concrete inserts shall be the standard types as manufactured by Crane Co., Grinnell Co., Cooper B-Line, or approved equal, meeting the requirements specified herein. Unless otherwise approved by the Owner all hangers, supports, and concrete inserts shall be listed with the Underwriters' Laboratory.

B. DESIGN: Hangers and supports shall be adequate to maintain the pipe lines, apparatus, and equipment in proper position and alignment under all operating conditions and have springs where necessary. Hangers and

supports shall be of standard design where possible, and be best suited for the service required. Where required, they shall be screw adjustable after installation. Supporting devices shall be designed in accordance with the best practice. Sufficient hangers and supports shall be installed to provide a working safety factor of not less than 4 for each hanger, assuming that the hanger is supporting 12 feet of pipe filled with water. On pipes 3 inches in diameter and larger which are covered with heating insulation, hangers and supports shall include proper pipe protection saddles. Hangers and supports shall be designed to resist seismic loading as defined by the UBC.

1. Hangers and supports shall be designed and selected in accordance with MSS Standard Practices: SP-58, Pipe Hangers and Supports - Materials and Design; and SP-69, Pipe Hangers and Supports - Selection and Application.

C. SUPPORTS FOR FRP AND PVC PIPING: Rigid plastic piping normally shall be supported by the same type of hangers used with steel pipe, except that in no instance shall C-clamp, or other point-bearing supports be allowed. Riser clamps, if required, shall be full-circumferential type only. Support spacing shall be based on the plastic pipe manufacturer's recommendations for the service conditions, but not more than 5 feet on center. Flexible plastic tubing or rigid plastic pipe operating at temperatures high enough to materially lower its strength, shall be supported continuously by light metallic angles or channels and special hangers.

D. SADDLE STANDS: Saddle stands shall be of adjustable type. Each stand shall consist of a length of 1 1/4" standard weight pipe fitted at the base with a 6"x6"x3/8" steel plate welded on and at the top with saddle contoured to the size of supported object and welded to a 1 1/4"-12 zinc plated fine thread rod with two jamb nuts as shown on the Drawings. Stanchions shall be of similar construction to the saddle stand, except that they shall be fitted at the top with cast iron pipe saddle supports or with pipe stanchion saddles with yokes and nuts. Where adjustable supporting devices are not required, pipe lines 3" in diameter and smaller may be supported on Owner approved cast iron, malleable iron, or wrought steel hooks, hook plates, ring or ring plates.

E. ANCHORS: Anchors shall be furnished and installed where specified, shown, or required for holding the pipe lines and equipment in position or alignment. Anchors shall be designed for rigid fastening to the structures, either directly or through brackets. The design of all anchors shall be subject to review by the Engineer.

1. Anchors for piping shall be of the cast iron chair type with wrought steel strap, except where anchors form an integral part of pipe fittings or where an anchor of special design is required.

F. INSERTS: Inserts for concrete shall be furnished galvanized and shall be installed in the concrete structures where required for fastening supporting devices. They shall be designed to permit the rods to be adjusted horizontally in one plane and to lock the rod nut or head automatically. Nail slots shall be provided in the exposed flanges of the insert. Inserts shall be designed to carry safely the maximum load that can be imposed by the rod which they engage.

G. MATERIALS: No use shall be made of wire, straps, chains, etc., for supporting piping, nor shall cast expansion shields be used for anchoring bolts. Hangers and supports of metallic construction shall conform to the requirements specified herein and to the following standards:

1.	Structural Steel	ASTM A36 and A283
2.	Steel bars (grade 1022)	ASTM A107
3.	Steel castings (grade N-1)	ASTM A27
4.	Iron castings (grade 35)	ASTM A42
5.	Cast iron pipe fittings	(class 125)
6.	Malleable iron castings	ASTM A47
7.	Bolting materials, steel	
	a. Bolts, yokes and stud bolts	ASTM A307
	b. Nuts	ASTM A536
	c. Physical requirements:	
	(1) Tensile strength	60,000-72,000 psi*
	(2) Yield strength	38,000-50,000 psi
	(3) Elongation	27 percent maximum
	(4) Reduction of area	35-55 percent
	*unless otherwise specified	
8.	Bolting materials, silicon bronze	
	a. Bolts, stud bolts, yokes and nuts (alloy A)	ASTM B98
	b. Physical requirements:	
	(1) Tensile strength	70,000 psi minimum
	(2) Yield strength	38,000 psi minimum
	(3) Elongation	17 percent maximum
9.	Bolting materials, stainless steel	
	a. Bolts, stud bolts and nuts (type 316)	ASTM A276
	b. Physical requirements:	
	(1) Tensile strength	75,000 psi minimum
	(2) Yield strength	30,000 psi minimum
	(3) Elongation	35 percent maximum

(4) Reduction of area 45 percent maximum

10. Where specified or shown, bolts, stud bolts, rods, yokes and nuts of hangers and supports shall be of silicon bronze or stainless steel as specified above with dimensions, threads and sizes equivalent to those specified in steel. Where submerged in process fluids or where located in covered manholes, bolts, stud bolts, rods, yokes and nuts of hangers and supports shall be of silicon bronze, unless otherwise noted.

H. SUPPORTS FOR PIPING: Brackets for support of piping from walls and columns shall be made of welded wrought steel and shall be designed for three maximum loads classified as follows:

1. Light _____ 750 pounds
2. Medium _____ 1,500 pounds
3. Heavy _____ 3,000 pounds

When medium or heavy brackets are bolted to walls, back plates of adequate size and thickness shall be furnished and installed to distribute the load against the wall. When used on concrete walls, the back plates shall be cast in the concrete. Where the use of back plates is not practicable, the brackets shall be fastened to the wall in such a manner that the safe bearing strength of the wall will not be exceeded. Pipe rolls or chairs shall be of the cast iron type. Pipe rolls shall be provided with threaded rods.

I. SPACING OF SUPPORTS/HANGERS: Pipe support spacing requirement are indicated on the Drawings or elsewhere in these Specifications, but in no case shall the spacing of hangers exceed the following:

MAXIMUM UNSUPPORTED PIPE SPAN (FEET)

Normal Pipe Size-Inches	Iron	Steel	PVC	FRP
1/2	-	5	3	-
3/4	-	6	4	-
1	-	7	4	3
1-1/4	-	7	4	-
1-1/2	-	9	5	4
2	-	10	6	5.25
2-1/2	-	11	6	-
3	-	12	6	7.5
3-1/2	-	13	7	-
4	8	14	7	8.5

J. Where concentrations of valves, fittings, and equipment occur, closer spacing of supports shall be required. In no case shall any total hanger load (weight of piping, insulation, and contents) exceed the following (load carrying capacities for hot rolled steel rod ASTM A107-61T):

Nominal Diameter-Inches	Maximum Safe Load-Pounds
1/2	1,130
5/8	1,810
3/4	2,710
7/8	3,770
1	4,960
1-1/8	6,230
1-1/4	8,000
1-3/8	9,470
1-1/2	11,630

K. SUPPORT OF VERTICAL PIPES: Where vertical pipe runs exceed 15 feet, and a support system is not indicated on the Drawings, provide carbon steel riser clamps for support and steadying of the pipe. Where possible, riser clamps shall be fitted and bolted below a coupling, flange, or hub. Maximum spacing of clamps shall be 15 feet.

L. PROTECTIVE COATINGS: All pipe brackets shall be coated in accordance with Section 09871 before fabrication. The brackets shall receive one finish coat after erection.

2.08 INSULATION FITTINGS

Insulation fittings shall be used wherever dissimilar metals are jointed. Insulation couplings, flanges, fittings, and unions shall be the products of F.H. Maloney Company, Cor Ban Products Company, Central Plastics, or equal. Fittings utilizing insulating bushings shall not be used.

PART 3 - EXECUTION

3.01 GENERAL

A. STORAGE AND HANDLING: During fabrication, storage, handling, and transporting, every precaution shall be taken to prevent damage to pipe. Pipe shall be handled only by means of cable slings (on bare steel pipe), by means of fabric slings (on coated pipe), or other methods approved by the pipe manufacturer for the pipe used. Mortar lined pipe shall be kept sufficiently moist to prevent drying out of the mortar lining prior to installation. All steel pipe over 14 inch size shall be fitted after

fabrication with internal bracing and stulls at both ends as a protective measure against deformation and injury to mortar lining. Pipe slings used during handling, and tie-down straps during transit shall be not less than 4 inch wide flat fiber or plastic straps. During storage and in transit, pipe 8 inches and larger shall be rested on saddles or on another support system approved by the pipe manufacturer, which shall ensure freedom from damage of the barrel, interior lining, and exterior coating. Not less than three (3) saddles or other longitudinal pipe supports shall be used during transit.

B. VERIFICATION OF DIMENSIONS: All dimensions essential to the correct location of the pipe, or fit of piping at equipment and valves, or to the proper location and orientation of pipe sleeves and wall castings, or to the avoidance of obstructions or conflict with other improvements, shall be accurately determined by the Contractor prior to fabrication of the piping involved. Any required change from the locations shown on the Drawings shall be indicated by the Contractor and submitted to the Engineer for review.

C. WELDING:

1. All welding operators shall be qualified under the Standard Qualification procedure of the American Welding Society (AWS). All welds shall be made by an electric shielded arc method of welding. Field welding of all joints shall be in conformance with AWWA C206.
2. The Owner shall have the right at any time to call for and witness the making of test specimens by any welder in accordance with these Specifications, and the expense of such tests shall be borne by the contractor.
3. Welds considered by the Owner to be deficient quality, or made contrary to any mandatory provision of these Specifications, shall be removed throughout its depth to expose clean base metal, but in case of a strictly local deficiency, the weld need not be removed throughout its entire length, provided that sufficient amount shall be removed to ensure that sound weld metal, only, remains. A cracked weld shall be removed throughout its length.
4. Certification of the welder's qualifications shall be submitted at the Owner's request.

D. CHANGES IN LINE AND GRADE: In the event that obstructions not shown on the Drawings are encountered during the progress of the Work which will require alterations to the Drawings, the Owner shall have the authority to change the Drawings and order the necessary deviation from the line or grade. The Contractor shall not make any deviation from the specified line or grade without the direction of the Owner. Should any

deviations in line or grade be permitted by the Owner in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, all additional costs for thrust blocks, valves, blowoff assemblies, extra pipe footage or other additional costs shall be borne by the Contractor.

3.02 INSTALLATION

A. GENERAL: The following requirements apply to the installation of all types of pipe unless more stringent requirements are specified. Prior to installation, the interior of all piping, fittings, and appurtenances shall be thoroughly cleaned of scale, dirt, and foreign substances, and effective means shall be taken to prevent the entrance of foreign matter during progress of the Work. The surfaces of exposed piping shall be kept free of marks and blemishes which cannot be removed to provide the finish required for a satisfactory appearance when painted or coated. Special care shall be taken to avoid abrasion of stainless steel.

1. Pipe, valves, and appurtenances shall be installed by mechanics skilled in the trade and in a thorough workmanlike manner following the best modern practice in pipe fabrication and installation. Fabricating, assembling, and installing of piping shall be in accordance with recognized codes of standard practice insofar as applicable, and the requirements of the pipe manufacturer unless otherwise specified. Pipe shall be installed accurately to the specified alignment and grade and to the satisfaction of the Owner. The routing of piping which is dimensioned on the Drawings may be changed only with the review of the Engineer.
2. In erecting the pipe, a sufficient number of screw unions, flanged joints, or mechanical couplings shall be used to allow any section or run of pipe or equipment to be disconnected without taking down adjacent runs. Screw unions shall be employed on pipelines 3 inches in diameter and under. Flanged joints or mechanical couplings shall be employed on pipe 4 inches in diameter or larger unless otherwise shown on the Drawings. Dielectric unions shall be installed at the junction of dissimilar metals.
3. Piping to be encased in concrete shall be securely held in place to prevent any change of position during placing of reinforcement steel and concrete. Care shall be taken to prevent damage to the pipe during placing operations. All joints shall be checked and tested before encasement. Where insulated flanges are to be installed in encased pipe, the reinforcement shall not touch the pipe or the flanges.
4. Excepting where the profiles of underground lines are shown, or elevations given, they shall be installed with cover adequate to

resist construction loads, but in no case shall the cover be less than 2 feet without concrete encasement.

5. Underground pipe shall be installed with the pipe in full contact with the subgrade excepting where concrete encasement is required.
6. Piping shall be adequately supported with hangers, clamps, supports, or other devices of appropriate design, and as specified herein. Where details are shown on the Drawings or specified herein, the supports shall conform thereto and shall be placed as indicated. System shall be adequately supported where details are not provided.
7. Holes blocked out in the concrete for piping shall not be permitted except where shown on the Drawings or reviewed by the Owner.
8. Welding of steel flanges in the fabrication of pipe assemblies shall conform to the applicable requirements of this Specification. Flanges shall be properly aligned and welded at right angles to the pipe axis. No steel bars or any hard wedging material shall be used to overcome large forces due to misalignment. Flange bolts shall be loaded evenly to eliminate unnecessary stresses. After a period of 24 hours, the bolts shall be checked to make sure that they are tight. Should flanged joints with rubber gaskets be over tightened and rubber flow occur, the gasket shall be replaced. Contact surfaces of carbon steel flanges where gaskets are required, studs for flange bolting, except stainless steel, bolts for sleeve-type couplings, and all epoxy coated pipe ends to be jointed by sleeve-type couplings, shall be coated with an approved antisieze compound immediately prior to assembly.
9. American National taper pipe threads shall be used on all threaded joints. Joint compound shall be applied to the male threads only, unless otherwise directed.
10. Anchorage lugs or restrained joints shall be provided where there is a possibility of joint pulling under pressure. Concrete thrust blocks per Standard Drawings may be used in lieu of the above where pipe is installed below ground unless otherwise called out on the Drawings.
11. Where pipes pass through walls or slabs, care shall be exercised to ensure joints being watertight. The pipe shall have an attached water stop and be free of all dirt and grease to secure a tight bond with the concrete. This shall apply to all walls and slabs.
12. Provide all necessary connections for instrumentation. Coordinate with the Instrumentation Subcontractor and with equipment suppliers for location of instruments

B. BURIED PIPING:

1. Pipe Installation:

a. Trenching, bedding and backfilling shall conform to the requirements of Division 2.
b. In general, the Work shall conform to the following sections of AWWA Standard C600:
   - Section 2, "Inspection, Receiving, Handling and Storage;
   - Section 3.1, "Alignment and Grade";
   - Section 3.3, "Pipe Installation";
   - Section 3.4, "Joint Assembly";
   - Section 3.6, "Valve and Fitting Installation";
   - Section 3.8, "Thrust Restraint";
c. The piping shall be placed when trench and weather conditions are suitable. No pipe shall be laid in water, and responsibility for the diversion of drainage and dewatering of trenches during construction shall be borne by the Contractor. In no case shall the lines being installed be used for drains. All pipe in place shall be inspected before completion of backfilling. In all backfilling operations, the Contractor shall be responsible for preventing damage to or misalignment of the pipe.
d. Pipe shall be laid uphill, from structure to structure, with bells upgrade. Pipe shall be bedded, true to line and grade, with uniform bearing for the entire barrel length. All material shall be removed from the interior of the pipe, and the inner surface of bells of collars and the outer surface of spigot ends shall be thoroughly cleaned so that good joints can be made. Pipe sections shall be so laid and fitted together, that when complete, the line will have a smooth and uniform interior.
e. The interior of each pipe, after being laid, shall be thoroughly cleaned.

2. Joint Installation: Installation of joints and couplings for buried piping shall conform to the following requirements:
   a. Joints of all sizes shall conform to the applicable requirements specified hereinafter for buried piping. Care shall be taken to keep pipe in correct alignment when making joints. Friction or lever pullers or other means of ensuring straight pulling shall be used on pipe larger than 8 inches and also on smaller sizes where damage to the end might occur. The "popping-on" of joints shall not be permitted. The fitting of piping to valves, hydrants, and wall castings shall be worked out in advance of installation to ensure correct orientation of the mating ends and bedding of approach piping.
   b. The interior mortar lining of pipe at joints shall be smoothly continuous and of full thickness. Flanges, flange bolts, and other exterior surfaces of restrained joints and flanged couplings shall be given two coats of a coal tar base coating suitable for the purpose. Where coatings of pipe and valves or

appurtenances do not lie in the same plane, the offset shall be filled gradually with a suitable quick setting polymer concrete (such as Waterplug; Hub construction specialties' All-Patch, or the Owner approved equal) to provide a smoothly continuous joint.

c. Mechanical coupling shall be coated with the same coating as the adjacent piping. Cover the coupling with sand prior to trench backfilling.

d. Silver solder shall be used for soldered joints in buried tubing.

3. Thrust Blocks: On all pressure pipelines 4 inch and larger with non-restrained joints, concrete thrust blocks shall be provided at all fittings and dead-ends, and at bends greater than 15 degrees unless otherwise called out on the Drawings. The concrete shall conform to the requirements for 2,500 psi concrete as specified in Section 03300, "Cast-in-Place Concrete," and shall be placed against properly dampened, undisturbed soil, centered on the thrust resultant line. The concrete shall be free of joints, and any mortar contaminating the joints shall be removed.

C. NONBURIED PIPING:

1. Pipe Installation: The horizontal piping shall be run parallel to the building walls and shall be level except where otherwise shown or specified; parallel lines shall be grouped on the same horizontal or vertical plane wherever possible. Vertical piping shall be plumb, and the entire piping configuration shall allow adequate clearances for convenient access for painting and preventive maintenance of valves and equipment. Piping shall clear obstructions, preserve headroom, and keep openings and passageways clear. If structural interference or other conditions prevent the running of pipes or the setting of equipment at the point indicated on the Drawings, the necessary minor deviations required, as directed by the Owner will be allowed, and shall be shown on the erection drawings in accordance with paragraph 1.03C.

2. Joint Installation: Installation of joints and couplings shall conform to the following requirements:

a. Steel Pipe with Welded Fittings shall be made by oxyacetylene or electric arc process in accordance with AWWA Standard C206.

b. Pipe Threads shall be in accordance with the requirements of ANSI B2.1, and shall be cut full and free from torn or ragged surfaces. No more than three threads on the pipe at any joint shall remain exposed after installation. Threaded joints shall be established with Teflon tape applied to the male ends only. The use of thread cement or caulking of threaded joints to stop

or prevent leakage shall not be permitted. Sharp-toothed pipe wrenches or similar wrenches shall not be used in making up copper or brass pipe.

c. Flanged Joints: Flanged joints shall be made with gaskets centered in the joint. Bolts, studs, and nuts shall be lubricated with graphite and oil so that the nuts can be turned by hand. Care shall be taken to prevent excessive initial tension to the bolt and studs and so that the tension applied is as nearly uniform as possible. The rust preventive compound applied to the faces of flanges before shipment shall be removed before installation. Where slip-on flanges are used, they shall be fillet welded to the pipe on both front and back sides in accordance with AWWA C206.

d. Tubing which is to be soldered shall be cut square, and all burrs shall be removed. Both the inside of the fitting and the outside of the tubing shall be well cleaned with steel wool or cloth backed sandpaper before sweating. Care shall be taken to prevent annealing of fittings or hard-drawn tubing when making connections. Joints for soldered fittings shall be made with a non-corrosive, paste flux and solid string or wire solder composed of 40 percent tin and 60 percent lead. Soft solder or cored solder shall not be permitted. Tubing to be coupled with flared compression type fittings.

e. Mechanical Coupling Type Joints of the sleeve, split sleeve, and flanged coupling adapter types shall be made in accordance with the printed instructions of the manufacturer. The pipe ends to receive the couplings shall be finished to the outside diameter and surface finish required by the coupling manufacturer. Prior to assembly, all surfaces which will be accessible after installation shall be given protective coating.

f. Joint Harnesses shall be provided at sleeve type coupling joints. The harnesses shall be tightened just sufficiently to preclude displacement of the downstream piping under hydraulic thrust.

g. Electrical Insulation Joints shall be provided at all connections between dissimilar metals and ferrous and non-ferrous pipe except where the non-ferrous pipe is an electrical non-conductor. The joints shall be tested after completion to verify non-conductivity.

h. Grooved End Couplings: Grooved end couplings shall be used where called out on the Drawings. If the Contractor proposes to use additional grooved end couplings, submit piping drawings in accordance with Part 1.03 showing location of the couplings and supports. Grooved end couplings shall be adequately supported to prevent movement of the pipe.

D. INSTALLATION OF PIPING THROUGH CONCRETE STRUCTURES:

1. Whenever a pipeline or any material terminates or extends at or through a structural wall or sump, the Contractor shall install, in advance of pouring the concrete, a wall sleeve or wall casting as required for the particular installation as shown on the Drawings.
2. Whenever any run of pipe is installed subsequent to placing of the concrete, the Contractor shall accurately position the opening in the concrete for such pipelines. Unless otherwise required, all pipes penetrating fluid containing or earth supporting portions of the structure shall be ring flanged.

    a. The opening shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for packing where pipe passes through wall to ensure watertightness around opening.
    b. The boxes or cores shall be provided with continuous keyways to hold the filling material in place and to ensure a watertight joint.
    c. Boxes or cores shall be filled with non-shrink grout or nonshrink concrete conforming to the following:
    NON-SHRINK CONCRETE: All non-shrink concrete shall contain one (1) pound of Embeco Aggregate per pound of water that is in excess of two gallons per sack of cement.

    NON-SHRINK GROUT: Non-shrink grout shall be made with the following proportions:

    - 1 part Type I Portland Cement (1 bag)
    - 1 part Embeco Aggregate (100 lbs.)
    - 1 part clean, well graded concrete sand (100 lbs.)
    - Approximately 5.5 gallons of water per bag of cement

3. Buried flexible joints shall be installed on all gravity pipe 4" and larger 3 feet from the face of the structure or building footing whether the joint is shown on the Drawings or not. The buried flexible joint shall be installed at the location shown on the plans.
4. Non-buried pipe shall have a removable section, flanged on 4" diameter pipe and larger or screwed union on 3" diameter pipe and smaller in the interior portion of the structure, whenever the pipe exits a structure.

E. PIPE SLEEVES: All piping which will pass through walls, slabs, footings, or beams shall be provided with pipe sleeves with annular space sealed or with wall castings as shown in the Standard Drawings. The Contractor shall provide the wall sleeves and castings for insertion in the concrete work covered in Section 03300, "Cast-in-Place Concrete," and

shall verify their correct setting prior to concrete placement. No pipe joint will be allowed to occur in the sleeve. The seal of both ends of the sleeve shall be flush with the concrete surfaces on completion of work and drying of sealant. Caulking and sealing of wall sleeves shall conform to the following requirements:

1. Preparation for Sealing: The annular space between the pipe and sleeve shall be cleaned of all loose particles and contamination, and shall be dry prior to sealing. polyethylene rod or polyurethane foam shall be used as a filler or joint back-up material. Tape or other recommended protection shall be applied on the structure surfaces to preclude contamination by the sealant, and any contamination which occurs shall be removed immediately, followed by a thorough washing of the surfaces to preclude contamination by the sealant, and any contamination which occurs shall be removed immediately, followed by a thorough washing of the surfaces with solvent. Prepared compound not used during the application time limits designated by the manufacturer of such compound shall be discarded.
2. Application of Compound Sealant: The sealing shall be performed after any required primer has been applied and backup material placed in strict conformance with the sealant manufacturer's written instruction. The application shall be made in clean, straight lines free of wrinkles, be tooled as required and finished with a convex surface just sufficient to provide the required flush surface upon drying. Work shall not be performed when the air temperature is below 50 degrees F.

3.03 POLYVINYL CHLORIDE PIPE

A. GENERAL:

1. Care shall be exercised in handling, loading, unloading, and storing PVC pipe and fittings to avoid distortion, scratches, gouges, dents, and in particular, scuffing of the ends. All plastic pipe and fittings shall be stored under cover in a flat horizontal position, and protected from the sun and the elements until ready for installation. Plastic pipe shall be transported in a vehicle having a bed long enough to provide support for the full length of the pipe. Any length of pipe or fitting that has been damaged or distorted shall be replaced.
2. Expansion joints shall be installed to limit the maximum expansion of the pipe run to 3 inches. Pipe shall not be installed at temperatures below 45°F.
3. All underground PVC piping shall include tracer wire or be marked with a 6 inch wide detectable blue marker tape. This tape shall contain a strip of detectable metal foil or other magnetically

detectable material running the entire length of the tape. The tape shall be placed approximately 18 inches directly above the pipe.

4. Flanged faces shall be thoroughly cleaned of all foreign substances before flanges are connected. Flanges shall be aligned and faces shall be parallel before the joint is made. Extra care shall be taken to load the bolts evenly so as to eliminate unnecessary stresses. A torque wrench shall be used on all PVC or PVC flanged pipe joints and on all PVC to metal flanges pipe joints. The following torque load shall be applied to produce the required 10,000 psi stress in the stainless steel bolts of flanged connections.

Sizes of Bolt (Inches)	Torque in foot-pounds
1/2	10
5/8	22
3/4	40

3.04 COPPER TUBING AND FITTINGS

A. Copper tubing shall be installed in a workmanlike manner. Bends shall be made by the use of fittings or with a bending tool on the proper radius to avoid flattening or kinking the tubing which will be subjected to thermal expansion and construction great enough to cause the line to bow or buckle shall be provided with expansion loops or offsets adequately spaced. Lines shown on the Drawings to be parallel shall be held truly parallel by means of an adequate number of supports. No waviness or sagging of the lines will be permitted. Tubes and fittings shall be cleaned of all impurities before a joint is made.

B. Stainless steel pipe, as specified herein, or standard weight seamless copper pipe conforming to the requirements of ASTM Standard B42, No. 120 or 122, shall be substituted for copper tubing wherever tubing lines are required to pass through concrete.

C. An insulating joint shall be provided whenever junction occurs between ferrous and non-ferrous metallic piping materials.

D. Soldered joints shall be made by mechanics experienced in this class of work. The joint shall be heated so that the heat is uniformly distributed around the entire circumference of the fitting. Heat shall be applied by a gas-air, acetylene-air, or blow torch. The use of an oxyacetylene torch will not be allowed. Excess solder shall be removed while it is still in a plastic state. The joint shall be allowed to cool undisturbed in still air before water is applied. Suitable adapters shall be used for connecting pipe to fittings and valves having threaded ends.

E. For flared fittings, the tube ends shall be flared so that the angle, radius, length, and diameter of the flare conform to the corresponding dimensions of the flare seat of the fitting. The flare shall be square and concentric with the tube and fitting. Flared tube fittings shall be assembled in accordance with the manufacturer's recommendations.

3.05 BRASS TUBING AND FITTING

Installation of brass tubing and fitting shall conform to installation of Copper Tubing and Fittings.

3.06 PROTECTIVE COATINGS

A. NONBURIED AND IMMERSED PIPE: All piping which is defined as; pipe, fittings, joints, couplings, valves and appurtenances shall be coated in accordance with the requirements of Section 09871, "Painting and Protective Coatings" It shall be the Contractor's responsibility to fully coordinate the protective coating requirements with the color code identification requirements to ensure compatibility of materials used. All piping systems shall be color coded in accordance with Section 09871.

B. BURIED PIPE: All pipe, fittings and joints shall be coated as called for on the contract drawings and the individual pipe specifications. All couplings, valves, and appurtenances shall be coated as follows:

- Tnemec System: Two Coats - Tnemec 46-H-413
- ICI Paints: Two Coats – DEVTAR 5A-HS

The total coating thickness shall not be less than 32 mils. Prior to coating, all surfaces shall be prepared in accordance with SSPC-SP2 or SSPC-SP3 (Refer to Section 09871).

3.07 TESTING

The Contractor shall perform hydrostatic, leakage, and operational tests as specified herein. The Contractor shall perform all excavation and other work required to locate and repair leaks and correct other defects which may be disclosed or develop under tests; the Contractor shall replace all coating, painting, backfill, or other permanent work removed in locating or repairing leaks and correcting defective piping. All gages and control devices connected to lines being tested must be disconnected for the duration of the test. Water shall not be used in testing air lines, chlorine lines, nitrogen lines, or other gas carrying pipes. High pressure air testing of PVC pipe in exposed or above ground installations shall not be permitted. The Contractor shall furnish and install a chart type recording meter for the pressure tests. The Contractor shall submit to the Owner before and after the test the gage and meter used so that these devices may be tested by the Owner.

A. TESTING REQUIREMENTS:

1. Testing Procedures: Contractor shall fully describe in writing all procedures for hydrostatically testing the piping and appurtenances, and for obtaining and disposing of water for the tests. The equipment for testing shall be itemized. Details of bulkheads, flanges or caps for the hydrostatic testing of the pipe shall be included with the submittal. The Contractor shall provide all fittings, outlets, temporary air valves and blow offs, and piping necessary for filling, emptying, and testing which are not shown as part of the piping installation. This plan shall be submitted for approval by the Owner at least four (4) weeks prior to testing.
2. Pressure Pipe, Flanged or Welded Joints: PVC with solvent welded, threaded or flanged joints shall be pressure tested as specified in Section 15044. No leakage shall be permitted.

B. PRESSURE TESTS:

1. General: All piping, including valves, shall be field-tested at a hydrostatic pressure of 150% of the pipe pressure class (unless specified otherwise), corrected to the elevations of the test gate, with duration of four hours minimum, for each pressure test, except as otherwise specified. Piping conveying liquids between process tankage, not subject to pumping, shall be tested to the maximum possible pressure that can be obtained under static conditions. Air piping shall be tested using air or nitrogen. Buried pipe shall be tested after backfilling. Contractor shall not pressure test against a closed mainline valve.

3.08 FLUSHING AND DISINFECTION

A. GENERAL: All piping shall be flushed clean of all dirt and foreign material following completion of the hydrostatic and leakage test. Air and gas piping shall be purged with air or inert gas as directed by the Owner.

B. DISINFECTION: Disinfection and testing of the potable water lines shall be performed in accordance with AWWA Standard C651.

END OF SECTION 15060

SECTION 15064

WATER PIPE AND PROCESS PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

Contractor shall furnish all tools, equipment, materials and supplies, including all labor required for complete installation, testing, and flushing of piping and appurtenances, all as shown on the Drawings and specified herein.

1.02 SCOPE OF WORK

A. WORK INCLUDED IN THIS SECTION: The Work of this Section shall include the furnishing, installation, and testing of pipe, fittings, specials, thrust blocks, and all required appurtenances as shown on the Drawings and as required to make the entire piping system operable.

1.03 CONTRACTOR SUBMITTALS

A. GENERAL: It is the responsibility of the Contractor to route all piping in such a way so as not to interfere with other piping, equipment, instrumentation, electrical work or structures. Pipeline routing shall be in accordance with the Drawings. Minor changes due to differences in equipment size or configuration will be permitted, provided that such changes do not interfere with other work. Any major deviations from the layouts shown on the Drawings shall require review and approval by The Owner.

Shop and erection drawings, together with other required information specified, shall be submitted in accordance with the requirements of Section 01340.

B. CATALOG DATA: Submit manufacturers' catalog data showing material, grade and class for all pipe, fittings, joints and couplings. Detailed catalog and engineering data sheets shall be submitted for all components such as flexible couplings, rubber gaskets and insulating joints. Submit affidavit of compliance for all referenced Standard Specifications.

C. LAYOUT DRAWINGS: Piping shall be fabricated to adhere to the Contract Drawings. The Contractor shall submit pipe layout drawings for approval by The Owner.

1. Steel Cylinder Water Pipe: The Owner will allow the manufacturer certain deviations from the planned grades. Layout drawings shall show all proposed deviations in grade and alignment. Departures from line and grade within the following parameters will be permitted in the manufacture of the pipe to allow the use of joint pulls to effect changes of alignment:

    a. Horizontal alignment shall be within 4 inches of the alignment shown on the contract drawings.

    b. In vertical alignment, depth may be reduced 1 inch or increased 4 inches if the following minimum vertical clearances between outside diameters of other facilities are maintained and no additional high or low points are created:

        (1) 1 foot vertical clearance between sewer and water pipelines (water above sewer only option unless an alternate option is specifically approved by State Health Department).

        (2) 0.5 feet vertical clearance between all other facilities except when specifically shown otherwise on the contract drawings.

    Contractor shall furnish and install all necessary cut to fit (C.T.F.), butt strap connections, and etc. as approved on the fabrication drawings. C.T.F.'s and butt strap connections shall be kept to a minimum and used only for maintaining horizontal and vertical alignment in accordance with the above requirements.

    Proposed departures in excess of these limits must be approved by The Owner prior to initiation of layout drawings.

    Computer printouts will be accepted in lieu of layout drawings except for such proposed departures.

2. Fabricated Steel Plate Specials: Fabricated steel plate specials submittals shall be approved prior to fabrication. The dimensions shall conform to AWWA C-208 except as modified herein or as otherwise shown on the plans.

    a. Pipe Outlets: The measurement from the outside of pipe to the face of flange shall be 12" unless otherwise shown.

Outlets shall be designed per AWWA Manual M-11, and design of stiffener plates shall follow the nomograph method.

Pipe outlets shall also be provided for chlorination corp stops, air valve assemblies, services, and other appurtenances required by the contract drawings. Brass plugs shall be provided for installation upon later removal of the chlorination corp stops.

b. Bends:

(1) The radius of bends shall be a minimum of 2 1/2 times the pipe diameter unless specified otherwise.

(2) Bends may be welded to adjacent pipe sections.

(3) Bends shall conform to the following table:

2-piece	0°	-	22° 29'
3-piece	22° 30'	-	44° 59'
4-piece	45°	-	67° 29'
5-piece	67° 30'	-	90°

3. Process Piping Installation Procedures: Installation drawings shall be supplemented with a set of written procedures for performing the field piping installation. The procedures shall cover in detail the preparation and making of the push-on, mechanical, flanged, welded, caulked, flared, hard-soldered, chemically-welded and screwed joints and couplings; measures to ensure integrity of interior pipe lining and exterior protective coating at all joints and couplings; the method of backing up and sealing the annular spaces in pipe sleeves; and the installation and adjustment of pipe hangers and other supports.

D. RUBBER GASKETS: Test results showing the properties of the material used in the rubber gaskets shall be submitted by the Contractor if requested by the Engineer.

E. CALCULATIONS: Manufacturer's calculations of wall thickness for steel pipe and outlet design calculations shall be included in the submittal.

F. COATINGS: A protective coating schedule shall be submitted for each type of pipe. The schedule shall show the type and thickness of all pipe interior and exterior coatings. Coatings on non-buried and submerged piping shall be in accordance with Section 09871.

G. TESTING AND DISINFECTION PROCEDURES: Procedures for hydrostatically testing and disinfecting (where specified) the piping, and arrangements for obtaining and disposing of water for the tests, shall be fully described. The equipment for testing shall be itemized. Details of bulkheads, flanges or caps for the hydrostatic testing of the pipe shall be included with the Submittal. The Contractor shall provide all fittings and piping necessary for testing and disinfection.

1.04 QUALITY

All piping systems shall be in accordance with these specifications and with the codes and standards specified herein. The codes and standards shall be the latest edition unless a specific year is designated. The completed systems shall meet all requirements of the California Division of Occupational Health and Safety.

1.05 PRODUCT HANDLING, DELIVERY AND STORAGE

A. GENERAL: Pipe shall at all times be handled with equipment designed to prevent damage to the interior or exterior coating of the pipeline. Steel pipe with cement mortar lining or having any other special coating or lining shall only be handled with wide canvas or rubber covered slings. Bare cables, chains hooks, or metal bars shall not be allowed to come in contact with the coating.

B. SHIPPING: When making shipments, all chains, cables and hold-down equipment shall be carefully padded where in contact with the pipe. For steel pipe, when the deformation exceeds one percent of the diameter, each end of the pipe shall be properly braced with approved interior supports or spiders.

C. UNLOADING: Unloading from the trucks shall be done with care using slings as indicated above for steel pipe or appropriate slings and cables for ductile iron pipe. No pipe shall be allowed to fall from trucks. Pipe shall only be unloaded using a crane or forklift.

D. GASKETS: Gaskets shall be stored in containers or wrappers which shall protect the gaskets from ozone and other atmospheric deterioration.

PART 2 - PRODUCTS

2.01 GENERAL

A. GENERAL REQUIREMENTS: All pipe fittings, couplings and appurtenant items shall be new, free from defects or contamination and be the standard product of the manufacturer. They shall be furnished in

pressure classes as specified or shown. All valves shall be provided as shown on the Drawings, schedules and as specified herein. Where not otherwise designated, the valves shall have pressure rating not less than the adjacent piping. All assemblies of valves, operators and accessories shall be complete and adequate for the intended purpose and shall include all essential components of equipment together with all mountings and other appurtenances normal and necessary for proper installation whether shown or not.

B. RAISED FACE FLANGES: Carbon steel or stainless steel flanges or flanged valves with raised face shall not be bolted directly to flat faced flanged fittings or valves. The raised face shall be removed or spacers approved by the valve or pipe manufacturer may be installed to allow bearing over 100 percent of the flange area. Some instruments may require raised face flanges. Coordinate and provide raise face flanges as required.

C. PIPE SCHEDULE: Pipe materials shall conform to the type and class as shown on the Contract Drawings.

2.02 FABRICATED STEEL PIPE (FSP)

A. GENERAL: Fabricated steel pipe and fittings shall be manufactured in accordance with AWWA C200, C208, and M-11. Steel shall be ordered with "no minus tolerance".

B. DESIGN REQUIREMENTS:

1. Steel shall be hot rolled low carbon steel plates or sheets conforming to ASTM A283 Grade D, ASTM A516 Grade 60, ASTM A572 Grade 42. Steel plate shall be fully kilned steel to fine graded practice.

2. Steel sheet and coil shall conform to ASTM A570 Grades 33, 36, 40 or 45 or ASTM A635 Grade 1015, 1018 or 1020. Steel coil shall be made of fully kilned steel to fine grain practice.

3. The design pressure shall be as listed on the Contract Drawings. Pipe class shall be 300 psi unless otherwise specified.

4. Cylinder thickness shall be calculated in accordance with AWWA M-11. Allowable stresses shall be in conformance with Item 5 below.

5. At the design pressure listed, the average allowable tensile stress shall not exceed 16,500 psi nor 50 percent of the minimum yield strength of the steel.

6. Buried pipe and fittings, in addition to internal pressure design, shall be designed for a maximum deflection of 2 percent of the internal diameter, considering the trench load plus a H-20 live load.

7. Pipe and fittings 42 inches and smaller shall have a minimum net inside diameter (ID), measured from face of lining to face of lining, equal to the nominal diameter. For pipe without lining, the net inside diameter (ID) shall not be less than the nominal diameter. The permissible tolerance shall be a plus or minus 1/4 inch.

8. Dimensions for collars, wrappers, stiffener plates, and crotch plates, and etc. shall be calculated in accordance with AWWA M-11. Allowable stress shall be in conformance with Item 5 above.

C. PIPE JOINTS:

1. General: Unless otherwise shown on the Drawings, all welded pipe joints shall be lap-welded in accordance with paragraph C.3 herein.

2. Steel for bell and spigot joints shall be hot rolled low carbon steel plate, bar, coil, strip or sheet conforming to paragraphs 2.02.B.1 and 2 above.

3. Bell and Spigot Joints: Bell and spigot joints for piping larger than 24" diameter and having a wall thickness greater than 0.1875", shall be Carnegie type joints. Bell and spigot joints for piping 24" dia. and smaller shall be formed joints either by swaging or rolling end of the steel cylinder. The joint shape shall conform to a rolled-groove rubber gasket joint as shown in AWWA M-11. The nominal thickness of a preformed bell ring shall not be less than the thickness of the steel cylinder to which it is attached. Bells and spigots shall have the same nominal diameter as the pipeline. Rubber gaskets shall conform to AWWA C200.

4. Welded Field Joints shall be lap welded. A bell shall be formed on the cylinder to accommodate the spigot. The spigot insertion shall be a minimum of 1 1/2 inches. Butt strap joints shall be used where indicated on the Plans or as directed by The Owner. For pipe less than 16 inches in diameter, butt straps for butt strap joints

shall be furnished with a 5-inch diameter hand hole, complete with screwed cap or plug, for mortaring the interior of the joint after field installation of the joint. For pipe greater than 16" in diameter, two (2) 5-inch diameter handholes shall be provided. No angular deflection shall be permitted at butt strap joints. All field welding of the pipe shall be in accordance with AWWA C206.

5. Mechanical Couplings: The ends of pipe for mechanical couplings shall be plain grooved, banded or welded slip on type grooved coupling adapter. Weld beads on the exterior of the pipe shall be ground off flush with the pipe for a distance, measured from the end of the pipe, of 1-1/2 times the length of the coupling.

6. Flanged Joints and Gaskets:

   a. Steel flanges shall conform to the requirements of AWWA C207, Class E or F. Flange faces shall be machined flat and have a serrated finish for connection to valves and equipment.

   b. Gaskets for flanged joints shall be 1/16 inch thick compressed non-asbestos sheet, and shall be of a quality equal to Garlock Blue-Gard 3000 or Anchor Green Klinger C4401.

   c. Bolts and nuts for buried or non-buried service shall be carbon steel conforming to ASTM A307 Grade B. Bolts and nuts used for buried service shall be coated per Section 09871 using protective coating system P6. Bolts and nuts for immersed or intermittently immersed installations shall be 316 stainless steel conforming to ASTM A276.

      All assembly bolts shall have hexagonal head conforming to ANSI B18.2.1 for wrench head bolts and nuts. All threads shall be coarse threaded in accordance with ANSI B1.1, Class 2A and 2B.

D. INTERIOR COATINGS: Pipe and fittings shall be lined as specified below and as indicated on the Drawings:

1. Type I lining shall be bare uncoated steel.

2. Type II lining shall be cement mortar lining in accordance with AWWA C205. Type II cement shall be used. The inside of joint recesses shall be lined in accordance with AWWA C205 Appendix A.

3. Type III lining shall be epoxy lining per Section 09871.

E. EXTERIOR COATINGS:

1. Non Buried Pipe: All non-buried, immersed or intermittently immersed pipe and fittings shall be coated in accordance with Section 09871.

2. Buried Pipe:

a. Type A coating shall be coal tar enamel with a fibrous glass mat felt wrap in accordance with AWWA C203. The coal tar enamel shall be Type II with a Type B primer. The finish coat shall be a white wash layer of Kraft paper. All joints, flanges and couplings shall be coated in accordance with AWWA C203.

b. Type B coating shall be reinforced mortar coating in accordance with AWWA C205. Type II cement shall be used. All joints and couplings shall be coated with a cement mortar using a diaper. The diaper shall allow the mortar to flow from one side of the joint, around the bottom and up the opposite side of the joint. The minimum diaper widths shall be:

10" pipe and smaller	9 inch
12" - 18" pipe	10 inch
20" pipe and larger	12 inch

The joint shall be backfilled following completion of the joint. If backfilling is not possible, upon completion of the joint, the joint shall be kept moist and shaded until the mortar has hardened.

c. Type C coating shall be a shop-applied coal tar epoxy in accordance with AWWA C210. All joints, flanges and couplings shall be coated in accordance with AWWA C210.

d. Type D coating shall be a three-part cold applied tape system in accordance with AWWA C214. The primer shall be a rubber and synthetic coating followed by a 20 mil thick minimum interwrap, consisting of a polyethylene backing with a butyl rubber adhesive, and then followed by a 30 mil thick minimum outerwrap, consisting of a

polyethylene backing with abutyl rubber adhesive. The tape coating system shall be suitable for operating temperatures up to 185°F. The tape system shall be Polyken YGIII or approved equal. All joints, flanges and couplings shall be coated in accordance with AWWA C214 and C209. However, the tape materials used shall be suitable for operating temperatures of 185°F.

2.03 MILL STEEL PIPE (MSP)

A. GENERAL: The Contractor shall furnish and install mill type carbon steel pipe and fittings as shown on the Drawings and as specified herein. Refer to the Pipe Schedule for pipe diameter, pipe schedule, lining and coating.

B. PIPE MATERIALS:

1. All mill steel pipe shall conform to ASTM A-53, type S or E, grade B.

2. All pipe and fitting connections 4 inches and larger shall be flanged, welded or mechanically coupled as shown on the Drawings, unless otherwise specified in the Pipe Schedule.

3. All pipe 3" and smaller shall have screwed fittings and connections.

C. FITTINGS:

1. All pipe fittings shall be the same schedule weight as the adjoining pipe.

2. All pipe fittings 4 inches and larger shall conform to ASTM A234, grade WPB.

3. All pipe fittings 3 inches and smaller shall be class 150 malleable iron fittings per ANSI B16.3.

4. Small branch outlet connections on piping 4" and larger shall be made by Thred-O-lets. Fittings shall comply with ANSI B16.9.

D. CONNECTIONS AND JOINTS:

1. Mechanical Couplings: Pipe ends for mechanical couplings shall be square cut or beveled with all burrs removed. All outside surfaces of the pipe ends shall be free of indentations, projections

or roll marks. Pipe ends for mechanical couplings shall have tolerances within the limits required by the coupling manufacturer.

2. Field Welded Joints: Both ends of the pipe section shall be plain, square cut and edge burrs shall be removed. Pipe with a wall thickness 15/64 inch and greater shall have both ends of the pipe beveled. Bevels shall have an angle of 30 degrees, with a maximum plus tolerance of 5 degrees and no minus tolerance. The width of the throat face at the end of the pipe shall be 1/16 inch plus/minus 1/32 inch.

3. Joint Compound (screwed joints) shall be Teflon ribbon dope thread sealant, Anchor Style 1175, Permacel, Rectorseal 5, or approved equal.

4. Screwed connection threads shall conform to ANSI B2.1.

5. Flange Connections:

    a. Steel pipe flanges shall conform to ASTM A105. Flanges shall be either weld neck or slip-on type. Slip-on type flanges shall be attached to the pipe or fitting by the means of two fillet welds in accordance with Section 4 of AWWA C207. Flange diameters and drillings shall match the adjoining flange of the valve or equipment. Flange faces shall be machined flat and shall have a serrated finish at connections to valves and equipment.

    b. Gaskets for flanged joints shall be 1/16-inch thick compressed non-asbestos sheet, and shall be of a quality equal to Garlock Blue-Gard 3000 or Anchor Green Klinger C4401.

    c. Bolts and nuts for buried and non-buried service shall be carbon steel conforming to ASTM A307 Grade B. Bolts and nuts used for buried service shall be coated per Section 09871 using protective coating system P6. Bolts and nuts for immersed or intermittently immersed shall be 316 stainless steel conforming to ASTM A276.

    d. Flat face flanges shall not mate with raised face flanges. (Refer to Section 2.01B). The Contractor shall be responsible for ensuring flange faces are compatible (ie. flat face/flat face or raised face/raised face).

E. INTERIOR COATINGS: Pipe and fittings shall be lined as specified below and as indicated in the Pipe Schedule.

1. Type I lining shall be bare uncoated steel.

2. Type II lining shall be cement mortar lining in accordance with AWWA C205. Type II cement shall be used. The inside of joint recesses shall be lined in accordance with AWWA C205 Appendix A.

3. Type III lining shall be epoxy lined per system P11 or P12, Section 09871.

F. EXTERIOR COATINGS:

1. Non Buried Pipe: All non-buried, immersed or intermittently immersed pipe and fittings shall be coated in accordance with Section 09871, "Painting and Protective Coatings".

2. Buried Pipe:

a. Type A coating shall be a coal tar enamel with a fibrous glass mat felt wrap in accordance with AWWA C203. The coal tar enamel shall be Type II with a Type B primer. The finish coat shall be a white wash layer of Kraft paper. All joints, flanges and couplings shall be coated in accordance with AWWA C203.

b. Type B coating shall be reinforced mortar coating in accordance with AWWA C205. Type II cement shall be used. All joints, flanges and couplings shall be coated with a cement mortar using a diaper. The diaper shall allow the mortar to flow from one side of the joint, around the bottom and up the opposite side of the joint. The minimum diaper widths shall be:

10" pipe and smaller	9 inch
12" - 18" pipe	10 inch
20" pipe and larger	12 inch

The joint shall be backfilled following completion of the joint. If backfilling is not possible, upon completion of the joint, the joint shall be kept moist and shaded until the mortar has hardened.

c. Type C coating shall be a shop-applied epoxy lining per P12 in Section 09871 in accordance with AWWA C210. All joints, flanges and couplings shall be coated in accordance with AWWA C210.

d. Type D coating shall be a three part cold applied tape system in accordance with AWWA C214. The primer shall be a rubber and synthetic coating followed by a 20 mil thick minimum interwrap, consisting of 30 mil thick minimum outerwrap, consisting of a polyethylene backing with abutyl rubber adhesive. The tape coating system shall be suitable for operating temperatures up to 185°F. The tape system shall be suitable for or approved equal. All joints, flanges and couplings shall be coated in accordance with AWWA C214 and C209. However, the tape materials used shall be suitable for operating temperatures of 185°F.

2.04 PRETENSION CONCRETE CYLINDER PIPE (CCP) (NOT APPLICABLE)

2.05 DUCTILE IRON PIPE (DIP)

A. Ductile iron pipe shall conform to ANSI A21.51 (AWWA C151) class to thickness designed per ANSI 21.50 (AWWA C150), Zinc coated and cement mortar lined per ANSI A21.4 (AWWA C104) unless otherwise specified, with bolted mechanical joints or push-on joints as indicated on the plans or special provisions. The minimum laying lengths for DIP shall be 18-feet. Cut sections of pipe (pups) shall not be less than 2 feet in length for pipe diameters 12 inches and smaller and not less than 3 feet for pipe diameters 18 inches and larger. Delivered pipe to include 5% +/- short joints.

B. Ductile iron pipe shall be minimum pressure class 350 for pipe diameters 12-inch and smaller, Class 250 for 18-inch and larger unless indicated differently on the plans.

C. Fittings shall be ductile iron and shall conform to ANSI A21.10 (AWWA C110) or A21.53 (AWWA C153), and ANSI A21.11 (AWWA C111). Fittings shall be bolted mechanical joints or push-on joints unless otherwise indicated on the plans, bid items, or the special provisions. All bends shall use mechanical joints for 18-inch and above. Fittings shall be tar (seal) coated and cement mortar lined per ANSI A21.4 (AWWA C104).

D. All ductile iron pipe and fittings shall be encased with V-Bio enhanced polyethylene at the time of installation. Polyethylene encasement and installation shall be in accordance with ANSI/AWWA C105.

Polyethylene encasement shall consist of three layers of co-extruded linear low density polyethylene, fused into a single thickness of not less than 8 mils. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of anti-microbial compound to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

2.06 POLYVINYL CHLORIDE PIPE (PVC)

A. GENERAL: Compounds for pipe and fittings shall conform to Cell Class 12454-A or 12454-B as defined by ASTM D 1784 unless otherwise noted.

B. SCHEDULE RATED PIPE:

1. Pipe: PVC pipe shall be of unplasticized compounds suitable for use with chemicals and sewage as shown on the Drawings. Pipe shall conform to ASTM D01785. Refer to Pipe Material Schedule herein for pipe schedule.

2. Fittings: Fittings shall be socket type or Schedule 80 threaded type. Conform to ASTM D-2466 (Schedule 40) or D-2467 (Schedule 80) for socket type fittings or to ASTM D02464 for threaded fittings.

3. Flanges: Flanges, where shown, shall be 150 pound, flat-face. The outside diameter and drilling shall match ANSI B 16.5, Class 150.

4. Solvent Cement: Conform to ASTM D-2564.

5. Gaskets: Neoprene full-faced gaskets 1/8 inch thick of 45 to 60 durometer ("A" scale) hardness; excepting that for chlorine solution service use natural rubber 1/8 inch thick of 75 $\pm$ 5) durometer ("A" scale) hardness.

6. Bolts: Bolts for use with flanges shall be corrosion-resisting steel conforming to ASTM A-276, Type 316.

C. CLASS RATED PIPE:

1. Pipe: Conform to AWWA C-900 or C-905. The outside diameter (OD) dimensions shall be cast-iron equivalent. The pipe pressure class shall be as indicated on the Drawings, and shall be 150 psi minimum.

2. Pipe Couplings: Couplings shall be push-on gasketed type as specified in AWWA C-900. The gaskets shall conform to ASTM F-477.

3. Fittings: Fittings shall be mechanical joint DIP fittings conforming to AWWA C110. Fittings shall be cement mortar lined with Type II cement in accordance with AWWA C104. Exterior coatings for fittings shall be a coal tar enamel with a fibrous glass mat and asbestos felt wrap in accordance with AWWA C203. The coal tar enamel shall be Type II with a Type B primer. The finish coat shall be a white wash layer of Kraft paper. The rubber gaskets for the mechanical joints shall conform to AWWA C111.

4. Bolts: Bolts for use with flanges shall be stainless steel conforming to ASTM A-276, Type 316.

D. GRAVITY PIPE (SEWER OR DRAIN PIPE) - 15 INCHES AND SMALLER:

1. Pipe and Fittings: Conform to ASTM D-3034. The minimum SDR shall be 35.

2. Joints shall be integral bell gasketed joints as specified in ASTM D-3034. The gaskets shall conform to ASTM F-477. All pipe shall have a home mark on the spigot end to indicate proper penetration of the joint.

E. GRAVITY PIPE (SEWER OR DRAIN PIPE) - 18 TO 27 INCHES

1. Pipe and Fittings: Conform to ASTM F-679. The minimum pipe wall stiffness shall be 46 psi.

2. Joints: Joints shall be integral bell gasketed joints as specified in ASTM F-679. The gaskets shall conform to ASTM F-477. The pipe shall have a home mark on the spigot end to indicate proper penetration of the joint.

F. GAS RATED PIPE-LOW PRESSURE:

1. Pipe: Pipe shall be made of PVC 1120 or 1220 ASTM D1784-78. PVC pipe schedule 40 shall meet ASTM D1785-76. PVC pipe 315 psi shall meet ASTM D2513-79. PVC tubing shall meet ASTM D2513-79. The words Natural Gas must be clearly marked on the piping along with the UCP shield.

2. Fittings: Fittings shall be made of PVC 1120 or 1220 ASTM D1784-78. Fittings shall conform to sizes as listed by International Association of Plumbing and Mechanical Officials (IAPMO), ASTM D-2466-78. Fittings shall have clearly printed on them the material designation and the UPC shield.

2.07 FIBERGLASS REINFORCED PLASTIC PIPE (FRPP) (NOT APPLICABLE)

2.08 COPPER TUBING AND FITTINGS (CT)

A. GENERAL: Contractor shall furnish and install hard drawn copper tubing with wrought copper and bronze fittings in sizes 4" and smaller, as shown on the Drawings and specified herein.

B. COPPER TUBING: Copper tubing shall be seamless cold-drawn tubing conforming to the requirements of ASTM Standard B 88-71, type K; provided that tubing furnished in coils and that for use with flared fittings shall be annealed. Tubing furnished in straight lengths shall have drawn temper.

C. FITTINGS: Fittings 1/4-inch to 4-inch shall be wrought copper solder joint fittings with the material conforming to the requirements of ASTM Standard B 75, No 120 or 122, and with design and dimensions conforming to the requirements of ANS B16.22. Fittings 1/4 and 3/8-inch shall be cast bronze fittings for flared tubing with the material conforming to the requirements of ASTM Standard B 62 and with design and dimensions conforming to the requirements of ANS B16.26. All unions shall have ground joints. The zinc content of bronze shall not exceed 5 percent and the aluminum content shall not exceed 2 percent.

D. FLANGES: Flanges and flanged fittings shall be cast bronze conforming to ASTM Standard B 61 or B 62. Flanges shall be class 300 with flat faces concentrically grooved, and conforming to the applicable requirements of ANS B16.24.

E. SOLDER: Solder shall conform to ASTM Standard B 32, alloy grade 50A.

F. FLANGE BOLTING: Bolts, studs, and nuts for bronze flange connections shall be silicon bronze conforming to ASTM Standard B 98, alloy No. 661 with threads conforming to the requirements of ASTM Standard A193, Section 14. Studs shall be threaded full length.

G. GASKETS: Flanged connections shall have 1/16 inch thick full-face gaskets made of rubber sheet packing, Crane Company "CC", Garlock style 22, or an approved equal.

H. NIPPLES: Extra strong red brass threaded nipples shall be used where specified on the Drawings.

I. THREADED JOINT COMPOUND: The joint compound for all threaded joints shall be Teflon ribbon dope thread sealant, Anchor Style 1175, Permacel, Rectorseal 5, or approved equal.

2.09 MECHANICAL COUPLINGS

A. GROOVED END COUPLINGS: Mechanical couplings shall be shouldered type conforming to AWWA C606. Coupling shall engage and lock the shouldered pipe ends allowing some degree of contraction, expansion, and angular deflection. Coupling housing shall be of ductile iron or malleable iron and shall consist of two or more segments held securely together by at least two steel bolts. Sealing gasket shall be of such design that internal pressure in the pipe increases the tightness of the seal and shall be of materials suitable for the intended service. The coupling shall have a rated working pressure not less than the pressure rating of the pipe. Gaskets shall be as recommended by the manufacturer for the temperature and service. The couplings shall be Victaulic, Gustin-Bacon or approved equal.

B. FLEXIBLE COUPLINGS: Flexible (sleeve) couplings shall be of the full sleeve type, split sleeve type, or flange adapter type, as shown on the Drawings, specified herein, or as otherwise permitted by The Owner. They shall provide the requisite pipe flexibility without jeopardizing pipe joint integrity due to hydraulic thrust, and shall have the same pressure-rating as the pipe. Couplings shall have all-metal bearing surfaces and shall be provided with appropriate bolts and nuts. Flexible couplings shall be restrained per AWWA M11 unless otherwise indicated.

1. Full Sleeve Type Couplings shall be gasketed, suitable to service temperatures up to 212°F, and for service temperatures greater than 212°F shall be as recommended by the manufacturer, and shall be of a diameter to fit the pipe. Each coupling shall consist of a steel middle ring, 2 steel followers, 2 gaskets, and the necessary steel bolts and nuts to compress the gaskets. The couplings shall be Dresser Style 38, Smith Blair 400 series, or approved equal.

2. Split Sleeve Type Couplings shall consist of one gasket, 2 housing clamps, and 2 bolts and nuts to obtain the flexibility for connecting the piping. Steel shoulders shall be provided and welded to the pipe ends to accommodate the couplings. The couplings shall be Kuhns, Ductile Iron Pipe Lock Coupling; M. B. Skinner Seal; or approved equal.

3. Flexible Flanged Coupling Adapters shall be of the sleeve type, consisting of steel middle ring, steel followers, gaskets, and steel bolts and nuts to compress the gaskets and restraining rods and collars per AWWA M11. Gaskets shall be suitable for temperatures up to 212°F, and for service temperatures greater than 212° F shall be as recommended by the manufacturer. The couplings shall contain anchor studs or restraining rods (as recommended by the manufacturer) of strength adequate to hold the pipe together under a pull equal to the longitudinal strength of the pipe at a tensile stress of 20,000 psi, and used only when specifically indicated. The flanged coupling adapters shall be Dresser Style 128, Smith Blair 913 series, or approved equal. If restraining rods are used, ease of removal and installation shall be considered and coordinated with The Owner.

2.10 EXPANSION JOINTS

Expansion joints for cast iron, ductile iron, and steel pipe shall be provided as shown on Drawings and in accordance with the manufacturer's recommendation. The expansion joints shall be Dresser Style 63 Type 2, double-end expansion joint, Smith Blair 612 series, or approved equal. The expansion joints shall have a deep packing chamber to provide for full and ample packing space. The followers shall be three-fourths as long as the packing chamber to afford a wide margin of take-up should future re-tightening of the expansion joint be necessary. The expansion joint packing chamber shall be accessible at all times with sufficient room available to pull out the followers and repack the joint. Standard packing shall consist of alternate split rubber-compound rings for sealing purposes and split jute rings for lubrication and shall be designed to operate at temperatures up to 212 degrees F. Special asbestos-type packings shall be furnished where temperatures exceed 212 degrees F. Expansion joints shall be of welded steel construction.

2.11 WALL SLEEVES (NOT APPLICABLE)

2.12 WALL CASTINGS (NOT APPLICABLE)

2.13 PIPE HANGERS AND SUPPORTS

The Contractor shall provide pipe hangers, brackets, saddles, clamps, and other supports as necessary to support all dead load, live load, and dynamic load experienced by the piping and appurtenances. Pipe supports conforming to these requirements shall be supplied whether or not shown on the Drawings. Supports shall be provided at, but not limited to, points of change in direction, both sides of flexible joints, dead ends and maximum spacing as defined by this specification. Pipe hangers, brackets, saddles, clamps, and other supports shall be adjustable type conforming to the requirements of ANSI B31.1, Section 6; and shall be shop primed, including all bolts, nuts, and threaded

parts. Where not specifically identified or called out on the Drawings, computations showing adequacy of Contractor selected hangers and supports to meet these requirements shall be submitted. The Contractor shall determine the required number and location of hangers before the support or roof system is installed. Hangers and supports so identified on the Drawings do not relieve the Contractor from meeting all requirements specified herein. Wherever possible, brackets shall be used in lieu of hangers.

A. GENERAL: Hangers and supports shall include all hanging and supporting devices of metallic construction shown, specified, or required for pipe lines, apparatus, and equipment other than electrical equipment. The contractor's working drawings, as required herein, shall show quantity, type, design, and location of all hangers and supports required under the various Contract items. Hangers and supports shall be painted the same as required for the supported piping.

1. Where specified or shown, bolts, stud bolts, rods, yokes, and nuts of hangers and supports shall be of steel. Bolts shall not be less than 1/2 inch diameter unless otherwise called for on the Drawings.

2. Except where otherwise shown, specified, or required, hangers, supports, anchors and concrete inserts shall be the standard types as manufactured by Crane Co., Grinnell Co., Fee and Mason Manufacturing Co., or approved equal, meeting the requirements specified herein. Unless otherwise approved by the The Owner all hangers, supports, and concrete inserts shall be listed with the Underwriters' Laboratory.

B. DESIGN: Hangers and supports shall be adequate to maintain the pipe lines, apparatus, and equipment in proper position and alignment under all operating conditions and have springs where necessary. Hangers and supports shall be of standard design where possible, and be best suited for the service required. Where required, they shall be screw adjustable after installation. Supporting devices shall be designed in accordance with the best practice. Sufficient hangers and supports shall be installed to provide a working safety factor of not less than 4 for each hanger, assuming that the hanger is supporting 12 feet of pipe filled with water. On pipes 3 inches in diameter and larger which are covered with heating insulation, hangers and supports shall include proper pipe protection saddles. Hangers and supports shall be designed to resist seismic loading as defined by the UBC.

1. Hangers and supports shall be designed and selected in accordance with MSS Standard Practices: SP-58, Pipe Hangers and Supports -

Materials and Design; and SP-69, Pipe Hangers and Supports - Selection and Application.

C. SUPPORTS FOR FRP AND PVC PIPING: Rigid plastic piping normally shall be supported by the same type of hangers used with steel pipe, except that in no instance shall C-clamp, or other point-bearing supports be allowed. Riser clamps, if required, shall be full-circumferential type only. Support spacing shall be based on the plastic pipe manufacturer's recommendations for the service conditions, but not more than 5 feet on center. Flexible plastic tubing or rigid plastic pipe operating at temperatures high enough to materially lower its strength, shall be supported continuously by light metallic angles or channels and special hangers.

D. SADDLE STANDS: Saddle stands shall be of adjustable type. Each stand shall consist of a length of 1 1/4" standard weight pipe fitted at the base with a 6"x6"x3/8" steel plate welded on and at the top with saddle contoured to the size of supported object and welded to a 1 1/4"-12 zinc plated fine thread rod with two jamb nuts as shown on the Drawings. Stanchions shall be of similar construction to the saddle stand, except that they shall be fitted at the top with cast iron pipe saddle supports or with pipe stanchion saddles with yokes and nuts. Where adjustable supporting devices are not required, pipe lines 3" in diameter and smaller may be supported on The Owner approved cast iron, malleable iron, or wrought steel hooks, hook plates, ring or ring plates.

E. ANCHORS: Anchors shall be furnished and installed where specified, shown, or required for holding the pipe lines and equipment in position or alignment. Anchors shall be designed for rigid fastening to the structures, either directly or through brackets. The design of all anchors shall be subject to review by the The Owner.

1. Anchors for piping shall be of the cast iron chair type with wrought steel strap, except where anchors form an integral part of pipe fittings or where an anchor of special design is required.

F. INSERTS: Inserts for concrete shall be furnished galvanized and shall be installed in the concrete structures where required for fastening supporting devices. They shall be designed to permit the rods to be adjusted horizontally in one plane and to lock the rod nut or head automatically. Nail slots shall be provided in the exposed flanges of the insert. Inserts shall be designed to carry safely the maximum load that can be imposed by the rod which they engage.

G. MATERIALS: No use shall be made of wire, straps, chains, etc., for supporting piping, nor shall cast expansion shields be used for anchoring

bolts. Hangers and supports of metallic construction shall conform to the requirements specified herein and to the following standards:

1.	Structural Steel	ASTM A36 and A283
2.	Steel bars (grade 1022)	ASTM A107
3.	Steel castings (grade N-1)	ASTM A27
4.	Iron castings (grade 35)	ASTM A42
5.	Cast iron pipe fittings	(Class 125)
6.	Malleable iron castings	ASTM A47
7.	Bolting materials, steel	
	a. Bolts, yokes and stud bolts	ASTM A307
	b. Nuts	ASTM A536
	c. Physical requirements:	
	(1) Tensile strength	60,000-72,000 psi*
	(2) Yield strength	38,000-50,000 psi
	(3) Elongation	27 percent maximum
	(4) Reduction of area	35-55 percent

*unless otherwise specified

8.	Bolting materials, silicon bronze	
	a. Bolts, stud bolts, yokes and nuts (alloy A)	ASTM B98
	b. Physical requirements:	
	(1) Tensile strength	70,000 psi minimum
	(2) Yield strength	38,000 psi minimum
	(3) Elongation	17 percent maximum
9.	Bolting materials, stainless steel	
	a. Bolts, stud bolts and nuts (type 316)	ASTM A276
	b. Physical requirements:	
	(1) Tensile strength	75,000 psi minimum
	(2) Yield strength	30,000 psi minimum

(3)	Elongation	35 percent maximum
(4)	Reduction of area	45 percent maximum

10. Where specified or shown, bolts, stud bolts, rods, yokes and nuts of hangers and supports shall be of silicon bronze or stainless steel as specified above with dimensions, threads and sizes equivalent to those specified in steel. Where submerged in process fluids or where located in covered manholes, bolts, stud bolts, rods, yokes and nuts of hangers and supports shall be of silicon bronze, unless otherwise noted.

H. SUPPORTS FOR PIPING: Brackets for support of piping from walls and columns shall be made of welded wrought steel and shall be designed for three maximum loads classified as follows:

1. Light_____ 750 pounds
2. Medium _____1,500 pounds
3. Heavy_____3,000 pounds

When medium or heavy brackets are bolted to walls, back plates of adequate size and thickness shall be furnished and installed to distribute the load against the wall. When used on concrete walls, the back plates shall be cast in the concrete. Where the use of back plates is not practicable, the brackets shall be fastened to the wall in such a manner that the safe bearing strength of the wall will not be exceeded. Pipe rolls or chairs shall be of the cast iron type. Pipe rolls shall be provided with threaded rods.

I. SPACING OF SUPPORTS/HANGERS: Pipe support spacing requirement are indicated on the Drawings or elsewhere in these Specifications, but in no case shall the spacing of hangers exceed the following:

MAXIMUM UNSUPPORTED PIPE SPAN (FEET)

Normal Pipe Size-Inches	Iron	Steel	PVC	FRP
1/2	-	5	3	-
3/4	-	6	3	-
1	-	7	3.33	3
1-1/4	-	7	3.33	-
1-1/2	-	9	3.5	4
2	-	10	3.5	5.25
2-1/2	-	11	4	-
3	-	12	4.25	7.5
3-1/2	-	13	4.25	-
4	8	14	4.5	8.5
5	10	16	-	-
6	10	17	4.8	10
8	10	19	-	11
10	10	22	12	
12	12	23	10	
14	12	25	10	
16	12	27	8	
18	14	28	8	
20	14	30	6	
24	14	32	6*	
30	-	32	6*	

* Pipe insulator supports at 54-inch casing and at existing 3'x6' RCB shall be spaced with a support at the beginning and end of casing and/or RCB and the remaining supports evenly distributed throughout, but not to exceed table value.

J. Where concentrations of valves, fittings, and equipment occur, closer spacing of supports shall be required. In no case shall any total hanger load (weight of piping, insulation, and contents) exceed the following (load carrying capacities for hot rolled steel rod ASTM A107-61T):

Nominal Diameter-Inches	Maximum Safe Load-Pounds
1/2	1,130
5/8	1,810
3/4	2,710
7/8	3,770
1	4,960
1-1/8	6,230
1-1/4	8,000
1-3/8	9,470
1-1/2	11,630

K. SUPPORT OF VERTICAL PIPES: Where vertical pipe runs exceed 15 feet, and a support system is not indicated on the Drawings, provide carbon steel riser clamps for support and steadying of the pipe. Where possible, riser clamps shall be fitted and bolted below a coupling, flange, or hub. Maximum spacing of clamps shall be 15 feet.

L. PROTECTIVE COATINGS: All pipe brackets shall be coated in accordance with Section 09900 before fabrication. The brackets shall receive one finish coat after erection.

2.14 INSULATION FITTINGS

Insulation fittings shall be used wherever dissimilar metals are jointed. Insulation couplings, flanges, fittings, and unions shall be the products of F.H. Maloney Company, Cor Ban Products Company, Central Plastics, or equal. Fittings utilizing insulating bushings shall not be used.

2.15 PIPE SLEEVE SEALING MATERIALS (NOT APPLICABLE)

2.16 PIPING INSULATION (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 GENERAL

A. STORAGE AND HANDLING: During fabrication, storage, handling, and transporting, every precaution shall be taken to prevent damage to pipe. Pipe shall be handled only by means of cable slings (on bare steel pipe), by means of fabric slings (on coated pipe), or other methods approved by the pipe manufacturer for the pipe used. Mortar lined pipe shall be kept sufficiently moist to prevent drying out of the mortar lining prior to installation. All steel pipe over 14 inch size shall be fitted after fabrication with internal bracing and stulls at both ends as a protective measure against deformation and injury to mortar lining. Pipe slings used during handling, and tie-down straps during transit shall be not less than 4 inch wide flat fiber or plastic straps. During storage and in transit, pipe 8 inches and larger shall be rested on saddles or on another support system approved by the pipe manufacturer, which shall ensure freedom from damage of the barrel, interior lining, and exterior coating. Not less than three (3) saddles or other longitudinal pipe supports shall be used during transit.

B. VERIFICATION OF DIMENSIONS: All dimensions essential to the correct location of the pipe, or fit of piping at equipment and valves, or to the proper location and orientation of pipe sleeves and wall castings, or to the avoidance of obstructions or conflict with other improvements, shall

be accurately determined by the Contractor prior to fabrication of the piping involved. Any required change from the locations shown on the Drawings shall be indicated by the Contractor and submitted to The Owner for review.

C. WELDING:

1. All welding operators shall be qualified under the Standard Qualification procedure of the American Welding Society (AWS). All welds shall be made by an electric shielded arc method of welding. Field welding of all joints shall be in conformance with AWWA C206.

2. The Owner shall have the right at any time to call for and witness the making of test specimens by any welder in accordance with these Specifications, and the expense of such tests shall be borne by the contractor.

3. Welds considered by The Owner to be deficient quality, or made contrary to any mandatory provision of these Specifications, shall be removed throughout its depth to expose clean base metal, but in case of a strictly local deficiency, the weld need not be removed throughout its entire length, provided that sufficient amount shall be removed to ensure that sound weld metal, only, remains. A cracked weld shall be removed throughout its length.

4. Certification of the welder's qualifications shall be submitted at The Owner's request.

D. CHANGES IN LINE AND GRADE: In the event that obstructions not shown on the Drawings are encountered during the progress of the Work which will require alterations to the Drawings, The Owner shall have the authority to change the Drawings and order the necessary deviation from the line or grade. The Contractor shall not make any deviation from the specified line or grade without the direction of The Owner. Should any deviations in line or grade be permitted by The Owner in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, all additional costs for thrust blocks, valves, blowoff assemblies, extra pipe footage or other additional costs shall be borne by the Contractor.

E. Internal bracing adequate for handling and transportation shall be installed as soon as practical after the application of cement mortar lining. All bracing shall remain in the pipe until installation and backfilling are completed.

F. Gasket material shall be furnished with the pipe for storage in a cool, well ventilated place and protected from direct sunlight.

3.02 INSTALLATION

A. GENERAL: The following requirements apply to the installation of all types of pipe unless more stringent requirements are specified. Prior to installation, the interior of all piping, fittings, and appurtenances shall be thoroughly cleaned of scale, dirt, and foreign substances, and effective means shall be taken to prevent the entrance of foreign matter during progress of the Work. The surfaces of exposed piping shall be kept free of marks and blemishes which cannot be removed to provide the finish required for a satisfactory appearance when painted or coated. Special care shall be taken to avoid abrasion of stainless steel.

1. Pipe, valves, and appurtenances shall be installed by mechanics skilled in the trade and in a thorough workmanlike manner following the best modern practice in pipe fabrication and installation. Fabricating, assembling, and installing of piping shall be in accordance with recognized codes of standard practice insofar as applicable, and the requirements of the pipe manufacturer unless otherwise specified. Pipe shall be installed accurately to the specified alignment and grade and to the satisfaction of The Owner. The routing of piping which is dimensioned on the Drawings may be changed only with the review of The Owner.

2. In erecting the pipe, a sufficient number of screw unions, flanged joints, or mechanical couplings shall be used to allow any section or run of pipe or equipment to be disconnected without taking down adjacent runs. Screw unions shall be employed on pipelines 3 inches in diameter and under. Flanged joints or mechanical couplings shall be employed on pipe 4 inches in diameter or larger unless otherwise shown on the Drawings. Dielectric unions shall be installed at the junction of dissimilar metals.

3. Piping to be encased in concrete shall be securely held in place to prevent any change of position during placing of reinforcement steel and concrete. Care shall be taken to prevent damage to the pipe during placing operations. All joints shall be checked and tested before encasement. Where insulated flanges are to be installed in encased pipe, the reinforcement shall not touch the pipe or the flanges.

4. Excepting where the profiles of underground lines are shown, or elevations given, they shall be installed with cover adequate to

resist construction loads, but in no case shall the cover be less than 2 feet without concrete encasement.

5. Underground pipe shall be installed with the pipe in full contact with the subgrade excepting where concrete encasement is required.

6. Piping shall be adequately supported with hangers, clamps, supports, or other devices of appropriate design, and as specified herein. Where details are shown on the Drawings or specified herein, the supports shall conform thereto and shall be placed as indicated. System shall be adequately supported where details are not provided.

7. Holes blocked out in the concrete for piping shall not be permitted except where shown on the Drawings or reviewed by The Owner.

8. Welding of steel flanges in the fabrication of pipe assemblies shall conform to the applicable requirements of this Specification. Flanges shall be properly aligned and welded at right angles to the pipe axis. No steel bars or any hard wedging material shall be used to overcome large forces due to misalignment. Flange bolts shall be loaded evenly to eliminate unnecessary stresses. After a period of 24 hours, the bolts shall be checked to make sure that they are tight. Should flanged joints with rubber gaskets be over tightened and rubber flow occur, the gasket shall be replaced. Contact surfaces of carbon steel flanges where gaskets are required, studs for flange bolting, except stainless steel, bolts for sleeve-type couplings, and all epoxy coated pipe ends to be jointed by sleeve-type couplings, shall be coated with an approved antisieze compound immediately prior to assembly.

9. American National taper pipe threads shall be used on all threaded joints. Joint compound shall be applied to the male threads only, unless otherwise directed.

10. Anchorage lugs or restrained joints shall be provided where there is a possibility of joint pulling under pressure. Concrete thrust blocks per Standard Drawings may be used in lieu of the above where pipe is installed below ground unless otherwise called out on the Drawings.

11. Where pipes pass through walls or slabs, care shall be exercised to ensure joints being watertight. The pipe shall have an attached water stop and be free of all dirt and grease to secure a tight bond with the concrete. This shall apply to all walls and slabs.

12. Provide all necessary connections for instrumentation. Coordinate with the Instrumentation Subcontractor and with equipment suppliers for location of instruments

B. BURIED PIPING:

1. Pipe Installation:

a. Trenching, bedding and backfilling shall conform to the requirements of Division 2.

b. In general, the Work shall conform to the following sections of AWWA Standard C600:

- Section 2, "Inspection, Receiving, Handling and Storage;
- Section 3.1, "Alignment and Grade";
- Section 3.3, "Pipe Installation";
- Section 3.4, "Joint Assembly";
- Section 3.6, "Valve and Fitting Installation";
- Section 3.8, "Thrust Restraint";

c. The piping shall be placed when trench and weather conditions are suitable. No pipe shall be laid in water, and responsibility for the diversion of drainage and dewatering of trenches during construction shall be borne by the Contractor. In no case shall the lines being installed be used for drains. All pipe in place shall be inspected before completion of backfilling. In all backfilling operations, the Contractor shall be responsible for preventing damage to or misalignment of the pipe.

d. Pipe shall be laid uphill, from structure to structure, with bells upgrade. Pipe shall be bedded, true to line and grade, with uniform bearing for the entire barrel length. All material shall be removed from the interior of the pipe, and the inner surface of bells of collars and the outer surface of spigot ends shall be thoroughly cleaned so that good joints can be made. Pipe sections shall be so laid and fitted together, that when complete, the line will have a smooth and uniform interior.

e. The interior of each pipe, after being laid, shall be thoroughly cleaned.

2. Joint Installation: Installation of joints and couplings for buried piping shall conform to the following requirements:

   a. Joints of all sizes shall conform to the applicable requirements specified hereinafter for buried piping. Care shall be taken to keep pipe in correct alignment when making joints. Friction or lever pullers or other means of ensuring straight pulling shall be used on pipe larger than 8 inches and also on smaller sizes where damage to the end might occur. The "popping-on" of joints shall not be permitted. The fitting of piping to valves, hydrants, and wall castings shall be worked out in advance of installation to ensure correct orientation of the mating ends and bedding of approach piping.

   b. The interior mortar lining of pipe at joints shall be smoothly continuous and of full thickness. Flanges, flange bolts, and other exterior surfaces of restrained joints and flanged couplings shall be given two coats of a coal tar base coating suitable for the purpose. Where coatings of pipe and valves or appurtenances do not lie in the same plane, the offset shall be filled gradually with a suitable quick setting polymer concrete (such as Waterplug; Hub construction specialties' All-Patch, or The Owner approved equal) to provide a smoothly continuous joint.

   c. Mechanical coupling shall be coated with the same coating as the adjacent piping. Cover the coupling with sand prior to trench backfilling.

   d. Silver solder shall be used for soldered joints in buried tubing.

3. Thrust Blocks: On all pressure pipelines 4 inch and larger with non-restrained joints, concrete thrust blocks shall be provided at all fittings and dead-ends, and at bends greater than 15 degrees unless otherwise called out on the Drawings. The concrete shall conform to the requirements for 3,000 psi concrete as specified in Section 03300, "Cast-in-Place Concrete," and shall be placed against properly dampened, undisturbed soil, centered on the thrust resultant line. The concrete shall be free of joints, and any mortar contaminating the joints shall be removed.

C. NONBURIED PIPING:

1. Pipe Installation: The horizontal piping shall be run parallel to the building walls and shall be level except where otherwise shown or specified; parallel lines shall be grouped on the same horizontal or vertical plane wherever possible. Vertical piping shall be plumb, and the entire piping configuration shall allow adequate clearances for convenient access for painting and preventive maintenance of valves and equipment. Piping shall clear obstructions, preserve headroom, and keep openings and passageways clear. If structural interference or other conditions prevent the running of pipes or the setting of equipment at the point indicated on the Drawings, the necessary minor deviations required, as directed by The Owner will be allowed, and shall be shown on the erection drawings in accordance with paragraph 1.03C.

2. Joint Installation: Installation of joints and couplings shall conform to the following requirements:

   a. Steel Pipe with Welded Fittings shall be made by oxyacetylene or electric arc process in accordance with AWWA Standard C206.

   b. Pipe Threads shall be in accordance with the requirements of ANSI B2.1, and shall be cut full and free from torn or ragged surfaces. No more than three threads on the pipe at any joint shall remain exposed after installation. Threaded joints shall be established with Teflon tape applied to the male ends only. The use of thread cement or caulking of threaded joints to stop or prevent leakage shall not be permitted. Sharp-toothed pipe wrenches or similar wrenches shall not be used in making up copper or brass pipe.

   c. Flanged Joints: Flanged joints shall be made with gaskets centered in the joint. Bolts, studs, and nuts shall be lubricated with graphite and oil so that the nuts can be turned by hand. Care shall be taken to prevent excessive initial tension to the bolt and studs and so that the tension applied is as nearly uniform as possible. The rust preventive compound applied to the faces of flanges before shipment shall be removed before installation. Where slip-on flanges are used, they shall be fillet welded to the pipe on both front and back sides in accordance with AWWA C206.

d. Tubing which is to be soldered shall be cut square, and all burrs shall be removed. Both the inside of the fitting and the outside of the tubing shall be well cleaned with steel wool or cloth backed sandpaper before sweating. Care shall be taken to prevent annealing of fittings or hard-drawn tubing when making connections. Joints for soldered fittings shall be made with a non-corrosive, paste flux and solid string or wire solder composed of 40 percent tin and 60 percent lead. Soft solder or cored solder shall not be permitted. Tubing to be coupled with flared compression type fittings.

e. Mechanical Coupling Type Joints of the sleeve, split sleeve, and flanged coupling adapter types shall be made in accordance with the printed instructions of the manufacturer. The pipe ends to receive the couplings shall be finished to the outside diameter and surface finish required by the coupling manufacturer. Prior to assembly, all surfaces which will be accessible after installation shall be given protective coating.

f. Joint Harnesses shall be provided at sleeve type coupling joints. The harnesses shall be tightened just sufficiently to preclude displacement of the downstream piping under hydraulic thrust.

g. Electrical Insulation Joints shall be provided at all connections between dissimilar metals and ferrous and non-ferrous pipe except where the non-ferrous pipe is an electrical non-conductor. The joints shall be tested after completion to verify non-conductivity.

h. Grooved End Couplings: Grooved end couplings shall be used where called out on the Drawings. If the Contractor proposes to use additional grooved end couplings, submit piping drawings in accordance with Part 1.03 showing location of the couplings and supports. Grooved end couplings shall be adequately supported to prevent movement of the pipe.

D. INSTALLATION OF PIPING THROUGH CONCRETE STRUCTURES:

1. Whenever a pipeline or any material terminates or extends at or through a structural wall or sump, the Contractor shall install, in advance of pouring the concrete, a wall sleeve or wall casting as required for the particular installation as shown on the Drawings.

2. Whenever any run of pipe is installed subsequent to placing of the concrete, the Contractor shall accurately position the opening in the concrete for such pipelines. Unless otherwise required, all pipes penetrating fluid containing or earth supporting portions of the structure shall be ring flanged.

   a. The opening shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for packing where pipe passes through wall to ensure watertightness around opening.

   b. The boxes or cores shall be provided with continuous keyways to hold the filling material in place and to ensure a watertight joint.

   c. Boxes or cores shall be filled with non-shrink grout or non-shrink concrete conforming to the following:

      NON-SHRINK CONCRETE: All non-shrink concrete shall contain one (1) pound of Embeco Aggregate per pound of water that is in excess of two gallons per sack of cement.

      NON-SHRINK GROUT: Non-shrink grout shall be made with the following proportions:

      - 1 part Type I Portland Cement (1 bag)
      - 1 part Embeco Aggregate (100 lbs.)
      - 1 part clean, well graded concrete sand (100 lbs.)
      - Approximately 5.5 gallons of water per bag of cement

3. Buried flexible joints shall be installed on all gravity pipe 4" and larger 3 feet from the face of the structure or building footing whether the joint is shown on the Drawings or not. The buried flexible joint shall be installed at the location shown on the plans.

4. Non-buried pipe shall have a removable section, flanged on 4" diameter pipe and larger or screwed union on 3" diameter pipe and smaller in the interior portion of the structure, whenever the pipe exits a structure.

E. PIPE SLEEVES: All piping which will pass through walls, slabs, footings, or beams shall be provided with pipe sleeves with annular space sealed or with wall castings as shown in the Standard Drawings. The

Contractor shall provide the wall sleeves and castings for insertion in the concrete work covered in Section 03300, "Cast-in-Place Concrete," and shall verify their correct setting prior to concrete placement. No pipe joint will be allowed to occur in the sleeve. The seal of both ends of the sleeve shall be flush with the concrete surfaces on completion of work and drying of sealant. Caulking and sealing of wall sleeves shall conform to the following requirements:

1. Preparation for Sealing: The annular space between the pipe and sleeve shall be cleaned of all loose particles and contamination, and shall be dry prior to sealing. Polyethylene rod or polyurethane foam shall be used as a filler or joint back-up material. Tape or other recommended protection shall be applied on the structure surfaces to preclude contamination by the sealant, and any contamination which occurs shall be removed immediately, followed by a thorough washing of the surfaces to preclude contamination by the sealant, and any contamination which occurs shall be removed immediately, followed by a thorough washing of the surfaces with solvent. Prepared compound not used during the application time limits designated by the manufacturer of such compound shall be discarded.

2. Application of Compound Sealant: The sealing shall be performed after any required primer has been applied and backup material placed in strict conformance with the sealant manufacturer's written instruction. The application shall be made in clean, straight lines free of wrinkles, be tooled as required and finished with a convex surface just sufficient to provide the required flush surface upon drying. Work shall not be performed when the air temperature is below 50 degrees F.

3.03 STEEL PIPE (FSP, MSP, AND CCP)

Installation of FSP, MSP and CCP shall conform to the recommendations of the manufacturer, paragraph 3.02 and AWWA M-11 and as follows:

A. NON-BURIED PIPE:

1. The maximum joint length of non-buried pipe shall be 20 feet. Provide break out connections, flanged or screwed union, to facilitate taking down the pipe.

2. Provide flanged or screwed unions at all field connections.

3. Connections to existing pipe shall be by flange or screwed unions.

B. BURIED PIPE:

1. The maximum joint length of buried pipe shall be 40 feet.

3.04 STEEL PIPE FOR MOISTURE FREE CHLORINE GAS (SPCC)

A. GENERAL: All pipe, fittings and valves shall be installed in accordance with the recommendations of the Chlorine Institute and the chlorination equipment manufacturer and as described herein.

B. INSTALLATION:

1. When threaded joints are required, extreme care shall be taken to obtain clean, sharp threads; 2 or 3 cuts may be required to produce the desired perfect thread. Cut pipe shall be reamed after threading and threads and pipe interior shall be washed with trichlorethylene to remove cutting oils. Teflon tape, Anchor Style 1175, Permacel; or an approved equal, shall be used; it shall be applied so that tightening of the joint shall tighten the tape. If taped joints are to be opened and later reassembled, all evidences of the old tape shall be removed by the use of a wire brush before new tape is applied.

2. Cold or hot bending of pipe shall not be allowed.

3. All welded connections shall be thermally stress relieved in accordance with AWS, D1.1, Section 3.

3.05 STEEL CASING, JACKED/BORED INSTALLATION

A. Jacked steel casing shall be butt welded of sheets conforming to ASTM Specification A-283 and shall be constructed in accordance with the provisions of Section 306-2 of the "Standard Specifications for Public Works Construction," 1994 Edition, except as herein specified.

B. The casing pipe shall have a steel thickness not less than 3/4-inch. The casing pipe shall be a minimum of 20 feet in length to a maximum of 40 feet in length. Any and all increased cost resulting from the Contractor's use of steel casing pipe with greater diameter or thickness than the minimum specified shall be borne solely by the Contractor.

C. Steel casing pipe of the minimum size and thickness specified shall be installed in place by jacking and boring methods without the use of water or air at the locations shown on the plans, and to grades required to install carrier pipe. If the bore casing is equal to or exceed 18 inches in diameter and the length of the bore exceeds 80 feet in length, the contractor shall bore using a track machine, unless otherwise directed by the Engineer.

D. The carrier pipe shall be supported by steel casing spacer/insulators as manufactured by PSI (Pipeline Seal & Insulator, Inc.) spaced at 6 foot on center. The ends of the steel casing shall be sealed with a welded flange and a two piece fabricated end plate as shown on the plans (Sheet M6). The end plate shall then be sealed to the carrier pipes (30-inch PVC water, 2-inch back flush water, electrical conduits) with synthetic rubber "pull-on" seals and stainless steel bands, as manufactured by PSI. The annular space between the steel casing and carrier pipe shall be left empty unless grouting is specified by the Engineer or on the plans.

E. Voids, if developed outside the casing and within limits for boring or jacking, from any cause such as removal of rocks encountered inboring, shall be filled with lean grout forced in under pressure by insertion of a grout pipe outside of the casing. The lean grout shall consist of one part of portland cement to not more than four parts of sand by volume, place at low pressure. Grout pressure is to be controlled so as to avoid deformation of the casing. Sand for grout to be placed outside the casing shall be of such fineness that 100% will pass a No. 8 sieve and no less than 35% will pass a No. 50 sieve.

F. Payment for jacked steel casing pipe will be at the contract unit price per lump sum bid for jacked steel casing pipe placed in accordance with these plans and specifications. Payment shall be full compensation for furnishing all labor, excavation, backfill, boring, jacking, steel casing pipe, shoring*, equipment, services, transportation, sand cement, concrete, all grouting operations described herein, and other appurtenant items of labor and materials required to complete the work. The water carrier pipe will be paid for under the bid item for pipe.

G. Variation in the field position of the casing from the line and grade as indicated in the drawings shall be limited to 2-inch in lateral alignment and 1-inch in vertical grade providing that, in the case of gravity flow pipes, the final grade of the flow line shall be in the indicated direction.

H. Submit diameter, thickness, and class of steel casing; bore pit dimensions and locations; cathodic protection (if required); steel casing spacers/insulators and end seals; and construction methods and equipment in accordance with Section 01340.

* Shoring shall be by steel shelf from top of bore pit excavation to bottom, unless otherwise directed by Engineer.

3.06 DUCTILE IRON PIPE

Pipe laying shall conform to the applicable requirements of AWWA C600, except as modified herein.

A. Before the pipe is placed in the trench, it shall be inspected for defects and tapped with a light hammer to detect cracks; all defective, damaged, or unsound pipe will be rejected. The interior of pipe shall be thoroughly cleaned of foreign matter before the pipe is lowered into the trench and shall be kept clean during laying operations by plugging.

B. Except where necessary in making connections with other lines, or as authorized by District, pipe shall be laid with the bells facing in the direction of laying. On grades exceeding 10 percent, pipe shall be laid uphill. Wherever an abrupt change in direction or a dead end occurs in the line, adequate anchorage shall be provided as specified herein, or as indicated on the Drawings. Proper fittings shall be provided at all abrupt changes in direction, branches or dead ends.

C. Installation of electrical bonding shall be performed using one wire across each pipe connection or joint. Attachment of the wire to the pipe shall be accomplished using CADWELD connection per manufacturer's written recommendations. Each attachment shall be protected using Roybond primer and Handycap.

3.07 POLYVINYL CHLORIDE PIPE

A. GENERAL:

1. Care shall be exercised in handling, loading, unloading, and storing PVC pipe and fittings to avoid distortion, scratches, gouges, dents, and in particular, scuffing of the ends. All plastic pipe and fittings shall be stored under cover in a flat horizontal position, and protected from the sun and the elements until ready for installation. Plastic pipe shall be transported in a vehicle having a bed long enough to provide support for the full length of the pipe. Any length of pipe or fitting that has been damaged or distorted shall be replaced.

2. Expansion joints shall be installed to limit the maximum expansion of the pipe run to 3 inches. Pipe shall not be installed at temperatures below 45°F.

3. All underground PVC piping shall be marked with a 6 inch wide detectable blue marker tape. This tape shall contain a strip of detectable metal foil or other magnetically detectable material

running the entire length of the tape. The tape shall be placed approximately 18 inches directly above the pipe.

4. Flanged faces shall be thoroughly cleaned of all foreign substances before flanges are connected. Flanges shall be aligned and faces shall be parallel before the joint is made. Extra care shall be taken to load the bolts evenly so as to eliminate unnecessary stresses. A torque wrench shall be used on all PVC or PVC flanged pipe joints and on all PVC to metal flanges pipe joints. The following torque load shall be applied to produce the required 10,000 psi stress in the stainless steel bolts of flanged connections.

Sizes of Bolt (Inches)	Torque in foot-pounds
1/2	10
5/8	22
3/4	40

B. SCHEDULE RATED PIPE AND GAS PIPE:

1. Fittings: Transition from plastic to steel pipe shall be by flanges or by threaded slip joint plastic adapter or fitting. No plastic pipe shall be threaded. No solvent shall be used on threaded end of plastic adapters or fittings.

2. Anchorage: All line valves and fittings at downpipes shall be anchored to the wall in a manner to prevent stress and rotation of the pipe.

3. Joints: Joint material for plastic pipe shall conform strictly to the recommendations of the pipe manufacturer and ASTM D-2855.

   a. Joints shall be wiped clean and a solvent supplied by the manufacturer applied to both male and female connections.

   b. Two applications of the solvent shall be made.

   c. The treated surfaces shall be forced together as soon as the pipe material becomes soft or tacky and given 1/4 turn as recommended by the manufacturer.

C. CLASS RATED PIPE:

1. General: Conform to the recommendations of the manufacturer, Uni-Bell Plastic Pipe Association Recommended Standard B-3 (UNI - B-3) and AWWA Manual M 23 and herein.

2. Laying: Install pipe to the line and grades as shown on the Drawings and specified herein. When the installation is made at temperatures above the average soil temperature at burial depth, the pipe shall be snaked as recommended by the manufacturer. The pipe shall be bedded and backfilled in accordance with Section 02221.

3. Fittings shall be mechanical joint fittings in accordance with AWWA C110. Transition from steel pipe shall be by flanges or mechanical couplings. Transition from DIP shall be by flanges, mechanical couplings, mechanical joints or fittings.

D. GRAVITY PIPE (SEWER OR DRAIN PIPE):

1. Conform to recommendations of the pipe manufacturer, UBI B-5 and herein.

2. The spigot end of the pipe shall be inserted to the proper depth of the socket as indicated by the home mark.

3.08 FIBERGLASS REINFORCED PLASTIC PIPE (FRPP) (NOT APPLICABLE)

3.09 COPPER TUBING AND FITTINGS

A. Copper tubing shall be installed in a workmanlike manner. Bends shall be made by the use of fittings or with a bending tool on the proper radius to avoid flattening or kinking the tubing which will be subjected to thermal expansion and construction great enough to cause the line to bow or buckle shall be provided with expansion loops or offsets adequately spaced. Lines shown on the Drawings to be parallel shall be held truly parallel by means of an adequate number of supports. No waviness or sagging of the lines will be permitted. Tubes and fittings shall be cleaned of all impurities before a joint is made.

B. Stainless steel pipe, as specified herein, or standard weight seamless copper pipe conforming to the requirements of ASTM Standard B42, No. 120 or 122, shall be substituted for copper tubing wherever tubing lines are required to pass through concrete.

C. An insulating joint shall be provided whenever junction occurs between ferrous and non-ferrous metallic piping materials.

D. Soldered joints shall be made by mechanics experienced in this class of work. The joint shall be heated so that the heat is uniformly distributed around the entire circumference of the fitting. Heat shall be applied by a

gas-air, acetylene-air, or blow torch. The use of an oxyacetylene torch will not be allowed. Excess solder shall be removed while it is still in a plastic state. The joint shall be allowed to cool undisturbed in still air before water is applied. Suitable adapters shall be used for connecting pipe to fittings and valves having threaded ends.

E. For flared fittings, the tube ends shall be flared so that the angle, radius, length, and diameter of the flare conform to the corresponding dimensions of the flare seat of the fitting. The flare shall be square and concentric with the tube and fitting. Flared tube fittings shall be assembled in accordance with the manufacturer's recommendations.

3.10 BRASS TUBING AND FITTING

Installation of brass tubing and fitting shall conform to installation of Copper Tubing and Fittings.

3.11 PROTECTIVE COATINGS

A. NONBURIED AND IMMERSED PIPE: All piping which is defined as pipe, fittings, joints, couplings, valves and appurtenances shall be coated in accordance with the requirements of Section 09871, "Painting and Protective Coatings". It shall be the Contractor's responsibility to fully coordinate the protective coating requirements with the color code identification requirements to ensure compatibility of materials used. All piping systems shall be color coded in accordance with Section 09871.

B. BURIED PIPE: All pipe, fittings and joints shall be coated as called for on the contract drawings and the individual pipe specifications. All couplings, valves, and appurtenances shall be coated as follows:

- Tnemec System: Two Coats - Tnemec 46-450
- Koppers System: Two Coats - Koppers Bitumastic 50

The total coating thickness shall not be less than 32 mils. Prior to coating, all surfaces shall be prepared in accordance with SSPC-SP2 or SSPC-SP3 (Refer to Section 09871).

3.12 INSULATED PIPING (NOT APPLICABLE)

3.13 TESTING

The Contractor shall perform hydrostatic, leakage, and operational tests as specified herein. The Contractor shall perform all excavation and other work required to locate and repair leaks and correct other defects which may be disclosed or develop under tests; the Contractor shall replace all coating, painting, backfill, or other permanent work

removed in locating or repairing leaks and correcting defective piping. All gages and control devices connected to lines being tested must be disconnected for the duration of the test. Water shall not be used in testing air lines, chlorine lines, nitrogen lines, or other gas carrying pipes. High pressure air testing of PVC or FRP pipe in exposed or above ground installations shall not be permitted. The Contractor shall furnish and install a chart type recording meter for the pressure tests. The Contractor shall submit to The Owner before and after the test the gage and meter used so that these devices may be tested by The Owner.

A. TESTING REQUIREMENTS:

1. Testing Procedures: Contractor shall fully describe in writing all procedures for hydrostatically testing the piping and appurtenances, and for obtaining and disposing of water for the tests. The equipment for testing shall be itemized. Details of bulkheads, flanges or caps for the hydrostatic testing of the pipe shall be included with the submittal. The Contractor shall provide all fittings, outlets, temporary air valves and blow offs, and piping necessary for filling, emptying, and testing which are not shown as part of the piping installation. This plan shall be submitted for approval by The Owner at least four (4) weeks prior to testing.

2. Gravity Sewer Pipes or Other Pipelines Having Free Surface Flow Except Storm Drainage Pipelines: Gravity PVC sewer pipe or other pipe having free surface flow shall be given a water exfiltration test as specified herein. The Contractor has the option of using a low pressure air test in lieu of the water exfiltration test. If excessive groundwater is present which precludes use of the exfiltration test, the Contractor shall use either the low pressure air test or infiltration test.

3. Water Lines, Sewage Force Mains and other Pressure Piping Carrying Liquids: Water lines, sewage force mains and other pressure piping carrying liquids having bell and spigot gasketed joints shall be given a pressure and leakage test as specified herein.

Pipe Material	Test Standard
Ductile Iron	AWWA C-600
PVC (AWWA C-900 Pipe)	AWWA C-600
Steel Pipe	AWWA C-200

4. Pressure Pipe, Flanged or Welded Joints: PVC, FRP, steel, cast iron, ductile iron or other pipe material, with solvent welded, welded, threaded, flanged, grooved end or flexible couplings and

joints shall be pressure tested as specified herein. No leakage shall be permitted.

B. PRESSURE TESTS:

1. General: All piping, including valves, shall be field-tested at a hydrostatic pressure of 150% of the pipe pressure class (unless specified otherwise), corrected to the elevations of the test gate, with duration of four hours minimum, for each pressure test, except as otherwise specified. Piping conveying liquids between process tankage, not subject to pumping, shall be tested to the maximum possible pressure that can be obtained under static conditions. Air piping shall be tested using air or nitrogen. Buried pipe shall be tested after backfilling. Contractor shall not pressure test against a closed mainline valve.

2. Joint Exposure: All exposed pipe, fittings, valves, hydrants, and joints shall be carefully inspected before being cast in concrete and/or backfilled. Prior to backfilling of the trench, the Contractor may pressure test the pipeline for a duration of 30 minutes. However, this shall not relieve the Contractor of the full test after backfilling. All defects discovered shall be corrected by removal and replacement, as directed by The Owner and the work then retested to demonstrate satisfactory performance.

3. Thrust Blocks: Temporary or permanent thrust blocks shall be placed as required prior to tests, and the Contractor shall provide all necessary braces, plugs, thrust blocks, caps, flanges, and other materials to permit proper performance of the pressure testing; tests shall not be conducted until the concrete thrust blocks are capable of withstanding the loads produced.

4. Sectionalized Testing: The waterline may be bulkheaded and tested in sections. The bulkheads used for testing shall be of adequate design and construction to withstand the required pressures without causing injury to or excessive stresses in the pipe. Drawings showing the planned schedule of testing and the details of test bulkheads shall be submitted by the Contractor and approved by The Owner prior to the fabrication of the bulkheads. The Contractor shall furnish temporary piping and connections as may be necessary to get water into and out of the pipe for testing purposes. In filling the pipe with water the Contractor shall use procedures which ensure removal of air from the pipe before commencing the test.

Should the Contractor desire bulkheads for test purposes, he shall furnish, install, and remove them at his expense. Welded joints are indicated on the drawings to provide thrust restraint of the pipeline during normal operation. If welded joints are necessary at other locations to accommodate sectionalized testing, the Contractor shall install them at his expense. The pipe manufacturer and The Owner shall be notified sufficiently in advance regarding required pipe details to accommodate sectionalized testing. These details shall be approved by The Owner prior to testing.

C. LEAKAGE:

1. General: Leakage tests shall be conducted concurrently with pressure test. The lowest pressure during the leakage test shall be no less than 5 psi below the pressure used in the pressure test. The allowable leakage for pipes conveying liquids between process tankage (not subject to pumping) shall be determined in accordance with AWWA C-600 Section 4.2 where in the equation, P is the maximum pressure occurring anywhere in the pipeline. The duration of the test shall be not less than four hours, and measurement shall be made by means of a calibrated suction tank showing the amount of water required by the test pump to accurately maintain the specified test pressure. Tests shall be performed only in the presence of The Owner or, if scheduling of tests is such that The Owner cannot attend due to conflicting commitment, tests may be performed without The Owner's presence if the Contractor obtains written permission to do so from The Owner prior to initiation of testing. No test report shall be accepted unless proof of compliance with the foregoing requirement accompanies the test report.

3.14 FLUSHING AND DISINFECTION*

A. GENERAL: All piping shall be flushed clean of all dirt and foreign material following completion of the hydrostatic and leakage test. Air and gas piping shall be purged with air or inert gas as directed by The Owner.

B. EQUIPMENT AND SUPPLIES: The Contractor shall provide all equipment, and supplies for performing the work, and shall waste the water at locations or by procedures approved by The Owner. Permission and permits for discharging water from regulatory agencies shall be obtained by the Contractor. If required, the Contractor shall (at his expense) apply a reducing agent to the solution to neutralize residual chlorine or chloramines remains in the water. Flow of water shall be

* Note Disinfection not applicable to non-potable water conveyance project.

controlled to prevent erosion, damage to vegetation and altering of ecological conditions. The Contractor shall be responsible for furnishing fittings and all special pipe taps required for injecting any required sterilization solution.

C. DISINFECTION: Disinfection and testing of the potable water lines shall be performed in accordance with AWWA Standard C651.

3.15 INSPECTION

A. NOTIFICATION OF MANUFACTURE: Unless specifically waived, The Owner's Inspection Department shall be notified at least two working days prior to commencement of the manufacture of pipe.

B. HYDROSTATIC TESTING: Steel cylinders shall be hydrostatically tested to a stress equal to 75% of the minimum yield point of the steel. Certification of all cylinders is required by The Owner.

C. SPECIALS: Specials shall be bulkheaded and tested prior to lining and coating of weld seams at one-and-one-half (1 1/2) times the design pressure (class). Dye penetrant process may be used on all untested welds in lieu of hydrostatic testing if the straight pipe used in fabricating the special has passed a hydrostatic test of 75% of the yield point. All defective welds including pinholes and porous welds shall be chipped out, rewelded, and retested.

D. RUBBER GASKETS: Rubber gaskets shall be subject to inspection and/or testing by the Engineer. All unsatisfactory gaskets shall be immediately replaced at no expense to The Owner.

END OF SECTION 15064

SECTION 15081

GASKETS

PART 1 - REQUIREMENT

1.01 Gaskets for steel and cast iron flanges shall be in accordance with Section 15060, paragraph 2.02C.5.b.

PART 2 - MATERIALS

2.01 Gaskets for flanged joints shall be 1/16 inch thick compressed non-asbestos sheet, and shall be of a quality equal to Garlock Blue-Gard 3000 or Anchor Green Klinger C4401.

2.02 Wherever blind flanges are shown, the gaskets shall consist of 1/16-inch thick reinforced rubber which shall cover the entire inside surface of the blind flange and shall be cemented to the surface of the blind flange unless epoxy lining is specified on the plans.

PART 3 - EXECUTION

3.01 Gaskets that after installation are found to be leaking or defective in any way shall be replaced at no additional cost to the City.

END OF SECTION 15081

SECTION 15089

NUTS & BOLTS

PART 1 – GENERAL

1.01 DESCRIPTION

This section covers the requirements for furnishing and delivery of bolts and nuts for all systems as indicated in the Contract Documents.

PART 2 - MATERIALS

2.01 – GENERAL

A. ASSEMBLY BOLTS: Assembly bolts shall have a hexagonal head conforming to ANSI B18.2.1 for wrench head bolts and shall use heavy-pattern hex nuts.

B. THREADS: All bolts and nuts shall be coarse threaded in accordance with ANSI B1.1, with Class 2A and 2B fit.

2.02 – APPLICABLE CONDITIONS

A. NON-SUBMERGED CONDITION (Above Grade or Buried): All bolts and nuts in a non-submerged condition shall be per the following:

1. Bolts shall conform to ASTM A449-J429 Grade 5 or ASTM A325, Type 1.

2. Nuts shall conform to ASTM A563 C3 heavy hex.

3. Bolt length shall conform to the requirements of AWWA C-2074.1.4 (one (1) to three (3) threads longer than the total of two (2) flange thicknesses, the gasket thickness and the heavy nut thickness).

4. All nut and bolt surfaces shall be Xylan coated (fluorpolymer) with Tripac 2000 blue coating system or approved equal.

5. Tensile strength of bolts and studs shall be per ASTM 449, Table 3 (1992).

B. SUBMERGED CONDITION/POTABLE WATER CONTACT: All bolts and nuts in a submerged condition that may come in contact with potable water and/or within the interior of a water storage tank, vessel or related equipment which will contain potable water, shall be ASTM F593 Stainless Steel Type 316 bolts and studs and ASTM A276 Type 316 for heavy nuts shall be per the following:

1. The nuts shall be coated with (fluorpolymer) **(FDA- compliant Xylan 1400 RC/D12431 FDA Matte Black #2) Tripac 2000 coating system by Whitford Corp.** or approved equal.

2. Application of Xylan coating shall be by an applicator approved by Whitford Corporation (coating manufacturer). The nuts are to be coated to resist galling and allow future removal.

3. Minimum bolt tensile strength shall be:

a. 1/4″ to 5/8″ incl.	120,000 to 160,000 psi
b. 3/4″ to 1″ incl.	110,000 to 150,000 psi
c. 1 1/8″ to 1 1/4″incl.	100,000 to 140,000 psi
d. 1 3/8″ to 1 1/2″ incl.	95,000 to 130,000 psi

4. Minimum bolt yield strength shall be:

a. 1/4″ to 5/8″ incl.	95,000 psi
b. 3/4″ to 1″ incl.	75,000 psi
c. 1 1/8″ to 1 1/4″incl.	60,000 psi
d. 1 3/8″ to 1 1/2″ incl.	45,000 psi

C. SUBMERGED CONDITION/SEWAGE ENVIRONMENT: All bolts and nuts within an environment which is exposed to sewage, whether liquid or vapor, shall be per the following:

1. Bolts shall be in conformance with ASTM F593 Stainless Steel Type 316 for bolts and studs.

2. Nuts shall be in conformance with ASTM A276 Type 316 for heavy nuts.

3. The nuts shall be coated with Xylan (fluorpolymer) per Tripac 2000 blue coating system or approved equal.

4. Application of Xylan coating shall be by an applicator approved by Whitford Corporation (coating manufacturer). The nuts are to be coated to resist galling and allow future removal.

5. Minimum bolt tensile strength shall be:

a. 1/4″ to 5/8 incl.	120,000 to 160,000 psi
b. 3/4″ to 1″ incl.	110,000 to 150,000 psi
c. 1 1/8″ to 1 1/4″ incl.	100,000 to 140,000 psi
d. 1 3/8″ to 1 1/2″ incl.	95,000 to 130,000 psi

6. Minimum bolt yield strength shall be:

a. 1/4″ to 5/8 incl.	95,000 psi
b. 3/4″ to 1″ incl.	75,000 psi
c. 1 1/8″ to 1 1/4″ incl.	60,000 psi
d. 1 3/8″ to 1 1/2″ incl.	45,000 psi

END OF SECTION 15089

SECTION 15099

PROCESS VALVES, REGULATORS AND MISCELLANEOUS COMPONENTS

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in the Conditions of the Contract and Division 1 form a part of this Section. The Contractor shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to furnish and install all valves and appurtenances as indicated on the Drawings, and specified within.

1.02 SCOPE OF WORK

A. WORK INCLUDED IN THIS SECTION: The Work of this Section shall include the furnishing, installation, and testing of all valves and appurtenances as specified herein, shown on the Drawings and as required to make the entire facility operable except for those valves and appurtenances required to be provided in other Sections of these Specifications. Provide small diameter valves to isolate instrumentation and other miscellaneous uses from process piping.

B. RELATED WORK SPECIFIED ELSEWHERE: The following Work shall be included as part of the Work of this Section; provided that such Work shall be performed in accordance with the applicable requirements of the following Sections:

1. Process piping and appurtenant Section 15060
2. Cast-in-Place concrete Section 03300
3. Coating systems for water pumping plants Section 09871

1.03 VALVE SCHEDULE

Valves shall be of the type shown on the Drawings with rating and construction as specified in Division 15. All valves of the same type shall be of the same make unless otherwise approved.

PART 2 - PRODUCTS

2.01 PRESSURE RATING

All process valves shall be rated for a working pressure equal to or more than the pressure rating of the connection piping unless specifically shown otherwise on the Drawings or specified in other Sections of these Specifications.

2.02 OPERATORS

A. GENERAL: The operators shall be sized based on the maximum expected torque as per valve manufacturer's recommendations. The responsibility for proper operation shall reside with the valve supplier.

B. MANUAL OPERATORS: Manual operators, except where otherwise shown or specified, shall be worm-gear type, Limitorque HBC, E-I-M Type MG, or approved equal and shall include AWWA input limit stops when indicated. The axis of the worm shaft shall remain fixed during operation. A handwheel shall be provided except where an extension stem and floor stand or valve box, tee wrench and street box are required. Extension stems and accessories shall be sized for valve manufacturer's recommendations.

1. Gate and Globe Valves: All gate, globe and angle valves shall be fitted with cast iron handwheels of suitable size or gear operators in accordance with the manufacturer's recommendation.
2. Butterfly Valves: All butterfly valves 4 inch and smaller in size shall be electronic operated and valves 6 inch and larger in size shall be equipped with handwheel actuators. The operators shall be furnished by the manufacturer of the valve, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operators shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be for the service and all exposed nuts, bolts, springs, and washers shall be 316 stainless steel.
3. Plug and Ball Valves: All plug and ball valves 4 inch and smaller in size shall be lever operated and plug valves 6 inch and larger in size shall be provided with enclosed gear and handwheel operators unless otherwise shown or specified. Buried or submerged valves shall have properly constructed actuators for the service and all exposed nuts, bolts, springs, and washers shall be 316 stainless steel.
4. Chainwheel Operator: All valves six feet or more above the floor level shall be provided with chainwheel operators in lieu of the handwheel operator and shall be the valve manufacturer's standard, with galvanized chain to be furnished in the length required for operation.
5. Wrench Nut Operation: An AWWA nut or shaft key, as applicable, shall be provided in lieu of handwheel where required for connection to extension stem and floor stand or for buried valves. Nut shall be 2 inches square and be constructed of cast iron. The nuts shall have a flanged base upon which shall be cast an arrow at least 2 inches long showing direction of opening. The word "OPEN" shall also be cast on the flange. No submerged or

buried operator shall require maintenance following installation. Suitable gaskets, O-rings, and other features shall ensure permanent watertightness.

2.03 FLOOR STAND ASSEMBLIES

A. Floor Stands shall be provided for all submerged gates and valves and be complete with extension stems and stem guides where necessary to obtain support on not more than 5 foot centers. For manual operation, the stand shall incorporate a wrench handle with locking ratchet and indicator for direct ungeared, manual operation of the valve or may incorporate a worm gear and handwheel operator or equal. The extension stem shall be as required, and any necessary guides shall be of approved design for the given conditions. For motor-operated submerged valves, the floor stand shall be designed for mounting the motor operator, and the stem and guide shall be as required above for manual operation.

B. Floor Stands shall be heavy-duty cast-iron, non-rising, indicating pedestal type, designed specifically for the intended application. Handwheel shall have arrow cast in, as applicable, and the word "open" indicating direction for valve opening shall be incorporated. Each extension stem shall have an upper and lower universal joint of Type 316 stainless steel to compensate for any misalignment. The extension stem shall not be less than 3/4 inch diameter, extra-strength pipe. The step guides shall consist of a cast-iron block bolted to a cast or fabricated steel bracket. Each guide shall be adjustable in two directions at right angles to each other in a plane perpendicular to the stem. The floor stands shall be as manufactured by Crane, Clow, Kennedy, Mueller, Walworth or approved equal.

2.04 VALVE BOXES

A. GENERAL: The Contractor shall provide for all buried valves, cast-iron, precast concrete or manufactured asbestos-cement valve boxes, unless otherwise specified on the Drawings.

B. DESIGN: Valve boxes shall be designed to be installed over each direct buried valve adjustment and with flared base. Covers shall be cast-iron and shall have cast-iron ring. Covers on valve boxes shall be drilled to accept expansion rivets and shall have a brass nameplate affixed thereto identifying the process piping controlled by said valve and the sheet in the Contract Drawings where it can be identified. Each cover shall be affixed by brass chain to its respective box. The box shall be of such length as will be adapted, without full extension to the depth of the cover required over the pipe at the valve location. Boxes of improper length will be rejected. Boxes shall be suitable for the valve size and depth of trench as recommended by the manufacturer.

C. Cast Iron Valve Boxes shall have minimum wall thickness of 3/16 inch and shall be as manufactured by Alhambra Foundry, Clow, Mueller Co., Kennedy, or equal.

D. Precast Concrete Valve Boxes shall be Brooks Products, Inc., Traffic Box, Quick Set, or equal. All features shall be equivalent to cast-iron valve boxes.

2.05 PRESSURE RELIEF VALVES

All pressure relief valves on lines containing fluid or steam shall have the discharge of the valve piped to floor level.

A. STAINLESS STEEL VALVES shall be adjustable tension, spring loaded, flush seated type. The design of the valve shall be such that no "dead" spaces exist. All parts shall be 316 stainless steel.

B. WEIGHT LOADED RELIEF VALVES: For air and gas service, valves shall conform to ASME Unfired Pressure Vessel Code for noxious and inflammable gas service, Crane 2650, Farris, or approved equal.

C. SPRING LOADED RELIEF VALVES shall have a bronze or steel body and composition diaphragm and seating surfaces. The valves shall be as manufactured by Fisher Controls Company, GA Industries or approved equal.

2.06 SMALL DIAMETER ISOLATING VALVES

Provide all small diameter valves and cocks for shutting off process connections to instrumentation and other miscellaneous uses. These shall be gate valves and plug cocks of the same material and pressure rating as the adjacent process piping. Shutoff valves to instrumentation shall be coordinated with Division 15 and shall be not less than 1" NPT unless otherwise specified and manufactured by NIBCO T-585-70-66 or T-585-70-66-SU or approved equal.

2.07 HOSE BIBBS AND HOSE VALVES

Hose bibbs (HB) shall be 3/4 inch in diameter for all connections using potable water and shall consist of a globe valve or an angle globe valve with a bronze nose nipple, cap and chain. The valve shall be as specified. The valve shall be mounted so that the hose nipple is in the horizontal position.

Hose valves (H) and hose connections (HC) shall be of the size called out on the Drawings and shall consist of a gate valve or angle gate valve with a bronze nose nipple, cap and chain. The valve shall be as specified. The valve shall be mounted so that the nose nipple is in the horizontal position.

Hose valves and hose connections called out on the Drawings to be quick disconnects shall consist of bronze quick coupler. The valves shall be as Specified on the Drawings. The quick coupler shall be as manufactured by PT Coupling Co. or approved equal.

All hose bibbs connected to potable water supply shall be equipped with a vacuum breaker.

2.08 STRAINERS

A. WYE STRAINERS: Wye strainers shall be installed where indicated and as specified herein. Strainers shall be Fisher, Muesco, or approved equal. Strainers shall be suitable for 125 pounds per square inch working pressure. Strainers shall have cast iron body. Strainers shall be furnished with 316 stainless steel strainers with 1/32 inch perforations.

2.09 PRESSURE CONTROL VALVES (SELF CONTAINED)

Pressure control valves of the spring loaded self contained type shall be provided as shown on the Drawings and/or specified herein. The valves shall be for regulating back pressure or discharge pressure as shown on the drawings. Wetted materials shall be entirely suitable for the process fluid as indicated on Drawings. The body shall be bronze or steel unless specified otherwise. The valves shall be sized in accordance with the required flow rate, pressure differential, inlet or outlet pressure range as shown on the Drawings. The pressure control valves shall be as manufactured by Fischer Controls, GA Industries, Watts, or approved equal.

2.10 SOLENOID VALVES

All required solenoid valves on seal water lines and all others which are not specified with the equipment shall be supplied. Solenoid valves shall be packless construction two-way, three-way or four-way as required, and shall be correctly sized for the application. They shall be for normally energized or deenergized operation as required. Valve bodies shall be forged brass unless otherwise recommended by the manufacturer for a particular application. The solenoids shall be rated for continuous operation at 110 percent of rated voltage. They shall be 120V AC, 60 Hz operated. All coils shall be housed in NEMA 4 cases with provision for 1/2 in. electrical conduit. Solenoid valves shall be as manufactured by ASCO, Skinner, Magnetrol or approved equal.

2.11 PRESSURE GAUGES

Pressure gauges shall be WIKA Type 213.40LM, Ashcroft 1009, or approved equal, brass, liquid filled 4" dia face; conforming to the latest revision of AWWA C504 and the following requirements:

A. GENERAL: Pressure gauges for working pressures of 15 psi or less shall be actuated by a bellows or diaphragm. For working pressures greater than 15 psi, gauges shall be actuated by a copper alloy Bourdon tube. All gauges shall be provided with cleanout plugs or flushing connections. (Refer to Section 15131)

1. Diaphragm Seats: Pressure gauges installed on raw sewage or any pipeline carrying solids in concentrations greater than 500 mg/1 shall have a diaphragm seal between the process fluid and the pipe line and the seal shall be equipped with a flushing water connection.

2. Pulsation Dampeners: Pressure gauges without diaphragm seals shall have a pulsation dampener installed between the process fluid and the pressure gauge.

3. Shut-off Cock: Pressure gauges shall be installed with a shut-off cock between the process fluid and the diaphragm seal or pulsation dampener.

B. CONSTRUCTION: Pressure gauges shall be 4" dial size, liquid filled with 1" dia. corp. stop and bronze reducing bushings as detailed on the Drawings. Window shall be shatterproof glass or acrylic. Connectors shall be 1/4 inch, NPT, bottom, male.

2.12 ROTAMETERS - PURGING TYPE
(Not Applicable)

2.13 FROTH SPRAY NOZZLES
(Not Applicable)

2.14 CONDENSATE TRAPS
(Not Applicable)

2.15 BACK FLOW PREVENTORS

All back flow preventers required by these Specifications or shown on the Drawings shall be the reduced pressure type and shall consist of two spring loaded check valves and one differential relief valve. This device shall automatically reduce the pressure in the zone between the check valves. Should the upstream and downstream pressure drop to 3 psig

or less, the differential relief shall open and maintain the proper differential. Valves shall be supplied with inlet and outlet shut off valves. The valves shall conform to the requirements of the State of California USC List and shall comply with all provisions of AWWA Spec. No. C506-78. Valves shall be, or equal to, those shown in the following schedule:

Pipe Size	Manufacturer and Model
3/4" thru 1-1/2"	Cla-Val RP2 Watts 900
2" thru 10"	Wilkins 975XLRV

2.16 DRAINS

Floor and area drains not specified elsewhere shall comply with the following:

A. HEAVY DUTY DRAINS shall be cast iron body with cast iron tractor grate. The minimum free area of the grate shall be 29 square inches. The outlet pipe size shall be as shown on the Drawings. The drain shall be Figure 2141 as manufactured by Jay R. Smith or approved equal.

B. GUTTER DRAINS shall be used for small drainage areas. The drains shall be cast iron body with bronze flashing and bronze grate. The grating shall be flat strainer or low dome as called out on the Drawings. The outlet pipe shall be as shown on the Drawings. The drains shall be series 1600 as manufactured by Jay R. Smith or approved equal.

2.17 FASTENERS

Bolts and nuts used to join non-buried flanged valves to adjacent piping shall be carbon steel conforming to ASTM A307-65, Grade B. Protective Coating shall be the same as the pipe and valve.

Bolts and nuts used to join buried flanged or coupled valves shall be 316 stainless steel and coated per system P6 Section 09871.

2.18 VALVE TAGS

All valves shall be provided with a valve tag heavily stamped or engraved to duplicate the valve symbol shown on the Drawings, including hexagons and/or circles with notations, as applicable. The tags shall be stainless steel and a minimum of 1-1/4 inch diameter. Valve tags shall be secured to valves with 18 gauge type 304 stainless steel wire or stainless steel chain through a hole in the tag.

PART 3 - EXECUTION

3.01 INSTALLATION

Installation shall be in conformance with Section 15060 and the following requirements.

A. VALVES AND VALVE BOXES shall be set in true alignment and grade in accordance with the procedures submitted with the shop and erection drawings, and the valves mounted as shown. All adjustment and operating settings of valves and appurtenances shall be made in accordance with procedures and detailed instructions furnished with the erection drawings.

B. BURIED VALVES shall be firmly supported in place by the foundations to preclude strain on the pipe connections. The valve boxes shall be checked for centering plumb over the wrench nut to ensure that the box cover is flush with the finish grade. Earth backfill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to undisturbed trench face if less than 4 feet. Valves shall have their interiors cleaned of all foreign matter before installation. The valves shall be inspected in opened and closed positions to ensure that all parts are in working condition.

C. ABOVEGROUND VALVES AND COMPONENTS shall be rigidly held in place using supports and hangers as shown on the Drawings and as specified in Section 15060. The stem orientation of valves in elevated piping shall be as reviewed by the Owner for accessibility, but no valve shall have stem in the downward direction. Saddle type valve supports shall be provided for all valves in vaults. Supports shall be of rugged construction providing at least 120 degrees under-support for the valve body, shall be constructed of steel as specified in Division 5, and shall be anchored to the foundations.

3.02 PROTECTIVE COATINGS

A. INTERIOR: All interior non-working ferrous surfaces other than stainless steel shall be given an epoxy coating unless modified on the Drawings.

1. General: The epoxy coating shall be applied as specified herein.
2. Material:
   a. Except as otherwise provided herein, the material used shall be 100 percent powder epoxy and shall be Three-M Company "Scotchcoat," 134 Dow DC 3100, Furane 2611, or approved equal (refer to Section 09871).
   b. Where, in the Engineer's opinion, because of the nature of the item being coated, it would be impossible to use the powder epoxy method without causing damage to the item, the use of a

liquid epoxy will be permitted. Liquid epoxy shall be Keysite 750; Tnemec 20; or approved equal (refer to Section 09871).

3. Surface Preparation: The surface shall be blast-cleaned in accordance with SSC-SP-5 (White metal Blast Cleaning). The grit size used shall be as recommended by the epoxy manufacturer.
4. Application: Application of the epoxy coating shall be in accordance with the manufacturer's instructions, provided that, if liquid epoxy is permitted, it shall be applied in not less than three spray coats to give the required total thickness.
5. Thickness of Coating: The minimum dry coating thickness shall be 10 mils, except that the thickness of coating in the grooves for valves or fittings designed to receive a rubber gasket shall be approximately 5 mils. Valves which have a bonded seat shall not require coating of the seat grooves.
6. Inspection: Coating thickness shall be checked with a non-destructive magnetic type thickness gauge. Coating integrity shall be tested with a sponge testing unit operating at approximately 60 volts. All pinholes shall be marked, repaired and retested. No pinholes or other irregularities will be permitted in the final coating.
7. Field Repairs: If small local repairs are necessary, they shall be made using a liquid epoxy recommended by the manufacturer of the epoxy with which the item was initially coated. The surface shall first be hand-tool cleaned in accordance with SSPC-SP-2 (Hand Tool Cleaning). The repair epoxy material shall be applied in accordance with the manufacturer's instructions.

B. EXTERIOR: The exterior of surfaces shall be given a shop prime coating. The shop prime coating shall be compatible with the field applied coating.

1. Nonburied and Immersed Valves and Miscellaneous Components: All valves shall be coated in accordance with Section 09871.
2. Buried Valves: All valves and ferrous valve boxes shall be coated as specified in Section 15060 "Process Piping and Appurtenances."

3.03 TESTS

A. GENERAL: A minimum of one valve out of every five supplied in each size and class shall be tested in accordance with the following.

B. SHOP AND LABORATORY TESTS: Perform shop and laboratory tests on valves and appurtenances as follows:

1. Gate Valves: Perform shop tests for leakage in accordance with AWWA Standards, except no leakage shall occur with design pressure held for one minute.

2. Butterfly Valves: The following applies to all sizes specified from 3 inch diameter to 48 inch diameter.
   a. Gear Operator Tests: Manufacturer shall test each model of gear operator in accordance with AWWA C504, Section 3.8.1.
   b. Performance Tests: Manufacturer shall shop test each butterfly valve for performance, leakage, and hydrostatic pressure in accordance with Section 5 of AWWA C504. If no recent test data is available for valve size and class to be furnished under these Specifications, manufacturer shall perform hydrostatic and cycle tests of said Section 5.
3. Plug Valves:
   a. Material Tests: Manufacturer shall perform physical and chemical properties tests on all components to be used in manufacturing eccentric plug valves in accordance with Section 2.3 of AWWA Standard C504. Records of such tests, if requested by the Owner, should be made available.
   b. Gear Operator Tests: Manufacturer shall test each model of gear operator in accordance with Section 3.8.1 of AWWA C504.
   c. Valve Performance Tests: To demonstrate the adequacy of the valve, the proof of design test as described in AWWA Standard C504, Section 5 and C507, Section 13 shall be performed. The above tests shall be conducted by a laboratory approved by the Owner. The manufacturer shall furnish certified copies of reports pertaining to these tests.
   d. Warranty: The plug valves shall be guaranteed for a period of 3 years from date of project acceptance by the Owner by extending the valve manufacturer's warranty period.

B. FIELD TESTS: Test all valves and appurtenances for proper operating adjustments and settings and for freedom from vibration, binding, scraping, and other defects. The testing of the hydraulically and electrically controlled valves shall be supervised by a representative of the manufacturer who shall verify proper installation, adjustments, and performance. The adequacy of all pipe hangers and supports and valve supports to meet specified requirements shall be verified. All defects found shall be corrected as approved.

3.04 CLEANING

All valves and appurtenances shall be flushed clean of all foreign matter together with the piping as specified in other Sections.

3.05 COORDINATION WITH INSTRUMENTATION

It shall be the responsibility of the Contractor to coordinate with Division 13 regarding the requirements of the control valves.

3.06 COORDINATION WITH OTHER MECHANICAL SUPPLIERS

The installation and operation of the valve and motorized actuators shall be the unit responsibility of the valve supplier.

END OF SECTION 15099

SECTION 15101

BUTTERFLY VALVES

PART 1 - GENERAL

1.01 REQUIREMENT

Butterfly valves for buried water system service. Under this specification the Contractor shall be required to furnish, deliver, and unload within the time specified in the Special Requirements, the butterfly valves as specified on the bidding sheets and hereinafter described in these specifications.

1.02 VALVE MANUFACTURER

The name of the manufacturer of the valves to be furnished by the bidder shall be stated on the bidding sheets. Inasmuch as valves require an in-service review over an extended period of time for evaluation by the City for acceptance, it is necessary that proposed valves other than those specified must be submitted for evaluation well in advance of the bid opening, for acceptance prior to the award of the contract. Generally, the specified thirty five (35) day period following issuance of the Acceptance-of-Proposal will not result in approval of alternate valves.

1.03 GUARANTEE

The Contractor shall guarantee all materials and workmanship of items furnished under these specifications to be free from defects for a period of one (1) year after final completion and acceptance of the entire contract work. The Contractor shall, at his own expense, repair or replace all defective materials or workmanship supplied by him found to be deficient with respect to any provisions of this specification.

PART 2 - PRODUCT

2.01 VALVES

Butterfly valves shall conform to the latest revision of AWWA C-504 and the following:

Butterfly valves and operators shall be Class 150B and have flanged ends to mate ASA 150 lb. steel flanges. Above grade butterfly valves shall be furnished with power actuators.

Butterfly valves shall be furnished with operators of the traveling nut or worm gear type, self-locking in any position, and sealed, gasketed, and lubricated to withstand a submersion in water to 10 psi. The valve shall open by counter-clockwise rotation of a 2 inch square AWWA operating nut.

The operator shall be capable of meeting the torque requirements for opening and closing the valve against:

150 psi upstream and 0 psi downstream pressure.

Maximum inlet-outlet flow rate of 12 FPS, normal flow rate of 6 FPS, and shall be provided with AWWA stops capable of absorbing up to 300 foot-pounds of input torque without damage to the valve or operator.

Butterfly valves shall have Buna N seat bonded or mechanically retained, without use of metal retainers or other devices located in the flow stream, to the body and have disc seating edge of ni-crome or stainless steel. All internal mountings or working parts shall be stainless steel.

Butterfly valves shall have the shaft V-type self-adjusting packing. The shaft shall not be exposed between the valve body and the operator.

Butterfly valves shall be furnished with records of tests specified in AWWA C-504, Section 2.3 and Section 5. All valves shall be furnished with Certified drawings and parts list of the valve and operator. An affidavit of compliance to AWWA C-504 shall be furnished for all valves. Five (5) sets of the above information shall be furnished to the City.

Butterfly valves shall have their internal and external surfaces epoxy coated at the valve manufacturer's plant per Section 09871 ("Coating Systems for Water Pumping Plants").

Approved butterfly valves are DeZurik or City approved equal.

END OF SECTION 15101

SECTION 15102

RESILIENT SEAT GATE VALVES

PART 1 - GENERAL

1.01 A.W.W.A. GATE VALVES

All resilient seat gate valves shall have flanged ends and meet the requirements of A.W.W.A. C-509-(latest) for rubber seated gate valves and shall be tested bubble-tight. In addition, RS Gate Valves shall be furnished with the following items:

A. Valve body and bonnet shall be fusion bonded epoxy coated inside and out (10 mils nominal thickness) and meet all requirements of AWWA C-550.

B. Low zinc bronze or stainless steel stems.

C. All stainless steel body hardware.

D. A fully encapsulated wedge.

E. 2" square operator nut for buried valves or heavy duty hand wheel for above grade valves.

F. Approved Gate Valves are Mueller or equal pre-approved by the Owner.

END OF SECTION 15102

SECTION 15103

ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Single Manufacturer: Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 16000 - Electrical General Provisions apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01340 – Contractor Submittals.

B. Shop Drawings: Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.

C. Calculations: Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

D. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, butterfly valve manual actuators, and butterfly valve electric motor actuators under one cover and in accordance with the requirements of Section 01340 – Contractor Submittals.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The Contractor shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and shall be capable of holding the valve in any intermediate

position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.

B. Manufacturers: Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.

C. Materials: Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.

D. Actuator Mounting and Position Indicators: Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.

E. Standard: Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Slide Gates.

F. Protective Coatings: Protective coatings shall be in accordance with Section 09871 – Protective Coatings.

2.2 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adapter piece.
2. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. The spur or helical gears shall be of hardened alloy steel, and the worm gear shall be alloy bronze. Gearing shall be accurately cut with hobbing machines. Power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.
3. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.

4. Switches
   a. Electronic Type Switches: Limit switches or valve position shall be sensed by a 15 bit, optical, absolute position encoder. The open and closed positions shall be stored in a permanent, non-volatile memory. The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery. An electronic torque sensor shall be furnished. The torque limit may be adjusted from 40 to 100 percent of rating in 1 percent increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a "jammed valve" protection feature with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs. Valve actuators with electronic type switches shall be as manufactured by Limitorque or Auma Actuators, Inc.
   b. The actuator shall be wired in accordance with the schematic diagram. Wiring for external connections shall be connected to marked terminals. One of 1-inch and one of 1.25-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Switches shall not be subject to breakage or slippages due to over-travel. Traveling-nuts, cams, or micro switch tripping mechanisms shall not be used. Limit switches shall be of the heavy-duty open contact type with rotary wiping action.
5. Handwheel Operation: A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb.ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel. A clutch lever shall be provided to put actuator into handwheel operation. Valves with electric motor actuators having stems more than 7-feet above the floor shall be provided with chain activator handwheels. The clutch lever shall be provided with a cable secured to the chain to allow disengagement for manual operation.
6. Motor: The motor shall be of the totally enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480 volt, 3-phase 60 Hz current, and have Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. Bearings shall be of the ball type, and thrust bearings shall be provided where necessary. Bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the

failure of either item shall not require actuator disassembly or gearing replacement. Two Class B thermal contacts or solid state thermistors imbedded within the motor windings shall be provided to protect against over-temperature damage. The motor shall be provided with a space heater suitable for operation on 120 volt, single phase, 60 Hz circuit unless the entire actuator is a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion. Each electric motor actuator shall be provided with a local disconnect switch or circuit breaker to isolate power from the motor and controller during maintenance activities.

7. Open/Close Operating Speed: Unless otherwise indicated, electric actuators shall provide a full close to full open or full open to full close operating time range from [30 to 60 seconds].
8. Schedule for Electric AC Actuator Type: For a complete schedule of electric actuators required on project valves (4" diameter and larger), see Mechanical Schedule Drawings.
    a. All electric actuators identified as "OPEN/CLOSE ELECTRIC" in Schedules, shall have AC Reversing type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
    b. All electric actuators identified as "MODULATING ELECTRIC" in Schedules, shall have AC Modulating type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
9. Remote Actuator Control Station. Valves with electric motor actuators where the valve centerline is located at a height greater than 6.5-feet above the floor shall provide a remote actuator control station at a location no higher than 4-feet above the floor. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications. The actuator controls shall be wall-mounted beneath the valve at a location approved by the Design Engineer.

B. Electric Motor Actuators (AC Reversing (Open / Close) Control Type)
1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open / stop / close and local/off/remote selector switches on the actuator local control station.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 480 volt, 3-phase, 60 Hz current. A control power transformer shall be included to provide a 120 volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral

weatherproof compartment shall contain a suitably sized 120 volt ac, single phase, 60 Hz space heater to prevent moisture condensation on electrical components. A local power disconnect switch shall be provided with each actuator. A close-coupled, padlockable switch shall be provided with each actuator.

4. Local Control Station: Each actuator shall be provided with a local control station with the valve actuator assembly. The station shall include open, close, and stop push buttons, and a local/remote selector switch.
5. Manufacturers:
   a. Auma, AC Series.
   b. Limitorque, MX/QX Series
   c. Rotork, IQ3 Series
   d. No “Or-Equals” allowed.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments: Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

A. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

B. Inspection, Startup, and Field Adjustment: An authorized representative of the manufacturer shall visit the Site and witness the following:
   1. Installation of the equipment for not less than two (2) Work Days
   2. Inspection, checking, and adjusting the equipment for not less two (2) Work Days.
   3. Startup and field-testing for proper operation for not less than two (2) Work Days.

C. Instruction of Owner's Personnel: The authorized service representative shall visit the Site for not less than 2 Days to instruct the Owner's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

END OF SECTION

SECTION 15105

AIR VALVES

PART 1 - GENERAL

1.01 REQUIREMENT

Under these specifications the Contractor shall be required to furnish, deliver and unload at the place stated, and within the time specified in the Special Requirements, the air valves for water systems as specified on the Bidding Sheet and hereinafter described in these specifications.

1.02 VALVE MANUFACTURER

The name of the manufacturer of the valves to be furnished by the bidder shall be stated on the Bidding Sheet. If valves different than listed herein are proposed, the bidder shall submit drawings of the proposed valves to the Engineer prior to the time of opening bids. Bidder's drawings need not be submitted if such drawings have previously been approved by the Engineer as to compliance with the specifications.

1.03 GUARANTEE

The Contractor shall guarantee all materials and workmanship of items furnished under these specifications shall be free from defects for a period of one year after final completion and acceptance of the entire contract work. The Contractor shall, at his own expense, repair or replace all defective materials or workmanship supplied by him found to be deficient with respect to any provisions of these specifications.

PART 2 - PRODUCT

2.01 MATERIALS

All valves shall have a body of high grade cast iron and have all internal parts of solid bronze or stainless steel. All valves shall be designed for a working pressure of not less than 85 psi. All air valves within the pump station building shall be epoxy lined per System P12 of Section 09871. (Manufacturer to submit proposed coating to Engineer for Approval)

2.02 OPERATIONAL FEATURES

A. AIR VALVES: All valves shall be designed to automatically operate as specified herein:

1. Will positively open under atmospheric pressure to allow air to escape from the pipe through the valve.

2. Will positively close as water under low head fills body of the valve.

3. Will not blow shut under high velocity air discharge, to allow air to escape from pipe while pipe is being filled.

4. Will permit the escape of accumulated air under pressure, while pipeline is in operation.

B. AIR-VACUUM VALVES: Shall be designed to automatically permit the rapid egress of large amounts of air from the pipeline while the pipeline is being filled with water, and to permit the rapid ingress of large amounts of air into the pipeline while the pipeline is being emptied.

C. COMBINATION AIR-VACUUM AND AIR RELEASE VALVES: Shall be designed to automatically operate as described above for air-vacuum valves and air release valves.

2.03 SYSTEM AIR VALVES

Air valves for use in distribution systems shall be the float and lever type of the makes listed herein, or equal as approved by the Engineer:

Manufacturer		Sizes
A. AIR RELEASE VALVES:		
Apco 50	for 175 psi service	1/2"-3/4"-1"
B. COMBINATION AIR RELEASE & VACUUM VALVES:		
Apco 143-C	for 300 psi service	1"
Apco 145-C	for 300 psi service	2"
Apco 147-C	for 300 psi service	3"
C. AIR/VACUUM VALVES:		
Apco 142	for 300 psi service	1"
Apco 144	for 300 psi service	2"
Apco 152	for 300 psi service	4"

2.04 AIR VALVE SEATS

Air valve rubber seats shall be supplied for the appropriate operating pressure ranges which are indicated in the following table:

Pressure Range	Durometer	Seat
0-10 psi	45	Medium
11-50 psi	65	Medium
51-125 psi	75	Medium-Hard

126-300	85	Hard

2.05 MANUFACTURER'S "FIELD TAG" CERTIFICATION

All air valves delivered to the jobsite shall have a tag affixed to the valve by the Manufacturer stating the durometer rating and type of epoxy lining (if applicable). Air valves delivered without said field tags may be subject to rejection.

END OF SECTION 15105

SECTION 15107

RESILIENT SEAT BALL VALVES

PART 1 - GENERAL

1.01 REQUIREMENT

Ball valves for above grade water system service. Under this specification the Contractor shall be required to furnish, deliver, and unload within the time specified in the Special Requirements, the ball valves as specified on the bidding sheets and the Drawings and hereinafter described in these specifications.

1.02 VALVE MANUFACTURER

The name of the manufacturer of the valves to be furnished by the bidder shall be stated on the bidding sheets. Inasmuch as valves require an in-service review over an extended period of time for evaluation by the City for acceptance, it is necessary that proposed valves other than those specified must be submitted for evaluation well in advance of the bid opening, for acceptance prior to the award of the contract. Generally, the specified thirty five (35) day period following issuance of the Acceptance-of-Proposal will not result in approval of alternate valves.

1.03 GUARANTEE

The Contractor shall guarantee all materials and workmanship of items furnished under these specifications to be free from defects for a period of one (1) year after final completion and acceptance of the entire contract work. The Contractor shall, at his own expense, repair or replace all defective materials or workmanship supplied by him found to be deficient with respect to any provisions of this specification.

PART 2 - PRODUCT

2.01 VALVES

Ball valves shall conform to the latest revision of AWWA C-507 and the following:

A. All ball valves shall be of the tight-closing, shaft-mounted type that fully comply with AWWA Standard C507. Valve design shall be such as to eliminate metal-to-metal contact or wedging in the sealing action. Design pressure ratings shall be 150 psig or 300 psi as indicated on the Drawings and provide drop-tight shutoff against flow in one direction or in both directions as indicated. Design of valve shall be such that with the valve in the open position, the full and unobstructed circular inlet and outlet port diameter shall be as specified in Table 1 of AWWA Standard C507. With the valve in the closed position, valve shall be drop-tight at rated pressure. The manufacturer shall have manufactured tight-closing, rubber-seat ball valves in the specified service for a period of at least five years. Above grade ball valves shall be furnished with heavy duty handwheels.

B. Ball valves shall be furnished with operators of the traveling nut or worm gear type, self-locking in any position, and sealed, gasketed, and lubricated to withstand a submersion in water to 10 psi. The valve shall open by counter-clockwise rotation of a 2 inch square AWWA operating nut. Manual operators shall be equipped with mechanical stop-limiting devices to prevent over-travel of the ball in the open or closed positions. Operators shall be fully enclosed and designed to produce specified torque with a maximum pull of 80 lb. on handwheel or chainwheel and a maximum input of 150 ft-lbs. on operating nuts. Operator components shall withstand an input torque of 300 ft-lbs. at extreme operator positions without damage.

C. The operator shall be capable of meeting the torque requirements for opening and closing the valve against:

300 psi upstream and 0 psi downstream pressure. (Class 300)

150 psi upstream and 0 psi downstream pressure. (Class 150)

D. Maximum inlet-outlet flow rate of 12 FPS, normal flow rate of 6 FPS, and shall be provided with AWWA stops capable of absorbing up to 300 foot-pounds of input torque without damage to the valve or operator.

E. Ball valves shall have Buna N seat bonded or mechanically retained to the body, without use of metal retainers or other devices located in the flow stream. The ball seating edge shall be of ni-crome or stainless steel. All internal mountings or working parts shall be stainless steel. Seats shall seal a full 360° without interruption and have a plurality of grooves mating with a spherical stainless steel seating surface on the plug. Valve seats shall be field adjustable around the full 360° circumference and replaceable without dismantling the operator, plug or shaft. Where line size permits, seats shall also be capable of being replaced or adjusted without removing the valve from the line. Manufacturer shall certify that the rubber seat is field adjustable and replaceable.

In single-seated valves, there shall be one set of ball and body seats. In double-seated valves, there shall be two sets of ball and body seats. Single-seated valves shall provide drop-tight closure in one direction. Double-seated valves shall provide drop-tight closure in two directions.

The shaft shall not be exposed between the valve body and the operator.

F. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting ball travel by means of direct contact or interference with the valve ball in either the open or closed position and which utilizes a ferrous metal bearing surface in direct rubbing contact with an opposing ferrous metal surface, will <u>not</u> be acceptable.

G. Ball valves shall be furnished with records of tests specified in AWWA C-507. All valves shall be furnished with Certified drawings and parts list of the valve and operator. An affidavit of compliance to AWWA C-507 shall be furnished for all valves. Five (5) sets of the above information shall be furnished to the District.

H. Ball valves shall have their internal and external surfaces epoxy coated per Section 09871 ("Coating Systems for Water Pumping Plants").

I. VALVE BALLS AND SHAFTS: The valve ball shall be constructed of cast iron ASTM A48, Class 40, and shall be taper-pinned to an upper and lower fitted shaft of 18-8 Type 304 stainless steel that is turned, ground and polished to a 32 micro-inch or smoother finish per ANSI B46.1. Valves employing chromium-plated iron or steel shafts or trunnions shall not be accepted.

J. VALVE BEARINGS AND SEALS: The center section shall be fitted with sleeve-type bearings contained in the body hubs. Bearings shall be corrosion resistant and self-lubricating, with minimum wall thickness of 1/4". Material shall be Teflon-lined with fiberglass backing. Bearing surfaces shall be isolated from flow by O-ring type seals. The ball assembly shall be supported by a two-way thrust bearing assembly consisting of a stainless steel stud and thrust collar in a grease-packed cavity.

K. Approved ball valves are Pratt or City approved equal.

END OF SECTION 15107

SECTION 15112

DOUBLE-DOOR CHECK VALVES

PART 1 - GENERAL

1.01 REQUIREMENT

Check Valves for water service. Under this specification the Contractor shall furnish, deliver, unload and install, within the time specified in the Special Requirements, the check valves as specified in the Bidding Sheet and hereinafter described in these specifications.

PART 2 - PRODUCT

2.01 CHECK VALVES

Check valves shall be double door, spring loaded, normally closed by means of heavy duty stainless steel tension springs. Check valve bodies and all necessary parts shall be a size and type suitable for use with pressure as specified.

Disc shall seat tightly without slamming under specified working pressure.

The body and plate shall be cast iron (IBBM) with Neoprene Seal and 316SS Stop, Pin, Spring and Pin Retainer.

Check valves shall be subject to hydrostatic test of not less than 300 psi.

2.02 COATINGS

All check valves shall have all wetted ferrous parts epoxy coated. The epoxy shall be thermo-setting, approved for potable water, and shall conform to 09871.

All coated surfaces shall be visually and electrically examined for defects. The coating shall be holiday free with a low voltage wet sponge test per AWWA C-550.

END OF SECTION 15112

SECTION 15161

VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.01 GENERAL

A. TYPE OF PUMP AND PUMP COMPONENTS: This Specification is for close-coupled water lubricated, vertical turbine pumps in suction cans with above-ground flanged discharge and either enclosed or semi-open impellers. All parts of the pump exposed to water shall be of stainless steel, brass, heavy cast iron, or equivalent corrosion-proof material.

B. AWWA STANDARD: Unless otherwise specified herein, all applicable provisions of AWWA E-103 (Horizontal and Vertical Line Shaft Pumps) , latest, are hereby made a part of these Specifications.

C. TERMS AND DEFINITIONS:

1. The term “Pumping Unit” or “Units” shall be defined as a pump complete with motor, head assembly, bowl assembly, column assembly and other materials and components as described herein.

2. The term “Contractor” shall be defined as the general contractor or the organization entering into the contract with the Owner.

D. ACCEPTED MANUFACTURER: The pumps shall be manufactured by Peerless, or Owner approved equal. Refer to Par. 1.08 for “Alternate Pump Manufacturer Requirements”.

1.02 BASIC OPERATING REQUIREMENTS

A. GENERAL

1. Each pump will be used for pumping potable water and shall comply with NSF 61.

2. The capacities, heads, efficiencies, and horsepower requirements specified herein are for completely assembled units.

3. Each pumping unit shall meet the requirements and design points as specified in the Pump Schedule.

B. PUMPING UNIT REQUIREMENT: Each pump and motor combination shall be matched to deliver at least the maximum flow rate at the maximum speed.

1.03 UNIT RESPONSIBILITY

A. GENERAL

1. The Pump Manufacturer shall be responsible for providing the pump, lineshaft, pump shaft, motor shaft (with bronze adjusting nut), column piping, and the motor as a complete unit including discharge head to the Contractor for installation.

2. During the submittal process, the Pump Manufacturer shall provide a notarized certificate stating that all equipment and materials listed above will be provided by the Pump Manufacturer.

3. Pump Manufacturer shall attend pump start-up and provide field services for assistance to the Contractor. Refer to Par. 3.04 of these specifications.

B. COMPATIBLE EQUIPMENT

1. All combinations of manufactured equipment which are approved under this specification shall be entirely compatible and the Contractor and the listed manufacturer shall be responsible for the compatibility and successful operation of the various components of the units conforming to the specified requirements.

2. All necessary mounting, couplings and appurtenances shall be included with each unit.

3. All materials employed in the pump equipment shall be suitable for the intended application and shall be high grade commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

1.04 RELATED SECTIONS

A. SHOP DRAWINGS AND SUBMITTALS: Section 01340.

B. FIELD TESTING AND OPERATIONAL DEMONSTRATIONS: Section 01820.

C. PAINTING AND PROTECTIVE COATING: Section 09871.

D. GENERAL MECHANICAL AND EQUIPMENT PROVISIONS: Section 15010.

E. INDUCTION MOTORS: Section 15170.

F. VERTICAL HOLLOW SHAFT ELECTRIC MOTORS: Section 15171.

G. FIELD VIBRATION TESTING: Section 15991.

1.05 REFERENCE CODES AND STANDARDS

All equipment and materials shall meet the applicable provisions of the following reference codes and standards.

A. Hydraulic Institute (HI)

B. American Iron and Steel Institute (AISI)

C. American National Standards Institute (ANSI)

D. American Society of Testing and Materials (ASTM)

E. American Water Works Association (AWWA)

F. International Organization for Standardization (ISO)

G. Anti-friction Bearing Manufacturers Association (AFBMA)

1.06 SUBMITTALS

A. GENERAL:

1. Submit shop drawings, including related details and data, in accordance with Section 01340.

2. The Contractor shall make a complete and acceptable submittal to the Owner, as determined by the Engineer, by the second submission.

3. The Owner reserves the right to withhold monies due the Contractor or require a $3,000 deposit to cover additional costs of the Owner's review beyond the second submission.

B. PUMP DATA AND CALCULATIONS: Submit necessary data and calculations to demonstrate full compliance with the specification requirements, including, but not limited to:

1. Column and head losses, thrust data, etc.

2. Provide a detailed description of all pump materials and parts.

3. Other calculations or data that may be requested by the Owner or Engineer.

C. ALLOWABLE OPERATING RANGE: Provide statement by Pump Manufacturer specifying the "Allowable Operating Range" as defined by the HI Standards and AWWA E-103 Standard.

D. CERTIFIED PUMP CURVES:

1. The Contractor shall submit certified pump curves based upon factory testing by the pump manufacturer for approval by the Owner, for each pumping unit to be furnished herein; showing head versus capacity, bowl efficiency versus capacity; and NPSHR.

2. Each curve shall be continuous over the full operating range from zero (0) flow up to the maximum flow permissible through each pump, and each curve shall be based upon the RPM listed herein.

3. For variable speed operation, if applicable, include curve for operation at the specified minimum RPM.

4. Each curve shall state the RPM speed of the pumping unit, and shall be furnished full-size on 8 1/2" x 11" paper.

5. The Contractor shall provide pumps capable of meeting all aspects of the Pumping Unit Design Data section herein (Par. 2.04) and as shown on the Drawings.

E. PUMPING UNIT OUTLINE DIAGRAMS: Before the manufacture of the pumping units and appurtenances is commenced, the Contractor shall submit to the Owner for approval, detailed fabrication drawings of said pumping unit material.

F. NPSH REQUIREMENTS: Submit calculations and written certification from pump manufacturer that the pump furnished herein will operate compatible with the Net Positive Suction Head (NPSH) available.

G. DISCHARGE HEAD:

1. Submit details of fabricated steel discharge head and provide written certification from pump manufacturer that the discharge head has the capability of accommodating the specified drives and the design column length within acceptable vibration limits.

2. Submit seismic calculations signed and stamped by a civil or structural engineer registered in the State of California.

H. COATINGS: Provide coating manufacturer's information and data for fusion bonded epoxy lining and coating in accordance with Section 09871.

I. FIELD PROCEDURES: Submit for approval of the Owner a detailed field procedure for installation, adjustment, inspection, and testing of all pumping equipment.

J. TEST PROCEDURES: Pump manufacturer shall submit proposed shop testing procedures at least thirty (30) days prior to the test for approval by the Owner.

K. OPERATION AND MAINTENANCE INSTRUCTIONS: Complete and detailed operation and maintenance instructions shall be submitted in accordance with the Special Requirements.

L. ADDITIONAL SUBMITTAL REQUIREMENTS: Provide submittals and information as set forth in Section 1.07 herein ("Quality Assurance").

1.07 QUALITY ASSURANCE

A. MANUFACTURER'S EXPERIENCE – GENERAL:

1. Manufacturer of the Pumping Equipment specified in this section shall have experience in providing similar type equipment.

2. If required by Engineer or Owner, manufacturers shall show evidence with his submittal of at least five (5) installations where equipment of the same material and same application of the type specified herein have been in satisfactory operation for at least five (5) years.

3. The list of installations shall include the name and telephone number of the Plant Superintendent at each of the five (5) qualifying installations.

B. PERFORMANCE AND ACCEPTANCE TESTING: After completion of the facility, acceptance testing of the pumping units shall be performed in accordance with Par. 3.03 herein; and Section 15010.

1.08 ALTERNATE PUMP MANUFACTURER REQUIREMENTS

A. SUBMISSION REQUIREMENTS FOR ALTERNATE PUMP MANUFACURERS

1. Submission of an alternate pump selection and manufacturer (other than alternate manufacturer/model which may be stated herein) shall require that the Contractor provide the Owner with a $3,000 cash deposit within ten (10) calendar days following Award of Contract to cover engineering expenses related to the detailed review for an “approved equal” status.

2. The evaluation will be performed on a time and material basis; and any unexpended portion of the deposit will be returned to the Contractor.

3. Submission of a bid proposal with an alternate pump manufacturer is at the bidder’s risk since no detailed review or “equal” status determination of any alternate pump or manufacturer (other than provided for under this specification) will be performed prior to the bid opening.

B. NON-APPROVED PUMP MANUFACTURER:

1. Submission of a non-approved manufacturer may be subject to rejection.

2. Authority for determination of "approved equal" pump and manufacturer, including conformance with Specification requirements, shall rest solely with the Owner.

3. In the event that the Contractor's submission of an alternate pump selection and manufacturer is rejected, Contractor shall submit the specified pump and manufacturer at no additional cost to the Owner.

4. No additional contract time extension will be granted for the Owner's review and evaluation.

C. POTENTIAL REQUIRED REVISIONS TO STRUCTURES:

1. Should the equipment selected by the Contractor require revisions to the structures, piping, electrical, or other work shown on the drawings, the Contractor shall include the cost of such revisions in his bid for the equipment, and no extra payment shall be made for such revisions.

2. All such revisions shall be submitted for Owner approval and shall be subject to the approval of the Owner.

1.09 SYSTEM START-UP

Contractor shall provide system start-up and testing in accordance with Section 01820 ("Field Test and Operational Demonstrations"). The Pump Manufacturer shall furnish the services of a qualified field engineer to check installation, start-up and instruct Owner operating personnel in the proper operation and maintenance of the equipment. Refer to Par. 3.04 herein.

1.10 CERTIFICATION OF INSTALLATION

The Contractor shall submit a letter to the Owner confirming that all pumping equipment was inspected, operation checked, and installation approved in writing by the respective Pump Manufacturer and the Contractor. The letter shall be included with the warranty described in Section 1.11 herein; and an executed "Certification of Proper Installation" from the manufacturer shall be provided. The form is included in the appendix of these specifications.

1.11 WARRANTY

All pumping equipment shall carry an extended warranty for a two-year period from the date of acceptance. All warranties shall be turned into the Owner prior to project completion.

1.12 MAINTENANCE BOND FOR PUMPING EQUIPMENT

The Contractor shall provide a maintenance bond from a bonding company acceptable to the Owner equal to 100% of the pumping equipment value (including motors, pumps and pump assemblies) for a two (2) year term starting when the Owner has accepted the contracted work. Equipment and/or components failing within this period due to deficiency in design workmanship or material shall be removed, replaced, and reinstalled at no cost to the Owner, and said replacement shall be guaranteed for two years continuous service. The maintenance bond shall be submitted to the Owner prior to the performance test of the pump(s).

PART 2 - PRODUCTS

2.01 PUMP CONSTRUCTION

A. PUMP BOWLS:

1. The bowls shall be of close-grained, gray cast iron, Class 30 or better, precision cast, free from blow holes, sand pockets, and other detrimental defects.

2. The water passageways in said bowls shall be smooth so as to allow freedom from cavitation and permit maximum efficiency.

3. Each bowl shall have a rubber lateral seal ring and a side seal to prevent slippage of water between bowl and impeller.

4. In order to improve the guaranteed efficiency at the design point(s), lined bowls shall be furnished.

   a. Said lining, vitreous porcelain enamel or equal, shall be of such material and applied in such manner to produce a long effective life which and shall not be applied for the purpose of a short time gain in efficiency.

   b. Lining, identical to that furnished hereunder, shall have been used in the field, under identical conditions, with satisfactory results for at least a five-year period. Lining shall be NSF 61 certified.

5. The outside diameter of the bowls shall be of such size to fit the suction can ID, with proper clearances while maintaining maximum velocity of less than 4 FPS between the pump can and bell, flange or coupling.

6. The bowls shall be able to withstand a minimum of 1 1/2 times the maximum pump shut-off head (zero GPM) pressure or twice the pressure at rated capacity, whichever is greater.

7. Bowl material shall have a minimum tensile strength of 30,000 psi.

B. PUMP IMPELLERS:

1. The impellers shall be of the enclosed or semi-open type, constructed of C95200 aluminum bronze per ASTM B148.

2. They shall be balanced hydraulically and dynamically to prevent vibration and shall be smoothly finished on all surfaces to reduce friction losses to a minimum.

3. The impellers shall be accurately fitted and securely locked to the pump shaft, and vertical adjustment of the impellers shall be possible by means of an adjustment method in the driver assembly.

4. The impellers shall be NSF 61 certified.

C. IMPELLER LOCK COLLETS: The lock collets shall be constructed of AISI B-1113 steel or stainless steel.

D. PUMP SHAFT:

1. The pump shaft shall be constructed of AISI-416 stainless steel and shall be accurately machined to a sufficient dimension to provide smooth operation and to easily withstand torsional loads and other stresses encountered within the pump.

2. The pump shaft shall have adequate bearing support at every bowl section and at the top and bottom case section and shall be equipped with a suitable steel coupling for connection to the line shaft.

E. PUMP BEARINGS:

1. The suction case section and the discharge case section shall be sleeve type constructed of SAE 64 bronze.

2. The bowl bearings shall be sleeve type of zinc-free bronze, or equal as approved by the engineer.

3. Bearing area, bearing cooling, and bearing lubrication shall be ample for long trouble-free operating life of the equipment.

F. PUMP DISCHARGE CASE: The discharge case shall securely fasten the top pump bowl assembly to the column piping. This section shall be heavily reinforced with streamlined fluid passages and shall contain sleeve bearings for the pump shaft.

G. PUMP SUCTION CASE: The suction case shall securely fasten the bottom bowl assembly to the suction bell. This section shall be heavily reinforced with streamlined fluid passages and shall contain a sleeve bearing for the pump shaft.

H. PUMP SUCTION BELL: A suction bell constructed of Class 30 cast iron shall be provided, with entrance vanes so designed to allow even flow of water into the pump.

I. PIPE COLUMN NIPPLE:

1. The column nipple shall be threaded standard pipe and shall conform to the following diameter weight per foot table:

Nominal Size (Inches)	OD (Inches)	Weight Per Foot (Pounds)
4	4.500	10.79
6	6.625	18.97
8	8.625	24.69
10	10.750	31.20
12	12.750	43.77
14	14.000	54.57
16	16.000	62.58

2. The ends of the pipe section shall be faced parallel and machined with threads and/or flanged to insure proper alignment when assembled.

3. The exterior and interior surfaces of all column pipe shall be fusion-bonded epoxy lined and coated with 3M Scotchkoat 134 or approved equal with thickness and application procedures per paint manufacturer's published instructions (Refer to Section 09871, System P11).

4. Lining/coating shall be NSF 61 certified.

J. PUMP DISCHARGE HEAD ASSEMBLY:

1. The pump discharge head shall be of fabricated steel and shall be arranged for mounting, for connecting top column pipe, for connecting to top of suction can, and containing an above ground flanged discharge outlet.

2. A shaft mechanical seal assembly shall be provided, including permanent seal housing with renewable intervals (faces and springs, etc.).

3. The seal assembly shall be approved by the Engineer and shall be manufactured by John Crane, Durametallic or approved equal; and specifically selected for the fluid being pumped, and the operating pressures included.

K. PUMP LINE SHAFT ASSEMBLY: A line shaft shall be supplied, of ASTM A276, Type 416 material, or equal as approved by the Engineer, and shall conform to AWWA E-103.

L. PUMP NAMEPLATE:

1. The pump shall be provided with an easy to read, stainless steel nameplate.

2. It shall contain complete pump information including: pump manufacturer's name, serial number, pump model number, number of stages, speed, TDH and capacity in GPM at the middle design point, etc.

3. Said nameplate shall be mounted on the pump head.

M. WATERTIGHT SEAL: There shall be an appropriate gasket installed between the suction can flange and the pump discharge head assembly to insure and provide a watertight seal.

N. VORTEX SUPPRESSER: A stainless steel vortex suppressor (manufactured by Peerless Pump Company or approved equal) shall be provided and attached to the suction bell of the pump in order to prevent excessive turbulence in the water as it passes from the suction inlet pipe into the suction can, down between the bowl assembly and the suction can, and into the suction bell of the pump.

2.02 SUCTION CAN

A. GENERAL: This detailed specification is for requirements of booster pump suction cans used in conjunction with a line shaft vertical turbine close-coupled pump. The suction can shall be used with pump having a fabricated steel discharge head having above ground flanged discharge outlet. See Contract Drawings for reference.

B. REQUIREMENTS:

1. Suction cans shall be sized as shown on the Drawings, and as specified herein.

2. Suction cans shall be equipped with the specified steel base flange, welded to top of can, designed for attachment of the pump discharge head.

3. Suction cans shall be equipped with 3/4-inch minimum thickness bottom plate, fully-welded (double pass) to bottom of can.

4. Inlet pipe to suction can shall be sized such that the maximum velocity is less than 4 FPS.

5. Suction can lining including suction inlet pipe, shall be cement mortar lined (3/8-inch) by centrifugal application, in accordance with accepted manufacturing standards. Suction can coating shall be one (1) shop applied coat of damp-proof red primer (SO). Refer to System P1, Section 09871.

2.03 SPARE PARTS

A. Each pump shall be furnished with the following spare parts:

1. One (1) set of all bowl bearings
2. One (1) set of impellers
3. One (1) set of all wear rings
4. One (1) set of all pump shaft bearings
5. One (1) set of all gaskets and O-rings
6. Include any special tools required for normal maintenance

B. All spare parts furnished shall be identical and interchangeable with the original parts furnished in clearly identifiable and labeled containers.

2.04 PUMPING UNIT DESIGN DATA

A. GENERAL: The pumping unit shall be furnished in accordance with the design data described herein to fit properly in the proposed 18-inch suction can. The pump driver shall be 30 HP motor in accordance with the electric motor specifications.

B. OPERATING CONDITIONS: The pumps shall be suitable for continuous, long-term operation, operating outdoors under ambient temperatures of 30°F minimum to 115°F maximum. The project site elevation is approximately 950 feet above mean sea level.

C. DESIGN DATA: The pumping units shall be furnished in accordance with the following:

1.	Motor:	40 HP, 480V WP-1 enclosure, 4 pole speed, 20" BD dimension per VHS electric motor specifications
2.	Discharge Head:	12" x 12" x 16.5 FRA 20 fabricated steel; 12" dia. ASA 150 lb. discharge flange
3.	Column:	12" dia.
4.	Line Shaft:	1.19" dia. min.
5.	Bowl Assembly:	Nominal 15" dia. bowl (15.5" O.D.); 1 stages; 1780 RPM
6.	Suction Bell:	16" O.D.
7.	Suction Can:	20" O.D. cyl., 3/8-inch wall thickness, 14' 9" long (refer to Sht. No. 8 of Drawings for details).

8. Pump: Peerless 14 HH/LC; 1 stage; premium efficiency (hand polished); Imp. No. 2621973; or Owner approved equal.

D. OPERATING CONDITIONS:

1. Operating Conditions:

Pump Design Points	Min. Bowl Lab Efficiency
2,000 gpm @ 53' TDH*	75.1%
2,500 gpm @ 45' TDH* (Mid Design Point)	81.6%
2,810 gpm @ 41' TDH*	81.7%

*Exclusive of losses in column and head

2. Shut-off Head: 77 feet

3. Thrust (Hydraulic & Wt. of Rotary Parts). No continuous up thrust is allowed.

4. Drive Load: Drive load shall not exceed 36 BHP within the full operating range between 41' TDH to 53' TDH, when including shaft loss, bowl efficiency, column loss and discharge head loss.

5. NPSH: Maximum Net Positive Suction Head (NPSH) required at design point shall be 15.7-feet. Static pressure at the pump suction bell is approximately 7 psi. Refer to Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL: Pumping equipment shall be installed in accordance with approved procedures submitted with the shop drawings and as indicated on the Contract Drawings, unless otherwise approved by the Owner.

B. ALIGNMENT: Equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, vibration, shaft run-out or other defects. Equipment shall be secured in position and fixed neatly in appearance. Pumping unit shall be within 0.005" per foot of level at discharge head base.

C. DISINFECTION OF PUMPING UNIT: The pumping unit and material to be installed in the suction can shall be chlorinated just prior to installation by

spraying such areas with a solution having a chlorine residual of not less than 200 ppm.

D. COATING: All exposed materials except corrosion-resistant metals which have not been shop painted shall be field coated as specified in Section 09871 (Protective Coating). Shop painted items which have been damaged during transport and/or installation, shall be touched up per specifications and as approved by Inspector.

E. PUMP PEDESTAL: The pump station construction Contractor shall furnish and install the reinforced concrete pedestal and all necessary embedment and support items as described on the Specifications and Contract Drawings.

F. PIPING AND APPURTENANCES: Furnish and install piping and appurtenances associated with the vertical turbine pumps and motors in accordance with Section 15010 (General Mechanical and Equipment Provisions) and Section 15064 (Water Pipe and Process Piping) of the Technical Specifications and the Contract Drawings.

G. COORDINATION: The pump station construction Contractor will be responsible for coordinating all applicable aspects of the project with the pump and motor supplier including, but not limited to equipment installation procedures and requirements, specific materials to be furnished, scheduling of materials deliveries, overall construction schedule, equipment storage and protection requirements, and equipment testing requirements. The required coordination, including implementation of pump manufacturer's requirements as related to the equipment furnished, shall be included in the construction Contractor's bid price(s), and no additional compensation shall be made therefore.

3.02 FACTORY NON-WITNESSED PUMP TESTS

A. GENERAL:

1. Pump(s) shall undergo factory non-witnessed pump testing. Unless otherwise approved by Engineer, test driver shall be of the same horsepower and voltage as the specified motor.

2. Tests shall be performed in accordance with the applicable provisions of AWWA E103 and the standards of the Hydraulic Institute.

3. The acceptance test shall be per Hydraulic Institute Acceptance grade 1U; with no minus tolerance on efficiency.

4. All tests shall be performed at a submergence level pre-approved by the Engineer.

5. To successfully pass a laboratory performance test, a pumping unit shall meet all performance requirements specified.

B. NON-COMPLIANCE: Should results of the test indicate, in the opinion of the Engineer, that the pumps fail to meet any of the specified requirements, the Owner will notify the Contractor of such failure. The manufacturer shall thereupon, at no expense to the Owner, make such modifications and perform additional testing as may be necessary to comply with these specifications.

3.03 FIELD ACCEPTANCE TEST RESPONSIBILITY

A. GENERAL: The Contractor under this specification shall have full responsibility for the proper installation and performance of said pumping equipment, including furnishing the services of a pumping equipment field Service Engineer to inspect during equipment installation, and to adjust, if necessary, any portion of the pumping equipment required herein.

B. TESTING AND PERFORMANCE: The Contractor's Field Service Engineer (Pump Manufacturer) shall be responsible for the pumping unit field acceptance tests. The pump unit(s) shall perform in the field substantially as shown on the certified pump curves furnished by the Contractor after reasonable allowances for field conditions. The head capacity, input horsepower, and overall efficiency values will be determined for at least three points in the stated operating range of the pump, and will be compared with the certified curves.

C. INDEPENDENT TESTING COMPANY REQUIREMENT: For field testing measurements, Contractor or Pump Manufacturer shall arrange and pay for an independent testing organization as approved by the Owner. The independent testing organization shall supply all necessary measuring equipment (calibrated test gages, flow measuring, shaft RPM measurement, electrical current measuring and vibration testing equipment, etc.).

1. The Owner's flow meter (with accompanying factory certification), may be utilized for obtaining test flow rates subject to approval by the Owner.

D. FIELD TEST DOCUMENTATION: Field Service Engineer for Pump Manufacturer shall provide documentation to Engineer (including “Certification of Proper Installation”) for all field adjustments made and tests performed.

E. NON-COMPLIANCE: In the event that the tests reveal noncompliance of the workmanship or equipment with these specifications, the Contractor shall be required to perform, at his own expense, such work and furnish materials as will, in the opinion of the Engineer, restore the equipment to the specified performance.

3.04 SERVICES OF MANUFACTURER

A. GENERAL: The services described herein are for field installation and field acceptance testing as described in Par. 3.03 herein. For purposes of this paragraph, a work day is defined as an 8-hour period at the site, excluding travel

time. The Owner may require that the manufacturer's services described herein be furnished in three (3) separate trips.

B. INSPECTION, STARTUP AND FIELD ADJUSTMENT: The service representative of the manufacturer (Field Service Engineer) shall be present at the site for a minimum of two (2) work days.

C. INSTRUCTION OF OWNER'S PERSONNEL: The training representative of the manufacturer shall be present at the site for one (1) work day to instruct Owner personnel on the operation and maintenance of the pump equipment.

3.05 MAINTENANCE BOND FOR PUMPING EQUIPMENT

The Pump Manufacturer or Contractor shall provide a maintenance bond (**Refer to Appendix**) from a bonding company acceptable to the Owner equal to 100% of the pumping equipment value (including motors, pumps and pump assemblies) for a two (2) year term starting when the Owner has accepted the contracted work. Equipment and/or components failing within this period due to deficiency in pump design, workmanship or material shall be removed, replaced, and reinstalled at no cost to the Owner, and said replacement shall be guaranteed for two years continuous service. The maintenance bond shall be submitted to the Owner prior to the performance test of the pump(s).

3.06 IN-SERVICE CHECKS

As a part of the Work, in-service checks of each pumping unit shall be performed eleven months after acceptance (total 1 check) during the period of the warranty by qualified technical representatives of the Pump Manufacturer. Check shall be detailed and complete and thoroughly documented, including but not limited to the following: vibration testing (Section 15991), pumping plant efficiency testing by an independent testing organization as approved by the Engineer, motor inspection (including motor bearing), and shall be performed under the observation and to the satisfaction of the Owner’s Plant Superintendent or his designated representative. All costs for in-service checks shall be included in the Contract Price. In-Service Checks shall be conducted in accordance with Section 001820-1.07 of the Technical Specifications.

END OF SECTION 15161

SECTION 15170

INDUCTION MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION

Requirements specified in Conditions of the Contract and Division 1 form a part of this Section. This Section outlines the electrical requirements for squirrel-cage and wound-rotor induction motors, and forms a part of all other Sections of Division 15 unless otherwise specified.

A. RELATED WORK NOT INCLUDED IN THIS SECTION:

1. Painting and Protective Coatings, Section 09871

2. General Provisions, Section 15010

3. Deep Well Vertical Turbine Pumps 15162

4. Vertical Hollow Shaft Electric Motors 15171

5. Motor Controls, Section 16920

1.02 POWER WIRING

The power circuits shall supply alternating current, 60 Hertz and at the voltage as shown on the Drawings. The wiring shall be complete, and include all motor connections.

1.03 TERMINAL BOXES

The motors shall be equipped with metal terminal boxes for all conduit and wire connections, having minimum dimensions and usable volumes in accordance with NEMA MG1-2003.

Boxes shall be properly sized, diagonally split, and rotatable in 90 degree steps. Provide a gasket between the box and motor frame, and attach the box to the motor frame with high strength zinc plated and chromated steel bolts and cap screws.

1.04 FINISH

The castings shall be coated with a red-oxide zinc-chromate primer, and finished with a corrosion resistant epoxy coating. Refer to Division 9 – "Finishes".

1.05 NAMEPLATES

Provide stainless steel nameplates of ample size with clear numerals and letters.

A. NAMEPLATES shall indicate the manufacturer, serial number, model number, type, horsepower, phase, hertz, volts, design, full load amperes, locked rotor code letter, service factor, full-load speed, and class of insulation system based upon a reference ambient temperature of 40°C. Auxiliary devices and their ratings shall be described on the main nameplate, or on an additional nameplate of similar construction as the main nameplate. The full-load efficiency of motors 1 through 500 horsepower shall be identified on the nameplate by a nominal efficiency selected from the Nominal Efficiency column in MG1-2003, Table 12-12. Nominal and minimum efficiencies for motors larger than 500 HP shall be equal to or greater than the efficiencies listed in NEMA MG1-2003 for a 500 HP premium efficiency motor.

B. NAMEPLATE DATA shall be complete in English.

C. NAMEPLATES shall be secured to the motor frame with 316 stainless steel screws in accessible locations.

1.06 GROUNDING

Lugs shall be provided in all motor terminal boxes for grounding.

1.07 SUBMITTALS

Submit for District's approval shop drawings and technical data for motors supplied with driven equipment as specified in this Section, Section 15010, Section 15171 and Section 01340.

A. SHOP DRAWINGS: The equipment shop drawings shall be complete and include the following.

1. Plans shall show the equipment assembly, space requirements, clearances and locations for conduits and anchor bolts.

2. Elevations shall show the component arrangements of the equipment.

3. Details shall show the required enlarged small parts.

4. Dimensions shall be included on the Drawings.

5. Weights for equipment shall be included on the Drawings.

6. Certification of motor sound output in accordance with NEMA MG1-2003 shall be furnished. Machine sound shall be measured in accordance with IEE Std. 85 and field verified over operating range at startup.

B. TECHNICAL DATA: Complete equipment descriptive, operation and a guaranteed motor design and performance sheet which shall include the following data; horsepower, speed, service factor, ambient temperature rating, temperature rise, class, insulation class, voltage amperage, phase, frequency, starting code,

locked rotor amps, efficiency, power factor, etc. shall be submitted with the shop drawings.

C. CURRENT DATA: Submit eight copies to the City of field recorded current data. The data shall indicate the full load current for each motor, and current rating for the overload relay in each motor starter and controller.

D. TEST REPORTS: Copies of the factory test reports shall be certified by the manufacturer and submitted to the City as outlined in Section 15010.

E. INSTALLATION AND OPERATION REPORTS: Copies of the Manufacturers' Certified Reports for motor installations 75 horsepower and larger and motor operations, as specified in Section 15010, shall be submitted to the City.

PART 2 - PRODUCTS

2.01 GENERAL

Provide all the motors, and complete the installations as shown on the Drawings, and as required. The motors shall be completely fabricated, assembled, checked and tested at the factory in accordance with NEMA MG-1. The induction motors shall be U.S. Electrical Motors, General Electric, or approved equal.

A. ELECTRIC MOTORS: The motors shall be open or totally enclosed machines as specified and required. Motors shall operate continuously and satisfactorily in ambient temperatures from minus 10 degrees C to plus 40 degrees C and maximum elevations of 3,300 feet. Motors shall be sized for proper operation of the driven equipment without exceeding nameplate horsepower rating for continuous operation. Torque and slip characteristics shall be as recommended by the manufacturer of the driven equipment and as specified. Motors shall be supplied by the manufacturer of the driven equipment as specified in this Section, and specifically outlined in the equipment specifications. Motors shall be designed for high efficiency and high power factor. Nominal full-load efficiency shall meet or exceed the values stated in NEMA MG1-2003, Table 12-12 "Full-Load Efficiencies of Premium Efficient Motors." Nominal and minimum efficiencies for motors larger than 500 HP shall be equal to or greater than the efficiencies listed in NEMA MG1-2003 for a 500 HP premium efficiency motor.

B. MOTORS 1/2 HP THROUGH 800 HP shall be 460 volts, 3-phase and 60 Hertz unless otherwise indicated.

C. MOTORS SMALLER THAN 1/2 HP shall be 115/230 volts, 1-phase, 60 Hertz unless otherwise indicated.

D. MINIMUM REQUIREMENTS for motors 1/2 HP and larger shall be NEMA Design B and have NEMA Class "B" insulation, thermal Class 155 or higher.

1. Alternating current motors shall have a service factor of 1.15.

2. The motor load(s) shall not exceed the nameplate for each specified motor, when operating within the full operating BHP range of the pumps indicated in Division 11.

3. The motor must be able to accelerate the driven machine from zero to top speed at 90 percent of rated voltage without overheating.

4. Maximum locked rotor KVA/HP code letter shall be Code G for motor 15 HP and larger unless otherwise indicated.

E. ENCLOSURES for induction motors shall be approved for the installations and as indicated. All motors to be used indoors shall be drip proof or Weather-Protected Type 1; and outdoor motors shall be Weather-Protected Type 1, Totally Enclosed Fan-Cooled, or Totally-Enclosed Explosion Proof. The equipment shall have the manufacturer's corrosion resistant finish.

F. MOTORS shall be three (3) phase, constant speed, squirrel cage induction type and suitable for full voltage across the line starting unless otherwise indicated.

G. CONSTRUCTION OF MOTORS 250 HP AND SMALLER shall include cast iron housings and end brackets. Terminal box shall be cast metal with gaskets between the box and housing, and between the box and cover. The box shall have a threaded conduit entrance. Ventilating fans shall be non-corrosive. Vertical motors shall be provided with aluminum canopy caps. A condensate drain hole shall be furnished in each end bracket on horizontal motors and a single drain hole in the lower bracket of vertical motors.

H. BEARINGS: Provide bearings that are designed for average life expectancy of 40,000 hrs. for the conditions specified in continuous operation, proportion, mountings, and adjustments consistent with best modern practices for all applied radial and thrust loads at specified speeds. Design thrust bearings in vertical motors to carry up or down thrust that pump may impose during starting or operation at any capacity including shutdown. The bearings shall be anti-friction and the bearing chamber shall be coated with a rust inhibiting grease or oil. End brackets shall include lube fill and relief plugs, which allow regreasing while the motor is running.

1. Ball Bearings: The ball bearings shall be double shielded, grease or oil lubricated except for belted service frames where roller bearings shall be furnished. Provide lubrication from readily accessible inlet and outlet plugs or fittings. Provide bearing protection with internal shaft flingers or inner bearing caps.

2. Grease Lubricated Motors: Include fittings for periodic lubrication service except on motors that shall be equipped with factory-sealed bearings.

3. Oil Lubricated Bearing Housing: Equip with a reservoir of depth to provide space for settling of foreign matter, drain plug accessible from motor exterior, and a visual oil level indicator.

4. Sleeve Bearings: Equip with proper oil rings. Wicks or packings are not acceptable.

5. Ball Bearing Couplings on Horizontal Motors: Construct to absorb total movement and thermal expansion of motor and driven equipment shafts.

6. Couplings for Sleeve Bearing Motors: Type to prevent motor rotating thrust surface from contacting sleeve bearing thrust collar.

I. UNFILTERED VIBRATION velocity levels for standard motors resiliently mounted shall not exceed the limits at rotational frequency as specified in NEMA MG1-2003.

For the measurement of vibration on machines provided with a shaft extension keyway, the keyway shall contain a hall key. Motors shall be run at rated frequency and rated voltage with a virtually sinusoidal wave form. The power supply shall provide balanced phase voltages closely approaching a sinusoidal waveform. Tests may be performed where the voltage unbalance does not exceed 0.5%.

Measurement of the vibration shall be made with the machine at no load and uncoupled.

PART 3 - EXECUTION

3.01 GENERAL

Provide all the equipment installations and wiring installations, including connections as indicated, specified and required. Assure proper fits for all equipment and materials in the spaces as shown on the Drawings.

A. MOTORS:

1. Provide power, control, alarm, and grounding installations for all motors as indicated and required.

2. Check the connections and provide correct rotation for all motors.

3. Record the full load current to each motor, and the overload relay rating in each motor starter for the certified data submittal.

4. Provide the wiring for heaters in the motor frames and the required controls to de-energize the heater when the motor operates.

5. Provide the required wiring for all control equipment that shall be furnished and installed by other Sections of the Specifications.

3.02 FACTORY TESTS

A. ALL MOTORS SMALLER THAN 75 HP shall be given Level 1 tests as follows:

Level 1 - Routine Tests per NEMA MG 1-2003, in accordance with IEEE Std 112 (also known as Short Commercial Test), **with report**, including the following:

No load running current
Locked rotor current
Winding resistance
Bearing inspection
High potential test

All motors must have Level 1 tests.

B. ALL MOTORS 75 HP AND LARGER shall be given Level 2 tests, (in addition to the Level 1 tests indicated above) as follows:

Level 2 - Complete Initial Tests **with report**, per IEEE 112 Method B, including the Routine Tests, plus the following:

Full-load heat run
Percent slip, no-load current
Full-load current, locked rotor current
Input current at 125%, 100%, 75%, and 50% of rated load
Locked rotor torque
Breakdown torque (calculated)
Efficiency and Power Factor at 125%, 100%, 75%, and 50% of rated load

Sound Test performed at no-load in accordance with IEEE 85.
Vibration Test **with report**, demonstrating the motor conforms to NEMA MG 1-2003.

3.03 FIELD CHECKS

A. MOTOR INSTALLATIONS shall be complete and correct.

B. OPERATING TESTS shall be performed to observe that motors start, run and stop satisfactorily and comply with sound output and vibration requirements outlined in NEMA MG1-2003. Unless otherwise approved by District, motors greater than 500 HP shall comply with sound and vibration requirements as indicated for 500 HP premium efficient motors.

C. FIELD DAMAGED FACTORY FINISH on equipment shall be touched-up with paint that is equal in quality and color to the original factory finish. Final painting and color selection shall be in accordance with Section 09871.

END OF SECTION 15170

SECTION 15171

VERTICAL HOLLOWSHAFT (VHS) ELECTRIC MOTORS

PART 1 - GENERAL

1.01 GENERAL

The VHS Electric Motor shall be of premium efficient design and shall have rated horsepower, speed and "BD" dimensions as stated in Section 15161 (Vertical Turbine Pumps). The motor shall be a Vertical Squirrel Cage Induction Motor per NEMA and IEEE Standards in accordance with Section 15170 (Induction Motors).

PART 2 - PRODUCTS

2.01 MOTOR DESIGN

Each VHS motor shall be designed in accordance with the following:

A. FRAME: Cast Iron with copper windings

B. ENCLOSURE: WP-1

C. SERVICE FACTOR: 1.15

D. AMBIENT TEMPERATURE RATING: 50°C

E. INSULATION SYSTEM: Class F per NEMA MG 1-2003.

F. INSULATION: Thermal Class 155 or higher.

G. TYPE OF START: Solid State Reduced voltage or VFD

H. VOLTAGE: 480 or as indicated on Drawings

I. FREQUENCY: 60 Hz, 3 phase

J. STARTING CODE: "G" (5.6 to 6.29 KVA/HP Max.)

K. BEARINGS:

1. 40,000 hour bearing life.

2. Bearings supplied shall be of type and size sufficient to satisfy thrust loading requirements for each motor in accordance with manufacturer's standard design. Thrust bearings shall be deep-groove ball, angular contact ball or spherical roller type. High thrust design motors shall be

supplied with angular contact ball bearings whenever possible and in accordance with manufacturer's standard design. Where thrust requirements restrict the use of angular contact bearings, spherical roller bearings shall be furnished. Motors furnished with spherical roller bearings shall also be provided with a system of stainless steel coils in the oil reservoir for the circulation of cooling water.

3. Use synthetic lubrication oil per bearing manufacturer's recommendations.

L. MISCELLANEOUS FEATURES:

1. Space Heaters (75 HP and larger)

2. Screened Ventilation Openings

3. Stainless Steel Nameplate attached to motor containing complete motor data

4. Winding thermistors, one per phase, thermal protection for the winding, using positive temperature coefficient (PTC) sensors and a 40 Series Texas Instruments 50AA relay system. Motor vendor to furnish T.I. 50AA module. (Applies to all motors 75 HP and larger and all inverter-fed motors). Contacts shall be normally open and close on high temperature.

5. Non-Reverse Ratchet (NRR).

M. INVERTER DUTY: Motors indicated as “VFD” shall be premium efficiency and factory rated as inverter duty motors.

N. APPROVED MANUFACTURERS:

1. U.S. Motors
2. General Electric
3. Toshiba
4. Or equal as approved by Engineer

PART 3 - EXECUTION

3.01 SUBMITTALS

Contractor shall submit to Engineer for approval, a guaranteed motor design and performance sheet, which shall include the following data: horsepower, speed, service factor, ambient temperature rating, temperature rise, class, insulation class, voltage amperage, phase, frequency, starting code, locked rotor amps, efficiency, power factor, etc. Submit motor dimension prints, including coupling of hollow shaft.

Submit parameters required for the determination of the Reed Critical Frequency of vertical hollow shaft motors.

Submit data for type of thrust bearings and lubrication oil.

END OF SECTION 15171

SECTION 16000

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. It is the intent of this part of the Contract Documents to cover the work and materials necessary for erecting a complete electrical system, tested and ready for continuous use. The system shall be constructed in accordance with the Contract Documents, and Federal, State, and Local codes and regulations.

1.02 RELATED SECTIONS

A. The Contractor shall coordinate the work with other trades and furnish and install the equipment in accordance with the manufacturers' requirements.

B. The Related Work can be found in other Divisions of these specifications, such as, but not limited to:

Division 0	Bidding Requirements, Contract Forms, and Conditions of the Contract
Division 1	General Requirements
Division 2	Sitework
Division 3	Concrete
Division 9	Finishes
Division 11	Equipment
Division 13	Special Construction
Division 15	Mechanical
Division 17	Instrumentation

1.03 GENERAL PROVISIONS

A. Minimum sizes of equipment, and electrical devices, are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the work.

B. Work indicated on the Plans is approximately to scale, but actual dimensions and detailed Plans should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is governed by field conditions. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination.

C. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

D. The alignment of equipment and conduit shall be adjusted to accommodate architectural changes, or to avoid work of other trades, without extra expense to the Owner.

E. The Contractor shall furnish and install the parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

F. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

G. The Contractor shall layout and install electrical work prior to placing floors and walls. Furnish and install sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement.

Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

H. The Contractor shall furnish and install inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, or other mounting hardware are improperly placed, or installed, the Contractor shall do necessary work, at their own expense, to rectify the errors.

I. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 40 degrees C, and specifically rated for the altitude indicated on the Plans. Electrical equipment not rated for operation at that temperature shall be provided with air conditioning to meet the manufacturers' operating temperature.

J. If any contradictions, contrasts, nonhomogeneity, or inconsistency appears, the strictest criteria noted and the collective requirements in all the project documents shall apply.

K. The Contractor shall perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.

1.04 REGULATIONS, CODES, AND STANDARDS

A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations, codes, and standards, of the following:

1. National Electrical Code (NEC)
2. State and local codes
3. Institute of Electrical and Electronic Engineers (IEEE)
4. American National Standards Institute (ANSI)
5. American Society for Testing and Materials (ASTM)
6. Insulated Cable Engineers Association (ICEA)
7. National Electrical Manufacturers Association (NEMA) Standards
8. Federal Occupational Safety and Health Act (OSHA)
9. National Fire Protection Association (NFPA)

B. When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

1.05 SUBMITTALS

A. It is the obligation of the Contractor to organize their work, so that a complete electrical, instrumentation, and control system for the facility will be provided, and will be supported by accurate shop and record drawings, and O&M manuals.

B. The Contractor shall submit detailed shop drawings and data prepared and organized by the suppliers. The quantity of submittal sets required shall be as specified in the Contract Documents.

C. The submittals shall be neatly grouped and organized by specification section number, and sub-section. Related information shall be highlighted, and the specific product shall be marked. All submittals shall be complete and presented in one package. Incomplete submittals will be returned without review. If a portion of the project requires a fast-track schedule, that portion only may be submitted earlier under a separate cover letter. The following shall be submitted to the Engineer and returned, reviewed to the Contractor before fabrication is started.

1. A complete list of the equipment and materials, including the manufacturer's name, product specification, descriptive data, technical literature, performance charts, catalog cuts, installation instructions, and spare part recommendations for each different item of the equipment specified. The above shall clearly show all the specified requirements as described in the Specifications including but not limited to specific U.L. and NEMA rating, technical capabilities, test result verifications, Seismic Zone rating, and acceptance letters.

2. Drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will operate as intended. Drawings shall also show proposed layout, anchoring, support, and appurtenances of equipment, and equipment relationship to other parts of the work including clearances for maintenance and operations.

3. Any exceptions to these specifications, with the reasons for requesting such exceptions, with calculations and drawings for redesign of related components, including detail drawings showing internal and assembly details, with installation instructions. Proposed layout showing any modifications or exceptions to related work made necessary by this work, with calculations and drawings showing such modifications or exceptions.

4. Prior to project acceptance, The Contractor shall submit “Record Drawings” of the electrical, control, and instrumentation, along with step-by-step procedure manuals for the installation, operation start-up, and maintenance of the equipment. Each set shall include installation, operating, troubleshooting, and maintenance and overhaul instructions in complete detail. It shall also include possible breakdowns and repairs, and troubleshooting guides, as well as simplified wiring and control diagrams of the system installed. This shall provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance, and repair. Exploded or other detailed views of all equipment, devices, assemblies, and accessory components shall be included, together with complete parts lists and ordering instructions.

5. Record Drawings:
    a. The Contractor shall maintain a marked up set of Contract Document Plans showing actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (larger than #12 AWG), and all other deviations from the design Plans.
    b. Underground conduit and concealed items shall be dimensioned on the Plans from permanent, visible, building features.
    c. The Contractor shall provide actual motor size, starter size, and overload heater size, along with all other protective equipment for all 480 V and motor circuits as part of the one-line record drawings.
    d. The Contractor shall revise all conductor identification and panel schedules to indicate as-built conditions.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS AND METHODS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged or dirty materials, equipment, and parts are not considered to be new and unused and will not be accepted.

B. Field verification of scale dimensions on Plans is directed, since actual locations, distances, and levels will be governed by actual field conditions. The Contractor shall also review architectural, structural, yard, mechanical, and other Plans, and the accepted

electrical and mechanical shop drawings, and shall adjust their work to conform to the conditions indicated therein.

C. The fabricator of major components, such as distribution panelboards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein. Where possible, the major components shall be manufactured and supplied by the same fabricator.

D. Refer to various Division sections for individual equipment manufacturers. Indicated manufacturers are subject to strict compliance with the specifications and complete project documents. The reference to a particular manufacturer does not relieve the Contractor from conforming to the specified requirements.

2.02 NAMEPLATES

A. Where indicated elsewhere in these specifications, or on the Plans, the Contractor shall furnish and install nameplates, which shall be white laminate with black letters. The nameplates shall be fastened to the various devices with round head stainless steel screws. Each disconnecting means for service, feeder, branch, or equipment conductors shall have nameplates indicating its purpose.

2.03 EQUIPMENT ASSEMBLIES

A. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.

B. Custom fabricated electrical control panels, and enclosures shall bear a serialized UL label affixed by a local inspector, and the serial number shall be submitted with the assembly record shop drawings.

2.04 SEISMIC RESTRAINT

A. The construction area is classified by the Uniform Building Code (UBC) as Seismic Zone III. The Code requires that not only the structures, but also major electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the UBC, and the Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA) "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than UBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL EQUIPMENT

A. Coordinate the installation of electrical equipment with other trades.

1. Arrange for the building in of equipment during structure construction.
2. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, and other openings, as required to allow installation of equipment after structure construction is complete.

B. Verify that equipment will fit support layouts indicated.

C. Equipment Dimensions and Clearances:

1. Do not use equipment that exceeds the indicated dimensions. Except as approved in writing by the Engineer.
2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

D. Install equipment in accordance with the manufacturer's instructions.

E. Equipment Access:

1. Install equipment so it is readily accessible for operation and maintenance.
2. Equipment shall not be blocked or concealed.
3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

F. Equipment shall be installed plumb, square and true with the building construction, and shall be securely fastened.

G. Outdoor wall-mounted equipment, and indoor equipment mounted on earth, or water bearing walls, shall be provided with corrosion-resistant spacers to maintain ¼-inch separation between the equipment and the wall.

H. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

I. Equipment fabricated from aluminum shall not be imbedded in earth or concrete.

J. Provide all necessary anchoring devices and supports.

1. Use supports as detailed on the Plans and as specified.
2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
3. Hardware shall be stainless steel.
4. Do not cut, or weld to, building structural members.
5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

K. Contractor shall verify exact rough-in location and dimensions for connection to electrical items furnished by others.

1. Shop drawings shall be obtained from those furnishing the equipment.
2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.

3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.
4. Should any cutting and patching be required on account of failure of the Contractor to coordinate penetrations, such cutting and patching shall be done at the expense of the Contractor.
    a. The Contractor shall not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.
        1) Provide additional reinforcing if required.
        2) Cutting shall be done neatly using proper tools and methods.
    b. Subsequent patching to restore walls, ceilings, or floors to their original condition shall be done by the Contractor.

L. Provide concrete foundations or pads required for electrical equipment as indicated or specified.

1. Floor-mounted equipment shall be mounted on a 3-inch concrete housekeeping pad unless otherwise noted on the drawings. Pad shall be poured on top of the finished floor or slab. Contractor shall verify the distance to all equipment from the finished floor meets the current NEC requirements. All modifications shall be made to the electrical equipment as required.
2. All conduits penetrating concrete floors shall have a 3-inch concrete housekeeping pad unless otherwise noted on the drawings. Conduits should be grouped as allowed to limit the number of housekeeping pads required.

3.02 TEMPORARY POWER

A. The Contractor shall furnish, install, and maintain, temporary power and lighting systems needed for construction. This temporary system shall include weatherproof panel(s) for the Contractor’s main breakers and distribution system. Ground fault interrupting equipment shall be installed. Connections shall be watertight, with wiring done with Type SO portable cable. After construction is completed, the Contractor shall remove temporary power equipment and devices.

3.03 CUTTING AND REPAIRING

A. Where it becomes necessary to cut into existing work for the purpose of making electrical installations, core drills shall be used for making circular holes. Other demolition methods for cutting or removing shall be reviewed by the Engineer prior to starting the work.

B. The Contractor shall repair damage caused by construction, or demolition work, and restore damaged areas to original condition.

3.04 CORROSION PROTECTION

A. Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals, as required, with neoprene washers, 9 mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless steel bolts shall be used.

B. Factory finishes damaged during shipping, or construction, shall be restored to original new condition. Rust shall be removed, and bare metal surfaces shall be primed and painted to match the original surrounding finish.

C. Electrical panels, switchgear, motor control centers, and other electrical equipment, shall be shipped in sealed dust and moisture proof plastic sheet enclosures, and the seal maintained until units are installed. Said units shall be new and free of any dirt, dust, water, grease, rust, damaged parts or components. Relays, starters, circuit breakers, switches, contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, and other debris before testing and energizing.

D. Equipment shall be protected at all times with plastic sheet covers until the area is free of dirt, dust, paint spray, water, heat, and other trades. Heat shall be provided to eliminate condensation. All repairs due to storage will be the responsibility of the contractor.

3.05 COORDINATION OF THE ELECTRICAL SYSTEM

A. The Contractor shall verify actual equipment, and motor full-load, and locked-rotor current ratings. The necessary minimum equipment, wire, and conduit sizes are indicated on the Plans. If the Contractor furnishes equipment of different ratings, the Contractor shall coordinate the actual current rating of equipment furnished with the branch circuit conductor size, the overcurrent protection, the controller size, the motor starter, and the branch circuit overcurrent protection. The branch circuit conductors shall have a current carrying capacity of not less than 125 percent of the actual full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices, up to the equipment, shall not exceed 2 percent, when the equipment is running at full-load and rated voltage.

3.06 TESTING

A. The electrical work shall be free from improper grounds, and from short circuits. The correctness of the wiring shall be verified first by visual comparison of the conductor connections with connection diagrams. Next, individual circuit continuity checks shall be made by using electrical circuit testers. Last, the correctness of the wiring shall be verified by the actual electrical operation of the electrical and mechanical devices. Any deviation from the wiring indicated on the Plans, or accepted Drawings, shall be corrected and indicated on the record drawings.

B. Each conductor shall be identified as required by the Contract Documents. This identification shall be indicated on the record drawings to enable rapid and accurate circuit tracing by maintenance personnel.

3.07 ONE-LINE DIAGRAMS

A. One-line diagrams, as indicated on the Drawings, show circuit voltages, circuit protection rating, and other pertinent data. Where conflicts exist on the Drawings, the one-line diagrams shall take precedence. Grounding conductors are not necessarily indicated. See grounding requirements specified elsewhere herein.

END OF SECTION 16000

SECTION 16010

SCOPE OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Scope of work for the Contractor and responsibilities of the Owner's System Integrator (hereafter OSI). Together the Contractor and OSI shall work to provide a completely operable system. The OSI for this project is SKM Engineering, LLC. and the contact person is Mark Jeppsen (mark.jeppsen@skmeng.com, 801-683-3760).

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents in order to provide a complete and coordinated project.

1.2 REFERENCES

A. The installation and commissioning of the Instrumentation and Control System shall conform to all applicable codes, regulations, standards and specifications, including, but not limited to those listed below. These publications are referenced to by designation but not by edition. The latest edition accepted by the Authority Having Jurisdiction in effect at the time of bid shall govern.

1. State and Local Codes and Authority Having Jurisdiction (AHJ)
2. American National Standards Institute (ANSI)
3. American Petroleum Institute (API)
4. Federal Communications Commission (FCC)
5. Federal Occupational Safety and Health Act (OSHA)
6. International Society of Automation (ISA)
7. Institute of Electrical and Electronic Engineers (IEEE)
8. National Electric Code (NEC).
9. National Electrical Manufacturers Association (NEMA)
10. National Fire Protection Association (NFPA)
11. Underwriters Laboratories, Inc. (UL)

1.3 DEFINITIONS

A. The following definitions may be used throughout this section and subsections (refer to the contract drawings sheet I001 for instrumentation abbreviations):

1. CTC: Communications termination cabinet.
2. FAT: Factory acceptance test.
3. HMI: Human machine interface.
4. I&C: Instrumentation and control for process systems

5. IS: Instrumentation supplier.
6. LAN: Local area network.
7. LCP: Local control panel.
8. NC: Normally closed.
9. NO: Normally open.
10. OIT: Operator interface terminal.
11. OSI: Owner's System Integrator.
12. PC: Personal computer.
13. PID: Control action, proportional plus integral plus derivative.
14. PLC: Programmable logic controller.
15. P&ID: Process and instrumentation diagram
16. RIO: Remote input/output
17. SCADA: Supervisory control and data acquisition.
18. UPS: Uninterruptible power supply.
19. VCP: Vendor control panel.
20. WAN: Wide area network

1.4 SCOPE OF WORK

A. Work provided outside of Contractor's scope:

1. The OSI will not be providing any equipment for this project.

2. The following System Integration Services are being supplied by the OSI:

a. PLC, OIT & SCADA System programming
b. The OSI will be on site for loop testing and system commissioning.
c. The OSI will provide an electronic O&M manual that will contain the following:
1) Copies of all programming files

B. The Work is to provide a complete and operational electrical, I&C System as described by the Contract Documents. This includes but is not limited to the following:

1. In order to provide a complete system, oversee and coordinate with all equipment and services being provided outside of Contractor's scope.

a. The Engineer is responsible to ensure that equipment being supplied by others related to the I&C System complies with the requirements of the Contract Documents
b. The Contractor is responsible to coordinate the installation, commissioning and scheduling of equipment related to the I&C System that are provided by others.

2. Provide electrical and instrumentation submittals are required by Division 16. This includes but is not limited to the following:

a. Instrumentation hardware submittal (including TR20 forms).
b. Control panels design and submittal.
c. Loop drawings design and submittal.
d. Recommended spare parts submittal.

3. Following submittal approvals, do the following:

a. Procure all instrumentation hardware and accessories.
b. Procure hardware for and fabricate all control panels being provided.

c. Perform FAT's for all control panels being provided.

4. Provide PLC-F, Filter Console A, Filter Console B, and MCC-CW, and all other associated electrical equipment, conduit, wire and fittings as shown on the Contract Documents.

5. Oversee the demolition of existing equipment as required by the Contract Drawings.

6. Oversee the installation of the electrical and I&C Systems.

7. Oversee and document loop testing.

8. Oversee and document commissioning.

9. Maintain record drawings.

   a. Maintain on the construction site a set of the Contract Drawings, PLC Panel Drawings, and Loop Drawings that shall be continuously marked up during construction.
   b. The drawings should be updated at least weekly and will be checked monthly by the Owner's representative.
   c. Upon completion of startup, submit the marked up drawings to the Engineer for review and for drafting.

10. Provide O&M manuals that contain as-built drawings

1.5 ACTION SUBMITTALS

A. Electrical and Instrumentation Submittals shall be as outlined in Section 16000.

B. Instrumentation hardware submittal

1. Provide a comprehensive submittal that includes all instrumentation being supplied by the Contractor. Divide the submittal into the following:
   a. Table of Contents/Index.
   b. Instrument summary.
   c. Instrument TR20 Forms.
   d. Instrument Cut Sheets.
   e. Instrument Installation Drawings.
2. Provide an instrument summary (sorted by tag number) that has the following information:
   a. Tag number.
   b. Make, model and description.
   c. Associated process.
   d. Location.
   e. Calibrated range.
   f. Referenced loop drawing number and P&ID.
   g. Associated PLC.
3. Furnish TR20 instrumentation forms for each instrument using the forms outlined in ISA-TR20.00.01-2007. This requirement includes all instruments that are being installed as part of the project, whether they are Contractor, Owner and/or Vendor supplied. Show on each sheet who is the responsible party for supplying the instrument. The TR20 sheets should be provided electronically in Microsoft Word or Excel as well.

4. Provide instrument cut sheets for each instrument make and model being supplied for the project. Each cut sheet should have a list of instrument tag numbers that pertain to that particular cut sheet. The cut sheets should have enough information to verify that the instrument conforms to the Contract Drawings and Specifications.
5. Instrument installation drawings
    a. Provide instrument installation drawings for each make and model of instrument being supplied.
    b. Delineate what is being supplied by the Contractor and what is being supplied by other installers.
    c. Show overall dimensions, mounting locations and elevations.
    d. Show all cabling, conduit and piping locations.
    e. Show the ambient conditions of the location where the instrument is being installed which includes ambient temperature and humidity extremes, whether or not the atmosphere is corrosive and the area classification.
    f. Show mounting requirements, brackets, stands and anchoring.
    g. Show means for sun protection where required.

C. Control panels submittal
1. Provide a comprehensive submittal that includes all control panels supplied by the Contractor. Divide the submittal into the following:
    a. Table of Contents/Index.
    b. Panel Bill of Materials and Design Data.
    c. Panel Shop Drawings.
    d. Panel Hardware Cut Sheets.
2. The Panel Bill of Materials and Design Data shall include the following:
    a. Each panel will have its own Bill of Materials and Design Data information presented in association with the panel drawings. The Bill of Materials shall include all hardware inside or on the enclosure. The design data will include UPS and/or battery load calculations to show that the UPS is sized appropriately for load and for backup time. The design data will show panel weight, materials and finishes. HVAC design data shall be shown. Seismic criteria shall be shown if required by the Contract Documents.
3. Panel Shop Drawings:
    a. Each control panel shall be designed to perform its function(s) as shown in the Contract Drawings. The control panel designs shall take into account information shown throughout the Contract Drawings and Specifications.
    b. Show every internal wire and connection diagrammatically. Show all interfaces between the control panel and external equipment to be connected for power, controls, signal, communications, etc.
    c. All shop drawings shall include a title block with the name of the firm designing the control panels. The title block shall also include project information, Owner information and/or logo, drawing number and description, revision fields and date.
    d. All shop drawings shall be developed utilizing AutoCAD version 2008 or later. All shop drawings should be submitted in PDF and AutoCAD formats and as required by Section 013300.
    e. Panel layout drawing(s):
        1) Each control panel shall have shop drawing(s) which depict the front, back, sides and top/bottom of the panel. This includes showing any hardware mounted on the inside or outside of the panel.
        2) Layout drawings should include subpanel and swing-out panel layouts.
        3) Layout drawings should show locations of panel penetrations for cutouts, conduit entry and/or access plates.
        4) Layout drawings should show all of the components and provide a reference to the bill of materials.
        5) Show the elevations of door devices from the finished floor.

f. AC and/or DC power distribution diagrams:
   1) Each panel shall show power distribution schematics that show how the panel receives power and feeds all of its internal loads as well as associated external loads.
g. Communications and/or Network diagrams:
   1) For panels that utilize any means of communications both internally and externally, provide a diagram depicting each communication connection.
h. Input/Output and/or Internal wiring diagrams
i. Terminal block diagrams

4. Provide panel hardware cut sheets for each make and model of equipment being supplied for the project. The cut sheets should have enough information to verify that the equipment conforms to the Contract Drawings and Specifications.

D. Loop Drawings Submittal

1. Provide a comprehensive submittal that includes loop drawings for every control loop on the project. This includes but is not limited to all loops shown on the P&ID's, all loops associated with auxiliary inputs/outputs not shown on the P&ID's (e.g. UPS status information).
2. Loop drawings may only be finalized after all control panels, MCC's and other electrical submittals, and instrumentation submittals have been approved. Obtain all of the required information from each of these submittals to properly show the wiring of each control loop. The loop drawings shall not be submitted with incomplete information due to the lack of obtaining the appropriate information for each loop.
3. The loop drawings shall designed for and printed to 11x17 size paper. Divide the submittal into the following:
   a. Laminated Cover and Back and Spiral Binding.
   b. Table of Contents/Index (by loop number).
   c. Loop Drawings.
4. Loop Drawings Requirements:
   a. All loop drawings shall include a title block with the name of the firm designing the loop drawings. The title block shall also include project information, Owner information and/or logo, drawing number and description, revision fields and date.
   b. All loop drawings shall be developed utilizing AutoCAD version 2008 or later. All loop drawings should be submitted in PDF and AutoCAD formats.
   c. Each loop drawing shall have a look and feel that follows that of the example loop drawing shown in the Contract Drawings.
   d. Each loop drawing should have the following as a minimum:
      1) Six area divisions, from left to right which are:
         a) Field/Process Area (this area will show field and process equipment).
         b) Junction Boxes (this area will show any field junction boxes associated with the loop).
         c) Local Control Panel (this area will show any local control panels associated with the loop).
         d) Electrical Room (this area will show electrical equipment such as starters, VFD's, power feeders, etc. associated with the loop).
         e) Programmable Logic Controller (this area will show PLC Inputs/Outputs associated with the loop).
         f) SCADA (this area will show logical connections for the Inputs/Outputs from the PLC to the SCADA System).
   e. Each loop drawing will show each instrument or field device associated with the loop and its wiring connections and wire labels.
   f. Each electrical enclosure (junction box, local control panel, PLC panel, starter panel, etc.) will show terminal numbers and terminal block group references.

g. All wires to be installed by the Contractor shall be dashed while all wires installed by the panel shop should be solid.
h. Show continuation lines to associated loops that may interface with each loop.
i. Show all wiring associated for the loop including power, controls, signal and communications.

E. Recommended Spare Parts Submittal

1. Submit a list of spare parts for all of the equipment associated with the I&C System. The list of spare parts shall include list pricing for each item.
2. Provide the name, address and phone number for each manufacturer and manufacturer's local sales representative.
3. Indicate whether or not the spare parts are being provided under this contract or not.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. All equipment supplied for this project shall meet the requirements of the National Electric Code (NEC) and shall be listed by and bearing the label of the Underwriters' Laboritories (UL).

B. The Electrical Contractor shall be a company that has been actively involved in the installation and commissioning of I&C Systems for a minimum period of five years.

C. The Electrical Contractor shall have adequate facilities, manpower and technical expertise to perform the Work associated with the I&C System and as outlined by the Contract Documents.

D. The Contractor shall have similar project experience of at least four successfully completed projects for a similar water treatment facility. The Electrical Contractor must have performed similar work for these projects as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials provided under this Contract shall be new and free from defects.

2.2 MANUFACTURERS

A. All equipment provided for the I&C System shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Instruments which utilize a common measurement principle (for example, float switches) shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer.

2.3 OPERATING CONDITIONS

A. The I&C System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:
   1. Environment: Water Treatment Plant
   2. Temperature Extremes: 10°F to 122°F (Outdoors); 50°F to 122°F (Indoors).
   3. Relative Humidity: 20% to 90%, non-condensing.

B. Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete 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 weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

B. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment. Identification shall be prominently displayed on the outside of the package.

D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 INSTALLATION

A. The installation shall be in accordance with the requirements of Division 16. In addition, the following requirements shall be followed:

B. Instrumentation shall be mounted so that it is easily accessible and viewable and such that it does not restrict access to other equipment. Mount instrumentation to pipe stands or wall mounts if they are not directly mounted or if the Contract Drawings indicate otherwise.

C. The I&C System indicated throughout the Contract Documents are diagrammatic and therefore locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of

electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, the Contractor shall make such changes without additional cost to the Owner.

D. The I&C System is integrally connected to electrical, mechanical and structural systems. Coordinate with these other disciplines the installation of these related components. All conduit, cables and field wiring shall be as required by Division 16.

E. Instruments, control panels and all other I&C System related equipment shall be anchored by methods that comply with seismic requirements applicable to the Site.

F. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.

G. Instrumentation, control panels, wiring and all other I&C equipment shall be properly tagged and/or labeled per the requirements of Section 16195.

H. Installation of the I&C System shall be according to the finalized Loop Drawings

3.3 FIELD QUALITY CONTROL

A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

3.4 LOOP TESTING

A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
   1. All associated equipment, conduit and wire has been permanently installed, terminated and inspected.
   2. All wiring has been properly pulled, terminated and labeled.
   3. Each wire has been tested with a point-to-point test.
   4. All control panels and electrical equipment have been checked out and tested as required by Division 16.
   5. All instrumentation has been appropriately installed and calibrated.
   6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.

B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
   1. Loop Number and Description
   2. Check-Off List with room for sign-off and dated by the Contractor, OSI, and Owner's Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
      a. Each power distribution circuit.
      b. Each control circuit.
      c. Each alarm circuit.

d. Each PLC input/output point.
e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
f. Each hard-wired and software interlock.

C. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays.

D. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.

E. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

3.5 COMMISSIONING

A. The Contractor shall oversee, coordinate and be present during all commissioning activities.

B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

3.6 TRAINING

A. Develop a Training Plan for the training requirements of Division 16 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.

B. The Contractor shall train the Owner’s personnel on the maintenance, calibration and repair of instruments provided.

END OF SECTION 16010

SECTION 16060

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Demolition of existing electrical shall be as indicated on the Plans or as indicated elsewhere herein.

B. Demolition information shown on the Plans is based on visual field examination and existing record drawings. The Contractor is responsible for verification of all items indicated or not. All items affected that are not indicated on the plans shall be brought to the Engineer's attention before demolition for direction.

C. The Contractor shall confine demolition work to the item specifically identified on the plans. The Contractor shall be liable for any other damage he may inflict to the existing installations.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Care shall be taken in demolition or removal of items as indicated on plans as being returned to the Owner. The Contractor shall notify the Owner prior to removing existing equipment.

B. Whether indicated on the plans or not, the Contractor shall provide patching material to fill voids where demolition has taken place. Patching materials shall match, as nearly as practical, the existing original structure material for each surface being patched.

PART 3 - EXECUTION

3.01 COORDINATION

A. The Contractor shall verify existing field conditions, measurement, circuitry etc. as indicated on Plans prior to performing any demolition.

B. The Contractor shall verify that abandoned or removed wiring and electrical equipment serve only abandoned facilities. If demolished or abandoned electrical is necessary for proper operation of facilities to remain in service, the Contractor shall immediately notify the Engineer for direction.

C. Demolition shall not be performed without coordinating with new construction to limit down time and ease of switchover. The Contractor must coordinate with the Engineer and the Owner prior to any demolition.

D. Prior to performing any demolition work, the Contractor shall provide temporary wiring and connections to maintain existing systems in service during construction. Temporary wiring shall conform to the National Electrical Code.

3.02 PERFORMANCE

A. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor. However, equipment used, and methods of demolition and removal will be subject to approval of the Engineer.

1. Remove exposed abandoned conduit systems, including abandoned conduit systems in false ceilings.

2. Remove wiring in abandoned conduit systems to source of power supply, where indicated.

3. In exposed through-structure conduit or foundation locations, cut conduits and foundation below the finished structure surfaces in order to perform adequate surface patching.

4. Maintain electrical continuity of existing electrical installations that remain active. Modify installations as necessary to maintain continuity and provide adequate access as required by the National Electrical Code.

5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified elsewhere herein.

6. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed or demolished.

B. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.

C. Unless otherwise indicated existing, electrical equipment, conduit, wire, etc. indicated for demolition shall be removed and disposed of in a lawful manner, off site.

D. The Contractor shall move existing electrical equipment required to be returned to the Owner, to locations as directed by the Owner. Care shall be taken to ensure existing electrical equipment being returned to the Owner does not become damaged. The Contractor shall provide a means for storing and or stacking of the returned equipment prior to moving to final location, if necessary.

E. Items Abandoned in Place:

1. All items to be abandoned in place shall be de-energized.

2. Connections shown or otherwise indicated as disconnected shall be removed with lugs left in place and with all conduit and cable openings properly plugged and sealed as required by the NEC.

3. Any abandoned in-place equipment damaged by Contractor shall be repaired and restored to its original condition.

END OF SECTION 16060

SECTION 16111

CONDUITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish and install conduits as required, and as shown on the Plans. Materials employed shall be as shown on the Plans.

1.02 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. If changes from the Plan are proposed, shop drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 16000 for further submittal requirements.

1.03 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):
1. 1, Flexible Metal Conduit.
2. 6, Rigid Metal Conduit.
3. 360, Liquid-Tight Flexible Steel Conduit.
4. 467, Grounding and Bonding Equipment.
5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.
6. 651, Schedule 40 and 80 Rigid PVC Conduit.
7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
8. 884, Underfloor Raceways and Fittings.
9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.01 RACEWAYS

A. Exposed conduits in an unclassified or hazardous area shall be galvanized rigid steel (GRS) unless specifically indicated otherwise on the Plans. Conduits in corrosive, hazardous, or damp areas shall be PVC coated GRS unless otherwise indicated.

Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All conduits concealed in block walls or steel framing shall be EMT with compression fittings unless otherwise indicated. Set screw type fittings in EMT conduit will not be accepted. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than one inch.

B. Condulets type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors, damp or wet locations shall be weather tight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout. Conduit systems shall be water tight.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

G. Sealing fittings shall be provided for classified areas per the NEC requirements in hazardous or corrosive areas. Fittings shall be poured after the final walk-thru unless otherwise directed in writing by the engineer.

2.02 GALVANIZED RIGID STEEL (GRS)

A. Conduits and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. A half-lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

2.03 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Plans or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.

B. The zinc surface of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

C. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.055-inch (55 mil).

D. A PVC coating shall be bonded to the inner and outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable. The inside of conduit bodies shall remain undisturbed in the processing.

E. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

F. Conduit straps shall be PVC coated or stainless steel.

G. PVC coated conduits and fittings shall be as manufactured by Kor Kap Corporation, Occidental Coating Company, Rob-Roy, or equal.

H. PVC coated flexible conduits shall be liquid and vapor-tight and manufactured in accordance with UL 360 standards.

2.04 RIGID NONMETALLIC - PVC

A. Where specifically indicated on the Plans, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Plans, conduit supports shall be installed at five-foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vapor-tight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduits and connectors for 1 1/4 " and smaller shall be listed for grounding.

D. In non-corrosive areas, connectors for liquidtight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations. In corrosive areas, connectors shall be PVC-Coated galvanized.

2.05 ELECTRICAL METALLIC TUBING (EMT)

A. Per UL Standard for Electrical Metallic Tubing No. 797. Galvanized mild steel with interior coat of enamel.

B. Fittings shall be steel set-screw type. Cast type, indenter type or compression steel fittings are not acceptable.

C. Approved for plan specified locations only. Approved for conduits concealed in block walls and concealed in steel framed walls. Not approved for process areas where wash down or high humidity conditions exist.

2.06 ALUMINUM CONDUIT

A. Aluminum conduit is approved for wet and corrosive areas only. Prior approval from the engineer must be obtained when substituting for PVC coated.

B. Aluminum hardware and conduit shall be isolated from all dissimilar materials as appropriate.

1. Isolation from dissimilar metals in channel or support by a single layer of scotch #33+ or approved equal.
2. Isolation from concrete shall be by neoprene gaskets.
3. Aluminum shall not be used for concrete penetrations.

C. Aluminum conduit shall contain less than 0.4% copper

PART 3 - EXECUTION

3.01 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be concealed where possible except as specifically noted, or accepted by the Engineer.

E. Conduit runs shall not interfere with the proper and safe operation of equipment, and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to vibrating equipment such as motors, fans, and transformers. The maximum length of flexible conduit shall be 3 feet, unless approved in writing by engineer. Flexible conduit shall not be used for electricians convenience where rigid conduit could be used.

G. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying

fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads.

I. Bushings and lock nuts or hubs shall be used at conduit terminations. Conduit, bushings, locknuts, and enclosures shall be fastened to the conduit system prior to pulling wire. Splitting the bushings for installation will not be accepted. Hubs shall be used in all process areas outside of electrical rooms unless otherwise specified. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string. Splices shall be made in junction boxes only. Splices in conduit bodies will not be accepted.

J. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

K. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

L. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used. Test results should be submitted to the engineer.

M. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

N. Provide trenching, backfill, and compaction for conduits installed underground.

END OF SECTION 16111

SECTION 16123

600 VOLT CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the furnishing and installation of 600 Volt Class cables and conductors, terminations and splicing, and pulling lubricants.

B. SO & SJO Conductors are specified elsewhere in these specifications.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 REFERENCES

A. Insulated Cable Engineers Association/National Electrical Manufacturers Association (ICEA/NEMA):

1. S-68-516/WC 8, ethylene-propylene rubber-insulated wire and cable for the transmission and distribution of electrical energy.
2. S-61-402/WC 5, thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.
3. S-66-524/WC 7, cross-linked thermosetting-polyethylene-insulated wire and cable for transmission and distribution of electrical energy.

B. Underwriters Laboratory, Inc.

1. 44, rubber insulated wires and cables.
2. 83, thermoplastic-insulated wires and cables.
3. 486A, wire connectors and soldering lugs for use with copper conductors.
4. 486B, wire connectors for use with aluminum conductors.
5. 510, insulating tape.

C. National Electric Code

D. Insulated Cable Engineers Association

PART 2 - PRODUCTS

2.01 ACCEPTED MANUFACTURERS

A. Conductors and Multi Conductor Cables (MCC), subject to compliance with Contract Documents, the following manufacturers are acceptable: American Insulated Wire Corporation, Cablec Corporation, Okonite Company, Southwire Company, or equal.

2.02 CONDUCTORS

A. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors #6 AWG or smaller shall be THWN or XHHW. Conductors #2 AWG or smaller shall be XHHW. Conductors

#1 AWG or larger shall be XHHW-2. The minimum power or ground conductor size shall be #12 AWG.

B. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have insulation type as indicated on the Plans. "THHW" shall conform to ICEA S-61-402/NEMA WC 5 and UL 83 and "XHHW" shall conform to ICEA S-66-524/NEMA WC 7 and UL 44. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Plans. Panel control wiring shall not be less than No. 14 AWG.

C. Multi-conductor tray cables shall be rated 600 volts, listed by UL as Type TC cable or ITC for instrumentation cable only per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/Terminators shall be water tight and manufactured of the same material as the cabling system referenced elsewhere in division 16.

D. Multi-conductor tray cables to be installed in classified areas shall be armored, rated 600 volts, listed by UL as Type MC-HL cable per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/terminators shall be rated for classified areas and submitted upon accordingly.

E. All wiring shall be as indicated on the Plans. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

2.03 TERMINATIONS AND SPLICES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

B. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

C. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

D. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

E. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

2.04 PULLING LUBRICANT

A. All cables shall be properly coated with pulling compound (Aqua Gel, Polywater, or equal) before being pulled into conduits so as to prevent mechanical damage to the cables during installation. “Yellow 77” is not acceptable.

B. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

2.05 IDENTIFICATION

A. All conductors shall be numbered with "tube sleeve" type tags with heat impressed letters and numbers.

B. Color code all wiring as follows:

1. Lighting and power wiring:

		120/208 VAC	480VAC	12V DC	24V DC	120 VAC Control/ Power
a.	Phase 1	Black	Brown	Orange	Blue	Red
b.	Phase 2	Red	Orange			
c.	Phase 3	Blue	Yellow			
d.	Neutrals	White	White	Grey	Blue/White	White

2. Color code ends of feeder phase conductors only.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval. Conductor splices shall not be made in underground junction boxes or manholes unless specifically noted on the plans.

C. Install all cables in conduit. Manufacturer’s cables and SO cord may be installed without conduit where approved and noted on the plans.

D. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:

1. As specifically indicated on the Plans.
2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity de-rated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
3. When field conditions dictate and written permission is obtained from the Engineer.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted above.

1. 12 V DC, 24 V DC and 48 V DC control circuits may be combined in common conduit.
2. 120/208/240 V AC control circuits shall be isolated from all DC control circuits.
3. 277/480 V AC circuits shall be isolated from all other voltages.

G. Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor, with outer jacket.

H. Make splices only at pull or junction boxes.

1. Crimp or indented-type connectors are not allowed, unless approved by engineer.

END OF SECTION 16123

SECTION 16124

INSTRUMENTATION CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers cable use for process signal and controls.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the instrumentation cable shall be as manufactured by Belden, Okonite, or equal.

2.02 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Plans and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

E. Pairs installed in a cable tray shall have a UV resistant jacket, and shall have a jacket intended for cable tray use.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Plans.

B. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wires of shielded conductors at one end only.

C. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. Contractor shall supply terminal boards as required.
2. Do not field wire directly to devices.

END OF SECTION 16124

SECTION 16130

OUTLET, PULL, AND JUNCTION BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Outlet, pull and junction boxes.

B. Related Sections include but are not necessarily limited to:

Division 0	Bidding Requirements, Contract Forms, and Conditions of the Contract.
Division 1	General Requirements.
Section 16000	General Electrical Requirements.
Section 16111	Conduits.
Section 16141	Wiring Devices.
Section 16170	Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Refer to Section 16000.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Section 16000.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 16000.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Galvanized steel boxes:
   a. Appleton Electric Co.
   b. Steel City.
   c. Raco.
2. Sheet metal boxes for non-classified areas:
   a. Hoffman Engineering Co.
3. Corrosion-resistant boxes:
   a. Hoffman Engineering Co.
   b. Crouse-Hinds.
4. Hazardous location boxes (Class I, II & III):
   a. Appleton Electric Co.
   b. Crouse-Hinds.

c. Killark.
d. O-Z/Gedney.

5. Raintight and watertight boxes:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
6. Terminal boxes:
   a. Hoffman Engineering Co.
7. Boxes in sidewalk:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. O-Z/Gedney.
8. Boxes in earth:
   a. Carlon Electric Products.
9. Exposed switch and receptacle boxes:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. Killark.
10. Concrete Manholes
    a. Dura Crete
    b. Or equal

B. Submit requests for substitution in accordance with Specification requirements.

2.02 MATERIALS

A. Pull and Junction Boxes for Offices and other Dry Architecturally Finished Areas:

1. Material: 14 GA, galvanized steel.
2. Concentric knockouts on all four sides.
3. Flat cover fastened with screws.
4. NEMA 1 classification.
5. UL listed.

B. Pull and Junction Boxes for General Use Unclassified Areas Suitable for NEMA 12 Enclosures:

1. Material: 14 GA galvanized steel with seams continuously welded, ground smooth and no knockouts.
2. Zinc rich coating on all seams.
3. Stainless steel captivated cover screws threaded into sealed wells.
4. Flat door with oil resistant gasket.
5. NEMA 12 classification.
6. UL listed.

C. Pull and Junction Boxes for Wet Areas:

1. Material: 14 GA steel with polyester powder coating inside and out over phosphatized surfaces.
2. Seams continuously welded, ground smooth, no knockouts.
3. Stainless steel clamps on four sides.
4. Flat cover with oil resistant gasket.
5. NEMA 4 classification.
6. UL listed.

D. Pull and Junction Boxes for Corrosive Areas:

1. Material: 14 GA steel with powdered epoxy resin coating inside and out or fiberglass-reinforced polyester material.

2. Steel boxes:
   a. Seams continuously welded, ground smooth, no knockouts.
   b. Rolled lip around all sides.
   c. Hinged door.
   d. Captivated stainless steel door screws.
   e. Flat door with oil-resistant gasket.
3. Fiberglass-reinforced polyester boxes:
   a. Hinged door with latch and lockout.
   b. Neoprene door gasket.
   c. Grounding bushing(s).
4. NEMA 4X classification.
5. UL listed.

E. Pull and Junction Boxes for Hazardous Areas:

1. Material: Cast gray iron alloy or copper-free cast aluminum.
2. Drilled and tapped openings or tapered threaded hub equipped.
3. Flat bolted-down or threaded cover with neoprene gasket.
4. Stainless steel hex head screws.
5. Explosion proof, UL listed for Class 1 Groups C and D.

F. Pull and Junction Boxes for Sidewalks:

1. Cast-iron box and cover, hot-dip galvanized.
2. Flange for flush mounting.
3. Checkered cover with neoprene gasket, pry bar slots and stainless steel screws.
4. UL listed.
5. Drilled and tapped holes.
6. Watertight NEMA 4 classification.

G. Large Pull and Junction Boxes (100 CU IN and larger):

1. Located in offices and other dry architecturally finished areas where EMT is utilized:
   a. NEMA 1 gasketed without knockouts.
2. Located in general use areas:
   a. NEMA 12 construction:
      1) Welded steel.
      2) Furnished with gray enamel inside and out over phosphatized surfaces.
3. Located in wet and corrosive areas:
   a. NEMA 4X with stainless steel screws.
   b. Type 304 L welded stainless steel:
4. Constructed of 14 GA steel with seams continuously welded, ground smooth, no knockouts.
5. Rolled lip around all sides.
6. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
7. Split covers when heavier than 25 LBS.

H. Terminal Boxes:

1. Galvanized 16 GA steel box provided with plain blank screw cover, subpanel, and terminal points.
2. Refer to Drawing for dimensions and number of terminals.
3. Terminal blocks shall be screw-post barrier-type, white center marker strip.
4. Rated 20 ampere, minimum 600 V.

I. Fiberglass Cable-Pulling Enclosure:

1. Use: Access points to facilitate pulling of electrical cables in buried conduit runs.

2. Size and quantity: As shown on Drawings.
3. Type: Rectangular fiberglass composite, suitable for direct burial pedestrian traffic on top, -50 DegF, chemical, sunlight, and weather resistant.
4. Provide matching top with "ELECTRIC" logo.

J. Outlet Boxes:

1. Use: Installation of wiring devices.
2. Boxes for exposed wiring:
   a. Cadmium plated, cast, ferrous metal, with threaded hubs.
3. Boxes for concealed wiring:
   a. Code gage, hot-dip galvanized steel.
   b. Include bar hangers for metal stud partitions.
   c. Provide barriers between switches in boxes with 277 V switches on opposite phases.
   d. Use extension and plaster rings where required.
   e. Provide grounding screw.

K. Concrete Manholes

1. Use: Duct bank pulling location or splitting of duct bank.
2. Size and quality: As shown on Drawings
3. Type: Concrete traffic rated with rebar re-inforcing.
4. Other requirements:
   a. 30 inch diameter minimum opening with traffic rated cover. Cover shall contain the legend “Electrical”.
   b. 3 inch deep 6 inch wide minimum dimension sump shall be provided in the center of the manhole.
   c. Contractor shall install a 20 amp GFCI weatherproof in use receptacle in the manhole. Receptacle shall be located at the highest point on the wall of the manhole.
   d. Pulling eyes shall be provided on all four walls.
   e. Thin Wall blockouts shall be provided on all four walls.
   f. Contractor to seal manhole penetrations to eliminate leaks at the junction between the conduits and the manhole.
   g. Train cables around sides of manhole during installation. Keep cables away from sump and receptacle.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Use locknut and bushing for boxes in non-classified areas.

B. Use cast metal boxes with threaded conduit hubs in damp, wet or hazardous areas.

C. Use Type FS and FD boxes in wet areas and where exposed rigid steel conduit is required.

D. Use epoxy resin coated, stainless steel, cast aluminum or fiberglass boxes for corrosive areas.

E. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.

F. Use outlet boxes sized to accommodate quantity of conductors enclosed.

G. Use boxes sized to accommodate conduit tying into box.

H. Install pull boxes or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.

1. Make covers of boxes accessible.

I. Install pull boxes or junction boxes rated for the area classification.

J. Install rigid conduit squarely into boxes which do not have hubs or are drilled and tapped.

1. Install with locknut on the outside and bushing on inside.

K. Install conduit into boxes with hubs, or that are tapped, using thread lubricant.

L. Do not use back-to-back boxes on this Project.

M. Seal all points of conduit entry into fiberglass cable-pulling enclosures for a waterproof installation.

N. Support outlet boxes for incandescent fixtures and other ceiling-mounted devices in lay-in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.

END OF SECTION 16130

SECTION 16141

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Light switches, receptacles, device plates, dimmers, plug in strips and tele power poles.

B. Related Sections include but are not necessarily limited to:

Division 0	Bidding Requirements, Contract Forms, and Conditions of the Contract.
Division 1	General Requirements.
Section 16000	General Electrical Requirements.
Section 16130	Outlet, Pull, and Junction Boxes.
Section 16170	Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Refer to Section 16000.

1.03 SUBMITTALS

A. Shop Drawings:

1. Refer to Section 16000.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Light switches (except explosion proof):

a. Hubbell.

b. Slater.

c. P&S.

d. Arrow Hart.

e. General Electric.

f. Leviton.

2. Explosion proof light switches (Class 1 Div I & II):

a. Crouse Hinds.

b. Appleton Electric Co.

c. Killark.

3. Door switches:

a. General Electric.

b. Slater.

c. P&S.

d. Arrow Hart.

e. Micro switch.

4. Receptacles (except explosion proof):

a. Hubbell.

b. Slater.

c. P&S.

d. Arrow Hart.

e. General Electric.

f. Leviton.

5. Explosion proof receptacles (Class 1 Div I & II):

a. Crouse Hinds.

b. Appleton Electric Co.

c. Killark.

6. Welding receptacles:

a. Crouse Hinds.

b. Appleton Electric Co.

7. Tele power poles:

a. Wiremold.

b. Walker.

8. Dimmers:

a. Lutron.

b. General Electric.

c. P&S.

9. Plug in strip:

a. Wiremold.

b. Walker.

B. Submit requests for substitution in accordance with Specifications.

2.02 MATERIALS

A. Light Switches for Unclassified Areas:

1. Toggle type, quiet action, specification grade with grounding terminal.

2. Back and side wired.

3. Solid silver cadmium oxide contacts.

4. One piece switch arm rated 20 A, 120/277 V AC.

5. UL listed.

6. Color: White unless owner or engineer specifies otherwise.

7. Wall plate: Type 304 stainless steel.

8. Type: As indicated on Drawings.

B. Receptacles for Unclassified Areas:

1. Straight blade, grounding type, specification grade.

2. Back and side wired with wrap around bridge.

3. Rated 20 A, 125 V AC.

4. UL listed.

5. Color:

a. For use on normal power: White unless owner or engineer specifies otherwise.

b. For use on UPS systems: Red.

c. For use on isolated ground systems: Orange.

d. For special purpose receptacles: Black

6. Wall plate: Type 304 stainless steel.

7. Type: As indicated on Drawings.

C. Light Switches for Wet Areas:

1. Presswitch type, quiet action, specification grade, with grounding terminal.

2. Back and side wired.

3. Solid silver cadmium oxide contacts.

4. One piece switch arm rated 20 A, 120/277 V AC.
5. UL listed.
6. Color: White unless owner or engineer specifies otherwise.
7. Wall plate: Gray weatherproof presswitch type.
8. Type: As indicated on Drawings.

D. Receptacles for Wet Areas:

1. Straight blade, grounding type, specification grade.
2. Back and side wired with wrap around bridge.
3. Rated 20 A, 125 V AC.
4. UL listed.
5. Color: Ivory.
6. Wall plate: Weatherproof, cast aluminum, UL listed.
7. Type: As indicated on Drawings.

E. Ground Fault Circuit Interrupter Receptacles:

1. Straight blade, grounding type, specification grade.
2. Rated 20 A, 125 V AC.
3. UL listed.
4. Test and reset buttons.
5. Wall plate: Indoor or weatherproof as required.
6. Feed through type.

F. Light Switches for Corrosive Areas:

1. Corrosion resistant NEMA 4X enclosure with switch consisting of:
    a. Fiberglass reinforced polyester enclosure.
    b. Fiberglass reinforced polyester gasketed wall plate with built in toggle lever switch with stainless steel shaft.
    c. Grounding bushing.
    d. Rated 20 A, 125 V AC.
    e. UL listed.
    f. Type: As indicated on Drawings.
    g. Color: Yellow.

2. Optional: Corrosion resistant enclosure and switch consisting of:

    a. Cast copper free aluminum "FS" or "FD" ridge type hub box.

    b. Toggle type, quiet action, specification grade with grounding terminal.

    c. Rated 20 A, 125 V AC with solid silver cadmium oxide contacts.

    d. UL listed.

    e. Neoprene gasket.

    f. Cast aluminum cover with stainless steel screws and lever to activate switch.

    g. Type: As indicated on Drawings.

    h. Color: Yellow.

G. Receptacles for Corrosive Areas:

1. Corrosion resistant straight blade, grounding type, specification grade.

2. Back and side wired with wrap around bridge.

3. Rated 20 A, 125 V AC.

4. UL listed.

5. Color: Yellow.

6. Box: "FS" or "FD" ridge type cast hub box of copper free aluminum.

7. Gasket: Neoprene.

8. Wall plate: Weatherproof, cast aluminum, UL listed, WDL open or closed.

9. Type: As indicated on Drawings.

H. Explosion proof Light Switches for Use in Hazardous Areas:

1. Explosion proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.

2. EDS factory sealed.

3. Malleable iron body and cover.

4. Aluminum sealing chamber.

5. Front operated handle with stainless steel shaft.

6. Rated 20 A, 125 V AC.

7. With grounding screw.

8. Type: As indicated on Drawings.

I. Exposition proof Receptacles for Use in Hazardous Areas:

1. Explosion proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2, Groups F and G.

2. Factory sealed malleable iron receptacle with spring loaded cover.

3. Malleable iron mounting box.

4. Rated 20 A, 125 V AC.

5. "Dead front" construction requiring plug to be inserted and rotated to activate receptacle.

6. Type: As indicated on Drawings.

J. Welding Receptacles:

1. 60 A, 480 V, 3 pole, 4 wire, grounding type.

K. Plug In Strip: Surface steel raceway plug in strip with single 15 A, 125 V, 3 wire grounding type receptacles spaced 18 IN on center.

1. Pre-wired with two #12 TW and one #12 TW green insulated ground.

2. Minimum 1 1/4 IN wide x 3/4 IN deep.

3. Suitable fittings and snap in cover.

4. Finish:

a. Stainless steel.

5. Receptacle color:

a. For use on normal power: White unless owner or engineer specifies otherwise.

b. For use on UPS systems: Red.

c. For use on isolated ground systems: Orange.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount devices where indicated on the Drawings.

B. Surface mount receptacles and light switches in concrete construction.

C. In masonry and metal stud construction, recess mount receptacles and light switches unless device precludes recessed mounting or unless otherwise noted on the Drawings.

D. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.

E. Set switches and receptacles plumb and vertical to the floor.

F. Set recess mounted switches and receptacles flush with face of walls.

G. Do not connect dimmers to loads in excess of 80% of the rating of the dimmer.

H. Provide blank plates for empty outlets.

END OF SECTION 16141

SECTION 16142

WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. These specifications encompass outlet enclosures used on outlet devices where outlets are required to be weatherproof and/or physically protected while in use or idle.

B. These safety outlet enclosures shall be used in locations where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments.

C. They are also to be used where outlets are subject to contamination, corrosion or damage.

1.02 DESCRIPTION

A. The safety outlet enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover.

B. The safety outlet enclosure shall have cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when safety cover is closed.

C. The safety outlet enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.

D. The safety outlet enclosure shall be sufficient depth to allow full closure with attachment plug(s) in use.

1.03 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and the Contract Documents, prior to installation.

1.04 MANUFACTURER

A. Manufacturer shall be Taymac Corporation, or equal.

PART 2 - PRODUCTS

2.01 WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

A. The enclosures shall be used in outdoor locations, where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments, or as indicated on the Plans.

B. They are also to be used where outlets are subject to contamination, corrosion or damage.

C. The enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover, and shall be of sufficient depth to allow full closure with attachment plugs in use.

D. The enclosure shall have cord ports capable of allowing appropriate size electrical cords to pass through when safety cover is closed.

E. The enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant, and locking style, in areas where security is needed, as shown on the Plans.

F. The enclosure shall be Underwriters Laboratories (UL) listed per UL Standard 514C for non-metallic boxes, flush device boxes and enclosures, and conform to National Electric Code (NEC), Article 410.57 paragraphs a and b, Article 110.3 and Article 110.11, pertaining to damp, wet or possible corrosive installations.

G. Body materials shall be of a flame resistant, self extinguishing, ultraviolet inhibiting, impact resistant, polycarbonate resin such as GE Lexan 943A, or Mobay Makrolon 6457. Material must meet UL Standard 94.

H. Gasket materials shall be of sufficient thickness to form a weatherproof seal under normal mounting conditions. Thicknesses; 3/16” for base plate and 1/8" for covers. Material is to be closed cell neoprene foam by Monarch Rubber A5032, or equivalent, self-extinguishing and flame retardant. Material must meet UL Standard 94 HF1.

I. Mounting hardware shall be stainless steel, and of sufficient length to properly secure the device, and ensure seal to mounting surface.

J. The enclosures shall be installed over a weatherproof box and outlet in conformance with the manufacturer's instruction. Cover shall be mounted to insure that access holes for the portable line cords will be located at the lower end of the cover.

K. Manufacturer shall be Taymac Corporation, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed in accordance with the manufacturer’s recommendations.

END OF SECTION 16142

SECTION 16143

TERMINAL BLOCKS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers terminal blocks for control and other wiring.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 MANUFACTURERS

A. Terminal blocks shall be Entrelec, Phoenix Contact, Weidmuller, Allen Bradley or equal.

B. Surge protection blocks shall be Telematic, series SD, or equal.

C. Power distribution blocks shall be Ilsco Corporation, or equal.

PART 2 - PRODUCTS

2.01 TERMINAL BLOCKS

A. Terminal blocks shall mount on standard DIN rail, and be of the size required for conductors therein. A minimum of 25 percent spares shall be provided in each terminal box. No more than 2 conductors shall be allowed per termination. Jumper bar assemblies shall be installed for interconnecting terminal blocks, distributing power and signal commons. Terminal blocks shall be U.L. rated for 600 Volts, and 30 Amps, minimum.

B. Grounding terminal blocks shall be provided for instrumentation cable shields. The terminal blocks shall have distinctive 2-color bodies yellow and green, and shall be mounted to the DIN rail with metal screw down type clamps, providing a positive ground connection. One grounding terminal block shall be installed for every 2 instrument cables terminated. Grounding terminal blocks shall be U.L. rated for 600 Volts, and 20 Amps, minimum.

C. Terminal blocks shall be available in a variety of colors, including red, green, blue, gray, black, yellow, and orange.

D. DIN mount fuse holders shall have blown fuse indicators for DC and AC circuits. Fuse holders shall be of the compression clamp type. Fuse holders shall be U.L. listed, and rated for 600 Volts. Fuse sizes shall not exceed the U.L. current rating for the fuse holders.

E. DIN rail shall be prepunched, zinc bichromate plated steel. Symmetrical DIN rail shall be 35 mm X 7.5 mm, minimum.

F. Terminal blocks for 4 to 20 milliamp signals shall have knife disconnect switches, and accessible test points for testing and measurement of current loop signals, without the need for removing wire terminations.

2.02 SURGE PROTECTION BLOCKS (SPB)

A. Analog inputs and outputs shall be terminated at surge protection blocks (SPB). The SPBs shall be designed for a working voltage of 32 volts, and shall be fused.

B. SPBs shall provide full hybrid line to line protection, and shall have a GDT rating of 10,000 A (8/20μs pulse waveform).

C. SPBs shall be UL94 V-2 listed.

2.03 POWER DISTRIBUTION BLOCKS (PDB)

A. PDBs shall be Electro-tin plated and manufactured from high strength 6061-T6 aluminum alloy.

B. PDBs shall be UL Recognized rated 90º C and CSA Certified.

C. PDBs shall provide flexibility in using the connector as an in line splice or to reduce conductor size.

D. PDBs shall be rated for 600 Volts and dual rated for Copper and Aluminum Conductor.

E. PDBs shall have the sizes and ratings as shown on the Plans.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Each terminal block and fuse holder shall be identified with the circuit number, or conductor number, corresponding to the identification appearing on the shop Drawings for the equipment, or system.

B. Terminal block and fuse holder markers shall be computer printed plastic-type, with permanent markings.

C. End clamps and end sections shall be installed on each terminal block and fuse holder assembly.

D. Terminal blocks shall be gray unless specified otherwise.

END OF SECTION 16143

SECTION 16160

ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve a junction boxes where shown on the Plans.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 MANUFACTURERS

A. Enclosures shall be manufactured by Hoffman, Rittal, or equal.

PART 2 - PRODUCTS

2.01 STEEL

A. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans should be checked for special conditions.

2.02 NEMA RATING

A. 4X for corrosive areas and NEMA 4 for outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4X enclosures shall also be used in wet, or wash down areas.

B. All enclosures used in classified areas shall be NEMA 7.

C. In Waste Water facilities all enclosures in process areas shall be NEMA 4X stainless steel. Enclosures in electrical rooms, meeting rooms, offices and shops shall be NEMA 12 unless otherwise specified.

D. Areas not specified in Water Treatment, Wastewater, or other water related facilities shall be approved by the engineer for NEMA type prior to installation.

2.03 FIBERGLASS

A. Enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Enclosures shall be installed as indicated on the Plans, and according to manufacturer's instructions.

B. Enclosures shall be properly grounded, and shall include ground straps connected to hinged doors and accessories.

END OF SECTION 16160

SECTION 16161

CONTROL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. General: The SUPPLIER shall provide control panels and control panel instrumentation, complete and operable, in accordance with the Contract Documents.

1. Control panels.

B. Products shall be submitted for review in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society for Testing and Materials (ASTM):

a. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

2. Joint Industrial Council (JIC):

a. EMP 1, Mass Production Equipment.

3. National Electrical Manufacturers Association (NEMA):

a. ICS 4, Terminal Blocks for Industrial Use.

b. ICS 6, Enclosures for Industrial Controls and Systems.

c. 250, Enclosures for Electrical Equipment (1000 V Maximum).

4. National Fire Protection Association (NFPA):

a. National Electric Code (NEC).

1.03 SUBMITTALS

A. Shop Drawings:

1. Scaled panel face and subpanel face instrument and nameplate layout drawings.

2. Panel and subpanel materials of construction.

3. Panel and subpanel dimensions and weights.

4. Panel access openings.

5. Conduit and wiring access locations.

6. Internal wiring and terminal block drawings.

7. Nameplate text.

8. Scaled layouts of any graphic panels.

9. Seismic restraint requirements.

B. Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 ENCLOSURES

A. Enclosures shall be sized and rated for the application, and shall be as specified elsewhere.

2.02 ACCESSORIES

A. Furnish electrical equipment, devices, and accessories as required for a complete and operable control panel. Equipment, devices, and accessories shall be as specified elsewhere.

2.03 FABRICATION

A. General:

1. Fabricate panels with devices and instrument arrangements as required by the Plans.

2. Prime control panels with rust inhibitive shop applied primer and paint with two coats of UV resistant white water-based paint.

3. Finish interior of panel with epoxy glass white.

4. Provide control panels which meets the following requirements:

a. Panel depth per JIC EMP 1 1967, E7.1.4.

b. Door opening per JIC EMP 1 1967, E7.1.5.

c. Data pocket per JIC EMP 1 1967, E7.1.6.

d. Rigidity per JIC EMP 1 1967, E7.1.7.

e. Door alignment and reinforcement per JIC EMP 1 1967, E7.1.8.

f. Panel holes and openings per JIC EMP 1 1967, E7.3.2, E7.3.3, and E7.3.4.

g. Doors per JIC EMP 1 1967, E7.5.

h. Clear panel mounting space per JIC EMP 1 1967, E8.2.9.

i. Panel mounted control device location per JIC EMP 1 1967, E8.3.4.

j. Clearances in enclosures per JIC EMP 1 1967, E8.4.

B. Free-Standing Panels:

1. Minimum construction thicknesses:

a. Front panel, subpanel, or front door with cutouts: 0.123” .

b. Top, sides, back, filler plates and side or doors with no cutouts: Minimum thickness per, NEMA ICS 6, Tables 3 8,9.

2. Welded construction.

3. Completely enclosed, self-supporting, and gasketed dust tight.

4. Edges turned back minimum of 2”.

5. Seams and corners welded and ground smooth to touch and smooth in visual appearance.

6. Arrange control panel faces continuous and flush with face of adjacent electrical motor control centers.

7. Provide filler panels where necessary to close gaps between panels or back of panel and wall. Provide full length flush pan doors.

8. Provide full length piano hinges rated for 1.5 times door plus instrument weight.

9. Furnish doors with keyed alike locking handles and three point catch.

10. Provide appropriate conduit, wiring, and instrument openings in accordance with best panel design.

11. After cutouts have been made, finish opening edges to smooth and true surface condition.

12. Provide each panel with lifting eyebolts.

C. Wall Mounted Panels:

1. Minimum construction thicknesses:

a. Front panel, sub-panel or door with cutouts:

i. Width or height not exceeding 42”: 0.093”.
ii. Width or height exceeding 42”: 0.123”.

b. Side, top, back and doors without cutouts: minimum thickness per NEMA ICS 6, Tables 3 8,9.

2. Seams continuously welded and ground smooth.

3. Body stiffeners for extra rigidity if either height or width exceeds 28”.

4. Rolled lip around all sides of enclosure door opening.

5. Gasketed dust tight.

6. Three point latching mechanism operated by oil tight key locking handle.

7. Key doors alike.

8. Continuous heavy gage hinge pin on doors.

a. Hinges rated for 1.5 times door plus instrument weight.

9. After cutouts have been made, finish opening edges to smooth and true surface condition.

10. Front full opening door.

11. Brackets for wall mounting.

12. Maximum size shall be 60” tall 40” wide. All larger panels shall be supplied as free standing unless otherwise specified on the plans.

D. Panel Front Construction:

1. Minimum construction thicknesses: per NEMA ICS 6, Tables 3 8,9.

2. Welded construction.

3. Edges turned and ground smooth to touch and visual appearance.

4. At joints where panel face meets side walls, provide dustproof sponge rubber gasket entire height and face.

5. Use full length piano hinges rated for 1.5 times door weight for panel access door.

6. Equip doors with locking devices and handle and three point catches.

7. Finish all instrument cutouts smooth and true.

E. Panel Wiring and Piping:

1. Factory pipe and wire panels to identified terminal blocks equipped with screw type lugs.

2. Install all wiring without splicing in factory in raceways:

   a. Size raceways per the requirements of NEC Article 373.

   b. Raceways shall have removable covers.

3. Wire bending space shall be in accordance with Tables 307B, C in NEMA ICS 6.

4. Keep AC power lines separate from low level DC lines, I/O power supply cables, and all I/O rack interconnect cables.

5. Keep AC signal wires separate from DC signal wires.

6. When I/O wiring must cross AC power wiring, it shall only do so at right angles.

7. Arrange circuits on terminal blocks plus any spare conductors on adjacent terminals.

8. Provide necessary power supplies for control equipment.

9. Equip each panel with a main thermal magnetic circuit breaker. Limit load to maximum of 80 percent of circuit breaker rating.

10. Provide all necessary stabilizing voltage transformers, balancing potentiometers and rectifiers as necessary for specific instrument requirements.

11. Assure each panel mounted device is bonded or otherwise grounded to panel or panel grounding system by means of locknuts or pressure mounting methods.

    a. Equip panel with grounding terminals.

12. Arrange wiring with sufficient clearance for all leads.

13. Wiring to sub-panels or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without disconnecting wiring.

14. Identify all wires with plastic sleeve type wire markers at each end. Markers shall:

    a. Identify circuit numbers.

    b. Identify function and polarity.

15. Provide all wiring according to color code as follows:

COLOR OF INSULATION	120 V, 60 hZ SERVICE	CONTROL WIRING	LOW VOLTAGE DC SERVICE
Black	Phase Conductor		Negative (analog transmission)
Red		120V AC Controls	Positive (analog transmission)
White	Neutral	120V Neutral	
Blue		24V DC Controls	
Blue/White		24V DC Neutral	
Orange		12V DC Controls	
Orange/White		12V DC Neutral	
Green	Ground	Ground	
Yellow		Intrinsically safe circuits	

16. Termination requirements:

    a. Terminal block markings, mechanical characteristics and electrical characteristics shall be in accordance with NEMA ICS 4.

    b. Terminals shall facilitate wire sizes as follows:

        i. 120 VAC applications: Wire size 12 AWG and smaller.
        ii. Other: Wire size 14 AWG and smaller.

    c. Provide terminal blocks with continuous marking strip.

    d. Tag each I/O terminal to indicate tag number of the connected device.

    e. Provide terminals for individual termination of each signal shield.

    f. Provide 20 percent excess terminals for future expansion

17. Pneumatic tubes and appurtenances:

    a. Provide ¼” OD pneumatic control tubing.

    b. Main headers within panels shall be minimum 1”.

c. Compression type pressure fittings.

d. Equip panel instrument leads with globe type isolation valve.

e. Connection to devices not in the panel shall be terminated on tubing terminal plate.

f. Install tubing neatly and mount securely.

g. Do not route tubing in front of or in wiring raceways.

h. Code terminal plates.

i. Supply and install dual function filter regulator to serve pneumatic devices.

F. Panel Lighting and Power:

1. Receptacles:

i. One electrical outlet.
ii. One incandescent light fixture with door switch(es) and separate circuit breakers.

b. Panels or panel faces greater than 4 feet long:

i. One electrical outlet per 4 feet of length.
ii. Continuous fluorescent lighting strip with door switches and separate circuit breakers.

G. Environmental Controls:

1. NEMA 1:

a. Furnish circulation fans with filters and/or air conditioning as required to cool panel. Maintain panel temperature below 40°C or below requirements of equipment within the enclosure whichever is less.

b. Furnish panel heaters as required to prevent moisture condensation and maintain minimum temperature requirements of equipment within the enclosure.

2. Air conditioning applications shall include means of preventing moisture condensation.

3. For panels or control cabinets located outside, hazardous areas, classified areas or plans that require a NEMA 4 or 4X rating:

a. Furnish panel heaters as required to prevent moisture condensation and maintain minimum temperature requirements of equipment within the enclosure.

b. Furnish circulation fans with filters and/or air conditioning as required to cool panel. Maintain panel temperature below 40°C or below requirements of equipment within the enclosure whichever is less.

4. Maintain NEMA rating of original enclosure when installing heating or cooling equipment.

2.04 MAINTENANCE MATERIALS

A. Spare Parts:

1. Replacement Bulbs: Provide minimum 25 percent or 5 bulbs, whichever is greater, for each type of indicating light bulb for each type of indicator furnished in this Project.

2. Replacement Fuses: Provide minimum of 25 percent or 5 fuses, whichever is greater, for all sizes and types of control fuses provided within the control panel.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install free standing panels on concrete housekeeping pads as detailed on the Drawings.

B. Anchor panel fronts rigidly into wall system with approved anchoring devices.

END OF SECTION 16161

SECTION 16170

GROUNDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. A ground grid system consisting of the indicated configuration of copper wires, and ground rods, or concrete encased grounding electrodes ("UFER's") shall be provided to minimize station potential gradient irregularities and drain leakage and fault currents to earth.

B. Whether indicated on the Plans or not, neutral conductors, cable shields, metallic conduits, cable terminations, junction boxes, poles, surge arresters, metal buildings, skid mounted equipment, and other non-current carrying metallic parts of equipment shall be grounded to the ground grid per NEC.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 REFERENCES

A. National Electrical Code (NEC) Article 250

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured as herein described. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

2.02 GROUND RODS

A. Ground rods shall be copper-clad steel conforming to UL 467, 3/4 inch in diameter by 10 feet in length. Unless otherwise indicated, ground rods shall be driven into the ground until tops of rods are approximately 6 inches below finished grade. In counterpoise systems, tops of ground rods shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 10 feet apart and 10 feet from structures. Connections shall be made below grade. Contractor shall install a minimum of two ground rods unless more are specified.

2.03 CONNECTIONS

A. Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

2.04 GROUNDING ELECTRODE CONDUCTOR

A. Service entrance grounding electrode conductors shall be sized in accordance with NEC Table 250.66, unless otherwise indicated on the Plans. After being located to provide maximum physical protection, exposed ground wires shall be securely attached to structural supports at not more than 2-foot intervals with suitable fasteners. Bends greater than 45 degrees in ground wires are not permitted. Routing of ground conductors through concrete should be avoided, except where specifically called for in these Documents. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire.

2.05 EQUIPMENT GROUNDING CONDUCTOR

A. Neutral conductors shall be grounded where indicated. Equipment grounding conductors shall be sized in accordance with NEC Table 250.122, unless otherwise indicated. Ground wires shall be protected by conduit, where such wires run exposed above grade in non-fence enclosed areas, or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods, or counterpoises are not permitted.

2.06 EQUIPMENT GROUNDING

A. Equipment frames of motor housings, equipment skids, metallic tanks, metallic equipment enclosures, metal splicing boxes, chain-link fencing, and other metallic non-current carrying metal items, shall be grounded. Connections to earth shall be made in the same manner as required for system grounding.

2.07 SURGE ARRESTER GROUNDING

A. Surge arresters shall be grounded. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as required for neutral conductors. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other.

2.08 LIGHTING POLE GROUNDING

A. Base of lighting poles shall be connected to an adjacent ground rod as indicated on Plans. A ground connection from poles back to neutral ground points shall also be provided utilizing equipment grounding conductor.

2.09 METALLIC STRUCTURES

A. Metallic structures and buildings shall be grounded per NEC.

2.10 GROUNDING RINGS

A. When required, grounding rings shall be installed using bare copper cable with ground rods at a maximum of 25 feet intervals using thermoweld connecting means as indicated on Plans in accordance with NEC requirements. Ring shall be located a minimum of 10' from the building.

2.11 CONCRETE ENCASED ELECTRODE

A. Two Concrete Encased Electrodes shall be installed in all new structures whether specified on the plans or not. Concrete Encased Electrodes shall be installed using bare copper cable bonded to the rebar. Conductor shall be located in the footings of the building and installed in conformance with NEC requirements. If unspecified on the plans the cable length shall be 60 feet each and shall be bonded in at least 6 locations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. It is the intent of these Contract Documents that all device and equipment grounds shall be run as a separate conductor in the conduit from the equipment to the distribution panels or system ground. Wireways and enclosures shall be properly bonded and grounded, and ground conductors shall be run for all circuits.

B. Equipment cases and devices shall be grounded. Ground rods shall be driven, and concrete encased conduits installed, before a building, or structure is built, and ground conductors brought through the concrete to accessible points for grounding equipment. These systems shall be installed at each structure, where transformers, switchboards, panelboards, and MCC's are installed.

C. Ductbanks shall contain a bare copper ground conductor. The system ground conductors shall run continuously in ductbanks, through handholes and other raceway boxes. The system ground shall be connected to the structure grounding systems to provide a continuous grounding system. Each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and control systems shall be bonded to this grounding system.

D. Ground rods shall be installed not less than 6 inches below grade. Equipment, neutral, and surge arrester ground wires shall be connected to the ground grid as indicated.

3.02 TESTS

A. Pre-Energization Tests — Pre-energization tests shall include, but shall not be limited to tests required to perform under paragraph "GENERAL REQUIREMENTS." No part of the electrical system shall be energized until all station grounding system components have been tested and demonstrated to comply with the requirements specified, and until associated test reports have been submitted and approved.

B. Ground-Resistance Measurements — Ground-resistance measurements of each ground rod shall be taken and certified by the Contractor to the Engineer. No part of the electrical distribution system shall be energized prior to the resistance testing of that system's ground rods and grounding system and submission of test results to the Engineer. Test reports shall indicate the location of the ground rod and grounding system and the

resistance and the soil conditions at the time the test was performed. When the building water service is used as a ground or part of the grounding system, ground-resistance measurements shall also be made of this connection. Ground-resistance measurements shall be made in normally dry weather, not less than 48 hours after rainfall, and with the ground under test isolated from other grounds. The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 142 and Std 81.

3.03 TEST RESULTS

A. The Contractor shall perform the above tests and submit a certified test report prior to energizing the equipment.

END OF SECTION 16170

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Supports, anchors, sleeves, and seals, are indicated on the Plans, schedules, and specified in other sections of these Specifications.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:

1. One-hole Conduit Straps
2. One-Hole Conduit Straps with Clamp Backs
3. Two-Hole Conduit Straps
4. Conduit Hangers
5. I-beam Clamps
6. Channel Clamps
7. Round Steel Rods
8. Drop-in Anchors
9. Wedge Type Anchor Bolts
10. Lead Expansion Anchors
11. Toggle Bolts
12. Wall and Floor Seals
13. Cable Supports
14. U-Channel Strut System
15. Sleeves

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following: Abbeon Cal Inc., Ackerman Johnson Fastening Systems Inc., Elcen Metal Products Co., Ideal Industries, Inc., Josyln Mfg and Supply Co., McGraw Edison Co., Rawlplug Co. Inc., Star Expansion Co., U.S. Expansion Bolt Co., Allied Tube and Conduit Corp., B-Line Systems, Inc., Greenfield Mfg Co., Inc., Midland-Ross Corp., O-Z/Gedney Div; General Signal Corp., Power-Strut Div.; Van Huffel Tube Corp., and Unistrut Div; GTE Products Corp., and Robroy Industries.

2.02 GENERAL

A. Provide supporting devices that comply with manufacturer standard materials, design, and construction, in accordance with published product information, and as required for complete installations, and as specified herein.

2.03 SUPPORTS

A. Provide supporting devices of types, sizes, and materials indicated, and having the following construction features:

1. One-Hole Conduit Straps: For supporting electrical metallic tubing, and liquid tight flexible conduit; zinc plated steel, stainless steel or galvanized steel; snap-on, heavy duty.
2. One-Hole Conduit Straps with Clamp Backs: For supporting rigid metal conduit, and intermediate metal conduit; cast galvanized steel.
3. Two-Hole Conduit Straps: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
4. Conduit Hangers: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
5. I-Beam Clamps: Electroplated zinc or hot dipped galvanized malleable iron.
6. Channel Clamps: Electroplated zinc or hot dipped galvanized steel.
7. Round Steel Rod: National coarse thread, electroplated.

2.04 ANCHORS

A. Provide anchors of types, sizes, and materials indicated, with the following construction features:

1. Lead Expansion Anchors: For CMU walls, 1/4”-20 threads, set tool required.
2. Toggle Bolts: Electroplated steel, size as required.
3. Drop-in Anchors: Stainless steel, size as required.
4. Anchor Bolts: Stainless steel, size as required.
5. Lag Bolts: Stainless steel, size as required.
6. Half-round head, non-removable anchor bolts shall not be used.
7. Self-Tapping screws shall not be used.

2.05 SEALS

A. Provide seals of types, sizes and materials indicated; with the following construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sized indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
2. Conduit sealing bushings shall be manufactured by O-Z/Gedney, Model CSMI, or equal.
3. The conductor sealing bushings shall be manufactured by O-Z/Gedney, Model CSBG, or equal.

2.06 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.07 U-CHANNEL STRUT SYSTEM

A. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with the following fittings that mate and match with U-Channel:
   1. Fixture hangers
   2. Channel hangers
   3. End caps
   4. Beam clamps
   5. Wiring stud
   6. Thinwall conduit clamps
   7. Rigid conduit clamps
   8. Post Bases
   9. U-bolts

B. Approved for use with the following types of conduit:
   1. EMT
   2. IMT
   3. GRS
   4. PVC (where above conduits are approved for the same location.)

2.08 PIPE SLEEVES

A. Provide pipe sleeves from the following:

   1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

2.09 PVC COATED U-CHANNEL STRUT SYSTEM

A. Provide PVC Coated U-channel strut system for supporting electrical equipment, 20 mil PVC coated steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all Stainless Steel hardware, and the following fittings that mate and match with PVC Coated U-Channel:

   1. PVC Coated Strut nut
   2. PVC Coated Pipe straps
   3. Touch up compound (Gray)

B. Approved for use with the following types of conduit:

   1. PVC Coated GRS
   2. Aluminum
   4. PVC

2.10 STAINLESS STEEL U-CHANNEL STRUT SYSTEM

A. Provide Stainless Steel U-channel strut system for supporting electrical equipment, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all stainless steel hardware, and the following stainless steel fittings that mate and match with Stainless Steel U-Channel:

   1. Fixture hangers
   2. Channel hangers
   3. End caps
   4. Beam clamps
   5. Wiring stud
   6. Post bases
   7. Rigid conduit clamps
   8. U-bolts

B. Approved for use with the following types of conduit:

1. PVC Coated GRS
2. PVC

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of 2 or more parallel runs of conduits to be supported together on channel type hangers where possible. Install supports with spacing indicated and in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Comply with manufacturer’s recommendations for touch up of field cut ends or damaged PVC coated U-channel and fittings.

F. Remove burrs and apply a cold zinc galvanizing paint to field cut galvanized U-channel strut prior to installation.

G. Provide a minimum of two anchors per piece of u-channel. Maximum spacing of anchors shall be 12”.

END OF SECTION 16190

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Electrical identification work specified in this section covers the following:

1. Buried cable warnings
2. Electrical power, control and communication conductors
3. Operational instructions and warnings
4. Danger signs
5. Equipment/system identification signs
6. Conduit
7. Instruments and Enclosures

1.02 SUBMITTALS

A. Submittals shall include the following:

1. Manufacturers data on electrical identification materials and products
2. Samples of each color, lettering style and other graphic representation required for each identification material or system
3. Table or list of equipment, panel, and disconnect switch labels

1.03 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering electrical identification products maybe incorporated in the work include, but not limited to, the following:

1. Brady, W.H. Co.
2. Ideal Industries, Inc.
3. Panduit Corp.
4. or, equal

1.04 QUALITY COMPLIANCE

A. Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

B. Comply with applicable requirements of NEMA Std. WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise indicated, provide manufacturer standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option. Installer should maintain a consistent selection for each application.

2.02 COLOR-CODED CONDUIT MARKERS

A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers, extending 360 degrees around conduits; designed for attachment to conduit by adhesive, adhesive lap joint of marker, cable tie, matching adhesive plastic tape at each end of marker, or pre-tensioned snap-on. Except as otherwise indicated, provide lettering that indicates voltage of conductor(s) in conduit. Provide 8" minimum length for 2" and smaller conduit, 12" length for larger conduit.

B. Unless otherwise indicated or required by governing regulations, provide white markers with black letters.

C. Each end of conduits should be marked where the conduit enters and enclosure or junction of more than two conduits.

2.03 CABLE AND CONDUCTOR WIRE MARKERS

A. Cable and conductor wire markers shall be self laminating vinyl on white background, printed using a Brady TLS2200 printer, Seton printer, or equal. Handwritten wire markers are not acceptable.

B. Heat shrink tubing, or sleeve type wire markers are also acceptable. Markers shall be printed not hand written.

2.04 SELF-ADHESIVE PLASTIC SIGNS

A. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

B. Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

C. Where approved by engineer engraved stainless steel tags fastened with 18 gauge stainless steel wire may be attached to valves and isolated equipment.

2.05 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.

B. Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

C. Comply with governing regulations and requests of governing authorities for identification of electrical work.

D. Electrical identification shall contain identical markings on both ends of each conduit and cable. Identification shall be recorded on record drawings for both cables and conductors.

3.02 CONDUIT IDENTIFICATION

A. Where electrical conduit is exposed in spaces with exposed mechanical piping that is identified by a color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated use white as coded color for conduit.

3.03 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

3.04 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each piece of electrical equipment; including a general label for each major electrical system, including communication, control, and signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2” high lettering on 1-1/2” high sign (2” high where 2 lines are required), black lettering in white field. Provide text matching terminology and numbering of the Contract Documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
1. Panel boards, transformers, electrical cabinets and enclosures.
2. Access panel/doors to electrical facilities.
3. Major electrical switchgear.
4. Motor Control Center(s).
5. Service Entrace(s)

B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with stainless steel screws, except use adhesive where screws should not or cannot penetrate the substrate. Provide signs as required by NEC for multiple services, or remo

C. Engraved three-layer laminated plastic, black letters on white background, unless otherwise specified by drawings or engineer shall be provided for the following equipment:
1. TXs
2. Disconnect switches
3. Push button stations
4. Control devices
5. Instruments
6. Motors
7. All major pieces of process equipment
8. Actuators
9. Control valves
10. Solenoid valves
11. Any device relevant to the operation of the plant
12. Communications enclosures
13. Junction boxes

D. Stainless steel, 1/16” thick, with 1/8” stamped or engraved lettering, per Item C above.

May be used in lieu of phenolic engraved nametags on instruments and valves as approved by the engineer. Tag shall be attached with #18 stainless steel wire.

3.05 CIRCUIT IDENTIFICATION

A. The 3-phase wires shall be identified at the switchgear, panelboards and motor control centers as Phases A, B, and C. At 277/480V, Phase A shall be brown, Phase B shall be orange, and Phase C shall be yellow. At 120/208V, Phase A shall be Black, Phase B shall be Red, and Phase C shall be Blue. The neutral shall be white.

B. In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard, cable tray, or termination with circuit identification markers. This identification is applicable to all power, control, alarm, and instrumentation conductors and these markings shall be recorded on the Record Documents. Markers shall be slip-on PVC sleeve type as manufactured by Brady, Seton, or equal.

C. Markers for other cabling shall be B-292 vinyl as manufactured by Brady, Seton, or equal.

D. Exposed medium voltage conduits shall be labeled at 50-foot intervals with 1-inch letters stating the voltage - example - “12,470 volts”. Labels shall be vinyl plastic as manufactured by Brady, Seton, or equal.

3.06 AUTOMATIC EQUIPMENT WARNING SIGNS

A. Permanent warning signs shall be mounted at all mechanical equipment that may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

3.07 HIGH VOLTAGE WARNING SIGNS

A. Permanent and conspicuous warning signs shall be mounted on all equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 250 volts.

B. Signs shall be in accordance with OSHA regulation, and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

C. Signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18 gauge vitreous enameling stock. Sign shall read:

WARNING
HIGH VOLTAGE
KEEP OUT

3.08 CONDUCTOR FASTENERS

A. Glue-on type conductor fasteners shall not be used in any panels, panelboards, switchboards, switchgear, motor control centers, or other enclosures containing electrical devices and/or conductors.

END OF SECTION 16195

SECTION 16461

TRANSFORMERS – DRY TYPE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers dry type transformers used for low voltage, single and three phase, power distribution and lighting.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation. As a minimum the contractor shall submit the following information:

1. Dimensional Drawings
2. Weight
3. Voltage ratings of both the primary and secondary including taps
4. KVA rating
5. % impedance
6. Insulation class
7. Sound level
8. Wiring Diagrams
9. Installation Instructions

1.03 QUALITY ASSURANCE

A. ANSI C57.12.01, dry-type transformers

B. ANSI C89.2, dry-type transformers

C. NEMA ST-20, dry-type transformers

D. UL-506, specialty transformers

E. NEMA TP-1-2002

F. National Electric Code (NEC)

G. International Building code (IBC)

PART 2 - PRODUCTS

2.01 DISTRIBUTION – LOW VOLTAGE LIGHTING AND POWER

A. Transformers shall be premium high efficiency quiet type, and shall be installed where indicated on the Plans. The primary winding of the transformers shall have two 2 1/2% taps above, and below normal.

B. The transformers shall have a BIL of 10 KV with a temperature class of 185°C for transformers up to 25 KVA, and a temperature class of 220°C for larger transformers.

C. The sound level shall not exceed 44 dBa measured at 5 feet from the transformer after installation. Core and coil assemblies 30 KVA and larger, shall be mounted on rubber vibration isolators, designed to reduce harmonics generated noise.

D. Transformers shall be types manufactured by Square D, Cutler-Hammer, General Electric, Siemens, or equal.

E. Transformers shall conform to Seismic restraint requirements per the IBC and specification 16000.

F. Transformers shall be constructed using copper windings.

G. Transformers shall be ventilating type with NEMA 3R kit if installation is outdoors.

H. Transformer shall be rated for a continuous duty cycle.

2.02 FERRO RESONANT ISOLATION TRANSFORMERS

A. Ferro resonant isolation transformers shall be provided where indicated on the Plans. Regulation shall be + 3% for an input range of + 10%. Common mode noise rejection shall be better than 120 dB with transverse mode noise rejection better than 60 dB. Voltage spike attenuation shall be better than 250:1.

B. Isolation transformers shall be as manufactured by Shape Magnetronics, Control Concepts, Inc., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Transformers shall be installed as indicated on the Plans, and in accordance with the manufacturer’s instructions and recommendations.

B. Contractor shall provide painted metal wall brackets, when required.

C. Grounding shall be provided per NEC, and Section 16170.

END OF SECTION 16461

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers electrical panelboards.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and the Contract Documents, prior to installation.

B. Panel layout with alphanumeric designation, branch circuit breaker sizes and types, AIC rating, bus sizes, bus material and other characteristics.

1.03 QUALITY ASSURANCE

A. NEMA PB-1, Panelboards

B. NEC

C. UL67, Panelboards

PART 2 - PRODUCTS

2.01 PANELBOARDS

A. Dead front panelboards, including lighting distribution and control panels, shall be furnished and installed as indicated on the Plans. Buses shall be copper. If shown on the drawings as 4 wire neutral shall be 100% rated. Mounting and type of enclosures shall be as indicated on the Plans. Where not indicated, indoor enclosures shall be NEMA 12 and outdoor enclosures shall be NEMA 4. The minimum interrupting capacity of any device shall be 22 KAIC unless otherwise indicated on the Plans.

B. Protective devices shall be replaceable without disturbing adjacent units, and shall be of the bolt-on type. Snap in protective devices will not be accepted. Wire connectors shall be suitable for wire sizes indicated. Branch circuits shall be numbered as indicated on the Plans, and a complete typed circuit schedule shall be furnished under a transparent cover, and affixed to the inside of the panel access door. Phase busing shall be full height without reduction. Full size neutral and ground bars shall be included, and shall have suitable lugs for each outgoing circuit requiring connection. Spaces for future protective devices provided in lighting panels shall be bused for the maximum device that can be fitted into them.

C. Panelboards shall be finished with a primer, rust resistant phosphate undercoat and two coats of oven baked enamel with finish ANSI grey. They shall be sized to provide a minimum of 4 inches of gutter space on all sides. Doors shall not uncover any live parts, and shall be hinged and have latches that require no tool to operate. Panelboard doors shall be lockable. Lock and two keys shall be furnished.

D. Each panelboard shall have, on the outside of the door, a lamicoid nameplate with 3/4 inch letters as specified elsewhere in these Contract Documents.

E. Panelboards shall be as manufactured by Square D, General Electric, Eaton / Cutler Hammer, or equal.

F. Panelboards shall be service entrance rated where required, and as shown on the Plans.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Panelboards shall be installed as indicated on the plans and according to manufacturer's instructions.

B. Provide grounding per NEC, and Section 16170.

C. Contractor shall verify all NEC clearance requirements prior to installation.

END OF SECTION 16470

SECTION 16476

LOW VOLTAGE CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install, low voltage circuit breakers, as indicated on the Drawings and specified herein.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 QUALITY ASSURANCE

A. The breaker manufacturer's facilities shall be ISO 9001 certified.

PART 2 - PRODUCTS

2.01 GENERAL

A. Circuit breakers shall be as manufactured by Square D, Cutler-Hammer, Allen-Bradley, General Electric, or equal.

B. Circuit breaker frame, trip, short circuit, and interruption ratings shall be as indicated on the Drawings, except that they shall be coordinated with the ratings of the equipment actually furnished, and shall be modified where necessary to suit the equipment. Circuit breakers to be used in motor control centers shall be as indicated on the Drawings. Where no indication of type is given on the Drawings circuit breakers protecting motors shall be motor circuit protectors, and other circuit breakers shall be molded case type.

C. Circuit breaker for mounting in motor control centers, or for separate mounting shall be of the air-break type, quick-make and quick-break, 600 volt, with number of poles as indicated on the Drawings.

D. Each pole of the circuit breaker shall provide inverse time delay, and instantaneous circuit protection.

E. The breakers shall be operated by a handle, and shall have a switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits, and abnormal currents. Tripping due to overload, or short circuit shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. Latch surfaces shall be ground and polished. Poles shall be constructed so that they open, close, and trip simultaneously.

F. Breakers must be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes. The minimum interrupting ratings of the circuit breakers shall be at least equal to the available short circuit current at the line terminals.

G. Circuit breakers shall conform to the applicable requirements of NEMA Standards Publication No. AB1.

H. Molded case circuit breakers shall be ambient temperature compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element. Compensation shall be accomplished by a secondary bi-metal that will allow the breaker to carry rated current between 25 degrees C and 50 degrees C with tripping characteristics that are approximately the same throughout this temperature range.

I. On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.

J. Unless mounted in a switchboard, or panelboard, circuit breakers shall be housed in a NEMA rated enclosure as described elsewhere in these specifications.

K. Provide circuit breakers with shunt trip mechanisms where shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Circuit breakers shall be installed as indicated on the Drawings and per manufacturer's instructions.

END OF SECTION 16476

SECTION 16477

600 V FUSES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Extent of fuse work required by this section is indicated by drawings, and by requirements of this section.

B. Types of fuses specified in this section include the following:

1. Class L time-delay.

2. Class L fast-acting.

3. Class RK1 time-delay.

4. Class RK1 and Class J current limiting.

5. Class RK5 time-delay.

6. Class K5 time-delay, non-current limiting.

7. Class T current-limiting.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fuses of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.03 CODES AND STANDARDS

A. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting-Capacity Class K Fuses". Provide over-current protective devices which are UL-listed and labeled.

B. NEC Compliance: Comply with NEC as applicable to construction and installation of fusible devices.

C. ANSI Compliance: Comply with applicable requirements of ANSI C97.1 "Low-Voltage Cartridge Fuses 600 Volts or Less".

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties and accessories in accordance with Section 16000, and the Contract Documents. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristic curves, and mounting requirements.

1.05 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering fusible devices which may be incorporated in the work include, but are not limited to, the following: Bussmann, Gould-Shawmut, Reliance, or equal.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

2.02 CLASS L TIME-DELAY FUSES

A. Provide UL Class L time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting transformers, motors, and circuit-breakers.

2.03 CLASS L FAST-ACTING FUSES

A. Provide UL Class L fast-acting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit-breakers.

2.04 CLASS RK1 TIME-DELAY FUSES

A. Provide UL Class RK1 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors and circuit-breakers.

2.05 CLASS RK1 CURRENT-LIMITING FUSES

A. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit-breakers.

2.06 CLASS J CURRENT-LIMITING FUSES

A. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.

2.07 CLASS RK5 TIME-DELAY FUSES

A. Provide UL Class RK5 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors.

2.08 CLASS K5 ONE-TIME FUSES

A. Provide UL Class K5 one-time fuses rated 250-volts, 60 Hz, with 100,000 RMS symmetrical interrupting current rating for protecting non-inductive loads.

2.09 CLASS T FUSES

A. Provide UL Class T fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protection of physically small devices.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fuse types and sizes shall be as indicated on the Plans. Fuses shall be installed in accordance with the National Electric Code (NEC) requirements and the manufacturer’s written instructions.

B. Install fuses in proper fuse holders.

C. Where fuses are installed in the motor starters, fuses shall be sized to match the actual motor full load current.

D. Where fuses are installed in disconnect switches at HVAC units, the fuse sizes shall be sized to meet the HVAC manufacturer's requirements.

E. Fuses for control transformers shall be sized in accordance with the National Electrical Code.

F. Fuses shall be installed with the labels clearly visible.

3.02 FIELD QUALITY CONTROL

A. Prior to energizing fusible devices, test devices for circuit continuity and for short-circuits.

3.03 SPARE PARTS

A. Furnish 10% of installed fuses or 3 sets whichever is greater for each type and ampere rating. The set shall equal the number of poles in the appropriate equipment.

B. Furnish a spare fuse cabinet equal to Bussmann for storing spare fuses. Mount on wall in Electrical room as directed by the Engineer.

END OF SECTION 16477

SECTION 16481

MOTOR CONTROL CENTERS (MCC)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install, ready to use, motor control centers for use as indicated on the Plans and specified herein.

B. Circuit breaker ratings, and modifications, shall be as indicated on the Plans.

C. MCP ratings, and modification, shall be as indicated on the Plans.

1.02 SUBMITTALS

A. The motor control centers shall meet the requirements of the latest edition of Standards for Industrial Control No. ICS published by the National Electrical Manufacturers Association. The following minimum information and drawings shall be submitted for review:

1. Plan, front, side views and overall dimension of each motor control center.

2. Weight.

3. Internal wiring diagram of each plug in unit.

4. Internal wiring diagram of the motor control centers.

5. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.

6. One line and schematic diagram for each motor control center.

7. Bill of material list and Manufacturer's Product Data.

8. Installation instructions including seismic installation.

9. Manufacturer's certification that the following items are capable of interrupting and/or withstanding the specified short circuit condition:

a. Bus bar bracing

b. Feeder tap units

c. Starter units

B. Product information shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 MOTOR CONTROL CENTERS (MCC)

A. The motor control center fabricator shall be the manufacturer of the major components therein, such as circuit breakers and starters. Engineered motor control centers shall be by the component and housing manufacturer. The manufacturer shall comply with equipment specifications contained elsewhere in these Contract Documents.

B. Each component, as well as the complete assembly, shall be constructed and tested in accordance with latest NEMA Standards for Industrial Control. The type of construction of the control centers shall be NEMA Class II, Type B. Lifting eyes shall be provided on each section to facilitate handling.

C. Unit doors shall be mounted on the stationary structure and hinged on the side away from the vertical wireway. They shall be held closed with slotted thumbscrews.

D. Unit doors shall have positive action linkage with disconnect operating mechanism. Mechanism shall be designed so that it can be locked in the OFF position with up to 3 padlocks. When the handle is not padlocked, it shall be possible to open the door by releasing the door interlock with a small screwdriver. The control units shall be of the plug-in type. When doors are closed, the operating mechanism shall clearly indicate the ON or OFF position of the disconnect, and the door interlock mechanism shall engage. The disconnect operating mechanism shall be designed against inadvertent operation when the door is open. Each plug in unit door shall be provided with a nameplate, specified elsewhere herein, that indicates the circuit number and circuit name. The nameplate shall be attached to the door with brass or stainless steel screws. Each motor starter door shall be provided with an externally operated manual reset pushbutton for the overload relay.

E. It shall be possible to install up to 6 NEMA size one units in one vertical section. Units shall be completely enclosed with sheet steel. A small wireway shall be provided inside the unit, so all wiring can be laid in place without removing barriers or plates. Each vertical section that holds the units shall be rigidly formed of minimum 12 gauge, cold rolled sheet steel. The vertical front of board construction shall be supplied with minimum 20 inch depth.

F. Continuous horizontal wiring troughs shall be provided at both top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the MCC. A large continuous, full-height vertical wiring trough shall be provided in the right side of each section.

G. All starter wiring, control, and power shall be terminated in terminal strips in this trough for size 2 and smaller starters. Size 3 and larger starters shall have control leads terminating on the terminal strips in the trough. Terminal strips shall be split type to facilitate wiring connections without disconnecting factory or field conductors. Terminal strips shall be rated to accept conductor sizes as indicated on the Plans.

H. All bus bars shall be tin plated copper, and shall be of the ampacity indicated on the Plans. Unit bus bar stabs shall insure high contact pressure. The vertical bus bars shall be effectively isolated from accidental contact by plastic insulating medium.

I. Bus bar supports shall be of high impact strength non-carbonizing insulating material mounted on padded steel brackets and shall provide adequate dielectric strength and creepage distance. The bus structure shall be capable of withstanding short circuit current in accordance with NEMA standards, and as indicated on the Plans.

J. Each section shall be equipped with horizontal ground bus that shall be continuous across the MCC.

K. The MCCs shall be supplied as indicated on the Plans, and as specified herein and in accordance with NEMA Standard Pub. IS 1.1, latest edition. The MCCs shall be enclosed in NEMA Type 1 gasketed industrial use enclosures, unless otherwise shown. NEMA 3R enclosures shall provide sufficient depth for air conditioning units to be mounted on the end of the structures. If the MCCs contain VFDs or Solid State Starters that require cooling, their respective sections shall be louvered top and bottom, and fans shall remove heat from within the sections.

L. All metal surfaces and structural parts shall be given a phosphatizing, or equal, treatment prior to painting. The control centers shall then be given a gun metal gray undercoat which is equal to zinc chromate. The exterior of the enclosure shall be finished in standard ANSI Grey.

M. Spaces for future combination starters shall have all the hardware necessary so that a future plug in control unit can be installed without having to modify the vertical sections. The number of spaces for future control units shall be as indicated on the Plans.

N. Devices, such as, but not limited to, starters, circuit breaker, relays, timers, conductors, shall conform to other sections of these Contract Documents.

O. Provide customer metering instruments, as indicated on the Plans. Unless otherwise indicated on the Plans, metering units shall be electronic, capable of displaying volts line-to-line and line-to-neutral, and amps per phase.

P. Each section shall be equipped with horizontal neutral bus that shall be continuous across the MCC if the MCC is designated as 277/480 volt 4 wire.

Q. MCCs shall be as manufactured by Allen-Bradley, Square D, or Cutler Hammer Eaton

PART 3 - EXECUTION

3.01 GENERAL

A. The MCCs shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

B. Cables larger than No. 6 AWG, which hang from their vertical connections, shall be supported within 2 feet of the connection.

C. The motor overload relays shall be provided and sized based on the actual full load amperes of the motor connected to the starter.

D. The motor circuit protectors shall be adjusted to the lowest settings that do not cause false tripping.

E. Motor control centers shall be installed for seismic requirements as required in division 16000.

F. Motor Control Centers shall be provided in accordance with all applicable sections of division 16000.

3.02 FIELD TESTS

A. MCCs shall be tested in accordance with Section 16480.

END OF SECTION 16481

SECTION 16490

ARC FLASH COORDINATION STUDY

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Short-circuit and protective device coordination studies as prepared by the equipment manufacturer of the motor control center shall be given to the Owner.

B. The equipment manufacturer shall prepare an Arc Flash Hazard Analysis Study per the requirements set forth in the current issue of NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002, the IEEE Guide for Performing Arc-Flash Calculations.

C. The scope of the studies shall include the electrical distribution equipment that is being provided for the project as well as existing upstream devices and bussing.

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract.

1.03 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems

2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis

4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings

5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures

3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 – National Electrical Code, latest edition

2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.04 SUBMITTALS FOR REVIEW/APPROVAL

A. The studies shall be submitted to the Owner for review and approval prior to final completion.

1.05 FINAL SUBMITTALS

A. The results of the short-circuit protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Electronic PDF copies of the report shall be provided upon request.

B. The report shall include the following sections:

1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.

2. Short-Circuit Device Evaluation Table

3. Protective Device Coordination Methodology Analysis Results and Recommendations

4. Protective Device Settings Table

5. Time-Current Coordination Graphs and Recommendations

6. Arc Flash Hazard Methodology Analysis Results and Recommendations including details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.

7. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.

8. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

1.06 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be an employee of the approved engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.

E. The engineering firm shall have a minimum of twenty-five (25) years of experience in performing power system studies.

1.07 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software program.

PART 2 - PRODUCTS

2.01 STUDIES

A. The equipment manufacturer shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies.

2.02 DATA COLLECTIONS

A. Field data collection shall be performed by a certified Technician of the equipment manufacturer, qualified (as defined by NFPA 70E – 2004) to ensure accurate equipment modeling. The technician shall have completed an 8-hour instructor-led Electrical Safety Training Course. The course shall include NFPA 70E training which includes the selection and use of personal protective equipment.

B. The technician will visually inspect to verify the equipment ratings, conductor ratings and overcurrent device data by removing panels, covers and doors where required to document the necessary data used in the analysis. The technician can perform these inspections with the equipment energized provided the incident energy values are less than 40cal/cm², greater values or unusual site conditions will require an equipment shutdown so the equipment can be inspected de-energized.

C. The Owner shall provide qualified personnel to show the technician the equipment location and to open all equipment doors, locks, etc. necessary to collect nameplate data.

D. The technician will verify the owner’s one-line drawings and provide marked corrections where discrepancies are found.

E. Data collection shall begin downstream from the utility service and continue down through the Owner's electrical distribution system as defined under scope of work. The study shall not include any single phase AC circuits or DC distribution systems as these types of circuits and systems are excluded from IEEE 1584-2002 Arc Flash calculation guidelines. The study will not include equipment rated 240 volts or less per NFPA 70E, when supplied by a single transformer rated less than 125kVA.

F. The technician shall obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

2.03 SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:

1. Calculation methods and assumptions

2. Selected base per unit quantities

3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.

4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.

6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

C. For solidly-grounded systems, provide devices and compare to short-circuit ratings Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses

D. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses

2. The equipment manufacturer shall notify Owner in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.04 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device.

2. Medium voltage equipment overcurrent relays.

3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

6. Medium voltage conductor damage curves.

7. Ground fault protective devices, as applicable.

8. Pertinent motor starting characteristics and motor damage points, where applicable.

9. Pertinent generator short-circuit decrement curve and generator damage point.

10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Provide the following:

1. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram.

5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

6. The equipment manufacturer shall notify Owner in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

2.05 ARC-FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis.

B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. Circuits 240V or less fed by single transformer rated less than 125 kVA may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E.

D. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows: Fault contribution from induction motors should not be considered beyond 5 cycles.

H. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Provide the following:

1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.

2. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.

3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

A. The Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the equipment manufacturer under the separate Startup and Acceptance Testing contract portion of project specifications.

B. The Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. The equipment manufacturer shall notify Owner in writing of any required major equipment modifications.

3.02 ARC FLASH LABELS

A. The equipment manufacturer shall provide a 4.0 in. x 4.0 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electric Code) – Article 110.16

C. The label shall include the following information:

1. System Voltage
2. Flash protection boundary
3. Personal Protective Equipment category
4. Arc Flash Incident energy value (cal/cm²)
5. Limited, restricted, and prohibited Approach Boundaries
6. Study report number and issue date
7. Labels shall be printed by a thermal transfer type printer, with no field markings.

D. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
2. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.
4. Labels shall be field installed by the Contractor.

END OF SECTION 16490

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting fixtures.

1.02 QUALITY ASSURANCE

A. Reference Standards:

1. National Electrical Code (NEC)
2. UL Standard #57, Electric Lighting Fixtures
3. UL Standard #844, Electric Lighting Fixtures for Use in Hazardous Location
4. UL Standard #1570, Fluorescent Lighting Fixtures
5. UL Standard #1571, Incandescent Lighting Fixtures
6. UL Standard #1572, High Intensity Discharge Lighting Fixtures
7. Illuminating Engineering Society (IES)
8. All applicable local lighting ordinances

B. Miscellaneous

1. Lamps are identified for each luminaire in the Lighting Fixture Schedule on the Plans.
2. Lighting fixtures and electrical components:
   a. UL labeled, complete with lamps.
   b. Rated for area classification as indicated.
3. On the Plans, the location of lighting fixtures is intended to be used as a guide.
   a. Field conditions may affect actual locations.
   b. Coordinate with other trades to avoid conflicts in mounting of fixtures and other equipment.
4. The quality standard is established by the fixture listed in the Lighting Fixture Schedule.
   a. This quality standard includes, but is not necessarily limited to construction features, materials of construction, finish, and photometrics.

1.03 SUBMITTALS

A. The following shall be submitted to the Engineer for review:

1. Acknowledgment that products submitted meet requirements of standards referenced.

2. Manufacturer's technical information on products to be used including photometric performance curves for the fixture and ballast data.

3. Acknowledgment that products submitted are UL listed.

4. When general data sheets constitute part of the submittal, identify the products to be used on this project.

5. Manufacturer's installation instructions.

6. Identification of fixtures by Lighting Fixture Schedule.

7. UL nameplate data (Voltage, wattage, etc.).

8. Finishes, colors, and mounting type.

9. Pole, fixture, and accessories.

10. Pole wind loading.

B. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 16000, and other requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Lamps shall be manufactured by General Electric, North American/Phillips, Sylvania, or equal.

B. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule on the Plans.

C. Lighting ballasts shall be manufactured by General Electric, Advance, Jefferson, Universal, Bodine, Lithonia, or equal.

D. Light poles shall be as indicated on the Plans. Include base template, anchor bolts, cadmium-plated hardware and pole grounding lug, hand-hole, anchor base and bolt covers. Pole foundations shall be as indicated on the Plans.

2.02 MATERIALS

A. General:

1. Lamps:

a. See lighting fixture schedule on Plans for wattage, voltage and number required.

2. All Fixtures:

a. There shall be no live parts normally exposed to contact.

b. When intended for use in wet area:

i. Mark fixtures “suitable for wet locations.”

c. When intended for use in damp areas:

i. Mark fixtures “suitable for damp locations” or “suitable for wet locations.”

d. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lamp-holder, or other electrical parts.

e. Gasket seals: Urethane foam

f. Diffusers: UV stabilized acrylic plastic

3. Underground wiring:

a. Provide all wiring runs with separate green grounding conductor.

b. Ground all pole bases.

4. Pole wiring from base to ballast:

a. No. 12 type XHHW.

b. Each phase shall be protected by a 30A, 600V, type Tron waterproof fuse-holder, Bussman “Limitron” type fuse, size rating 3-times load current.

B. Incandescent Lamps:

1. Types:

a. 30-135 watts: Energy efficient

b. 200-500 watts: Standard

2. Inside frost

3. Base: Aluminum or brass

4. PAR/Halogen

C. Fluorescent Lamps:

D. Rapid start

1. Cool white (F32T8/41K-85CRI and F96T12/41K-70CRI/HO/ES)

2. Energy efficient or standard as noted on the lighting fixture schedule.

E. Metal Halide Lamps:

1. Bulb finish: Clear

2. Any burning position

F. LED:

1. 50,000 hour lifetime

G. Furnish a minimum of 2 lamps, or ten percent spare lamps of each type and wattage, whichever is greater.

2.03 FIXTURES

A. Fluorescent Lighting Fixtures:

1. Ballast:

a. Rapid start, high power factor type

b. CBM/ETL certified

c. Sound rating A

d. Two internal automatic-resetting thermal switch devices for coil and capacitor

2. Internal wiring: AWM, TFN or THHN

3. Channel and end plates: 22 GA steel

4. Steel door frame and socket track: 20 GA steel

5. Channel cover: 24 GA steel

6. Emergency ballast:

a. Integral rechargeable nickel-cadmium battery, battery charger, and automatic transfer circuitry.

b. Charging indicator light.

c. Test Switch.

d. Provide a minimum of 900 lumen output for 90 minutes upon loss of normal power.

e. Mounted integral to the fixture.

f. UL 924 listed.

7. Provide fixtures with emergency ballasts with permanent caution labels warning that the fixture is fed from an unswitched source.

a. Provide emergency ballast also with a similar caution label.

B. HID Lighting Fixtures:

1. Ballasts for high pressure sodium lighting fixtures:

a. Type: Regulating

b. Ballast design center variance: Maximum 5 percent from rated lamp wattage.

c. Lamp wattage regulation spread at the lamp voltage: Maximum 10 percent for ±10 percent line voltage variation.

d. Ballast primary current during starting not to exceed normal operating current.

e. Lamp current crest factor: Maximum 1.8 for ±10 percent line voltage variation at any lamp voltage, from nominal through life.

f. Power factor shall not drop below 90 percent for ±10 percent line voltage variations at any lamp voltage, from nominal through life.

g. Capacitor variance: Tolerance of ±6 percent which will not cause more than a ±8 percent variation in regulation throughout rated lamp life for nominal line voltage.

h. Capable of operation with an open circuit condition for a maximum of 6 months without significant loss of ballast or starting circuitry life.

2. Ballasts for metal halide/mercury vapor lighting fixtures:

a. Type: Auto-regulator

b. Voltage input range: ±10 percent

c. Lamp regulation spread: 20 percent maximum

d. Power factor: 90 to 90 percent

e. Input voltage dip (4sec.): 40 to 50 percent

f. Crest factor of lamp current: 1.6 to 2.0

3. Ballasts for exterior HID lamps:

a. UL approved

b. High power factor designed for -20°F temperature starting

4. LED Lighting Fixtures:

a. Type: Industrial low bay

b. Ballast housing: Die-cast

c. Filter: Activated charcoal

d. Refractor: UV stabilized molded acrylic

2.04 MISCELLANEOUS ELECTRICAL DEVICES

A. PHOTOELECTRIC CONTROL UNITS shall meet the following requirements:

1. Cadmium sulfide photocell

2. Aluminum weatherproof enclosure

3. 30 amp rated contacts

4. 120-volt AC power

5. The Photoelectric control unit shall be Tork Model 2100, or equal.

B. MOTION SENSORS shall meet the following requirements:

1. 110 degrees field of view, 60 foot range

2. Adjustable time setting from 15 seconds to 15 minutes

3. Operating temperature of -20 to +130°F.

4. Complete outdoor, weather proof sensor with complete mounting hardware

5. UL listed

6. The motion sensor(s) shall be manufactured by Leviton Model 50500-H or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lamps in all luminaires.

B. Replace all failed fluorescent, incandescent, metal halide, mercury vapor and high pressure sodium lamps with new lamps prior to final acceptance by Owner.

C. Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless steel chains and hooks. Each suspended fixture shall be electrically connected by a length of Type SO flexible cord. 3 conductor No. 14 AWG, minimum, with a twist-lock receptacle mounted in an individual junction box. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.

D. Provide mounting brackets and/or structural mounting support for fixtures.

1. Do not support fixture from conduit system.

2. Do not support fixture from outlet boxes.

E. Install with approved mounting hardware following manufacturer’s recommendations.

F. Pole mounted fixtures shall be mounted on steel or aluminum poles as indicated on the Plans. All metal poles shall be bonded to the facility ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated.

G. All anchor bolts and nuts shall be stainless steel. Contractor shall paint all steel poles with aluminum paint or other color in accordance with these Contract Documents.

H. Fixture mounting heights and locations indicated on the Plans are approximate and are subject to revision in the field where necessary to avoid conflicts and obstructions.

3.02 ADJUSTING AND CLEANING

A. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean after installation and prior to acceptance of Project by Owner.

END OF SECTION 16500

SECTION 16611

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the requirements for uninterruptible power supplies (UPS's) to be provided as shown on the Plans.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and the Contract Documents, prior to installation.

1.03 REFERENCES

A. National Electrical Code (NEC) Article 250

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The UPS equipment shall be manufactured by Powerware, or equal.

B. The UPS shall be sized for a minimum of 30 minutes of backup power for its connected load.

C. The UPS shall be a line-interactive type, consisting of a ferroresonant or linear transformer, battery charger, batteries, inverter, and microprocessor control. The batteries shall be maintenance free, premium type.

D. The UPS shall pass lightning and surge protection ANSI/IEEE C62.41 standards, Category A and B. The UPS shall be UL 1449 listed.

E. The output waveform shall be a pure sine-wave with less than 5% total harmonic distortion on the inverter.

F. The UPS shall have a digital display for load-dependent runtime, volts in, volts out, battery voltage, percent loading, and alarm codes.

G. The UPS shall operate between 0 and 40°C, at a minimum of 95% efficiency on-line.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install the UPS equipment in accordance with the manufacturers' recommendations.

B. The UPS shall be provided with a two year parts and factory service warranty.

END OF SECTION 16611

SECTION 16902

ELECTRICAL CONTROLS RELAYS AND ALARMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes the following:

1. Pushbutton and Selector Switches
2. Relays
3. Alarms
4. Intrinsic Safety Barriers
5. Wire-ways
6. Watt-hour Transducers
7. Elapsed Time Meters and Time Clocks

1.02 RELATED SECTIONS

A. Section 16000 General Electrical Requirements

B. Section 16160 Enclosures

1.03 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control Systems.

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

D. NEMA ST 1 - Standard for Specialty Transformers (except General Purpose Type).

1.04 SUBMITTALS

A. Data - a complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each of the different items of equipment specified. The data shall include a complete Bill of Materials.

B. Drawings - containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to other parts of the work including clearances for maintenance and operations.

C. Submit shop drawings in accordance with the Contract Documents, and NEMA ICS 1 specifications indicating control panel layouts, dimensions, support points, wiring connections and diagrams.

1.05 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the Contract Documents.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation data in accordance with the Contract Documents.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data in accordance with the Contract Documents.

D. Include recommended preventative maintenance procedures and materials.

PART 2 - PRODUCTS

2.01 PUSHBUTTONS AND SELECTOR SWITCHES

A. Pushbuttons, pilot lights and selector switches shall be of the full size, heavy-duty industrial, oil tight, 120 volt, with interchangeable pilot lights, plug-in construction, double break silver contacts, chrome plated lock rings, with modular contacts, and NEMA rating equal to that of the enclosure on which devices are installed. All components shall be flush mounted on front of panel, unless otherwise noted.

B. Provide individual legend plates for indication of switch, pushbutton, and light function (e.g., Open, Closed, Hand-Off-Auto). A list shall be submitted for review and approval.

C. Pilot lights shall be high intensity LED type. Pilot lights shall have clear lenses and LED lamps colored as shown on the Plans. Common, remote push-to-test circuitry shall be provided for each control panel to simultaneously test all indicating lights on the panel using a single pushbutton when there are 10 or more lights on the panel. Control panels with less than 10 lights shall utilize individual push-to-test lights and control circuitry.

D. Pushbuttons shall be maintained as shown on the Drawings. Momentary requirements shall be followed. Provide extended head pushbutton for all stop functions, mushroom head for emergency stop functions, and flush head pushbuttons for all other functions. Where indicated on the Drawings pushbuttons shall be illuminated type. Provide locking mechanism for all lock out functions. Selector switches shall have black knob operator, be maintained contact type unless noted otherwise. The number and arrangement will be able to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with AC or DC throughput current of devices simultaneously operated by the switch contact but not less than 10 amperes resistive at 120 volts AC or DC continuous.

E. Potentiometers shall be provided with operators and resistive elements of the type. The quantity will be indicated on the Drawings and as required with legend plates indicating percent of span.

F. The above devices shall be manufactured by Square D, Allen Bradley, General Electric, or equal.

2.02 RELAYS

A. TIMING RELAYS shall be heavy duty, 300V A.C., 10 amps, solid state design, poles as required per application, -10°C to +60°C, have timing repeatability of ±2.0% of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Allen Bradley, Square D, Cutler Hammer, or equal.

B. CONTROL RELAYS shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 300-volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating lamp to show energized state. Each relay shall have a minimum of two double pole, double throw contacts, or as required. Control relays shall be Allen Bradley, Square D, Cutler Hammer, or equal.

C. ALTERNATING RELAYS shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 120 VAC, life expectancy of 100,000 operations, load indicating LED's, and switch for load locking and load selecting options. Alternating relays shall be manufactured by TimeMark models 261, 271, and 471, and Diversified Electronics model ARA for duplex, triplex, and quadplex alternators.

2.03 ALARMS

A. AUDIBLE ALARMS shall be UL listed, 120 VAC, with solid state circuitry, vibrating horn, non-metallic corrosion resistant housing, with required mounting hardware, suitable for outdoor use capable of producing 100 dB at 10 feet. The audible alarm shall be manufactured by Federal Signal model 350, Edwards model 870-EX, or equal.

B. ROTATING BEACONS for interior and/or exterior locations shall be UL listed, 120 VAC, with motor and cooling fan, rotating lights at 60 times per minute minimum, capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 371L or equal.

C. ROTATING BEACONS for corrosive and/or hazardous locations shall be UL listed, 120 VAC, with solid state circuitry, rotating lights at 60 times per minute minimum, suitable for outdoor use capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Edwards model 52EX or equal.

D. STROBE BEACONS shall be UL listed, NEMA 4X, 120 VAC, flashing at 80 times per minute minimum, producing peak candlepower of 520,000, effective candlepower of 165, with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 151XST, Edwards model 92EX, or equal.

2.04 INTRINSIC SAFETY BARRIERS

A. INTRINSIC SAFETY BARRIERS shall permit connection of devices located in a hazardous area to other devices located in a safe area. Intrinsic safety barriers shall be EMC compliant, 10 to 35 V dc, 35 mA output current, hazardous area terminals identified by blue labels, terminals accommodating conductors up to 12 AWG, ambient temperature rating of –20 to +60°C. The intrinsic safety barriers shall be manufactured by MTL Inc., Ronan Engineering Co., Phoenix Contact, R. Stahl Inc., or equal.

2.05 WIREWAYS

A. WIRE-WAYS shall be PVC, snap-in slot design, with non-slip cover. Safe area wire-ways shall be light gray and marked “Safe Area Wiring.” Hazardous area wire-ways shall be intrinsic blue and marked “Hazardous Area Wiring.” The wire-ways shall be manufactured by Panduit Corporation, or equal.

2.06 WATT-HOUR TRANSDUCERS

A. WATT-HOUR TRANSDUCERS for active or reactive power shall be DIN rail and surface mount, single phase or three phase with balanced or unbalanced load, electrically isolated input and output signals, 4 to 20 mA output signal, 0-10 mA to 0-10 A input current, 0-10 V to 0-600 VAC input voltage, 16-500 Hz selectable frequency. The watt-hour transducers shall be manufactured by Sineax model PQ502, or equal.

B. TIME CLOCKS shall be microprocessor based, have 24 hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 V AC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, Paragon Electric Company, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasteners shall be type 304 stainless steel.

B. Install devices in strict accordance with NEC requirements and per manufacturer’s recommendation.

C. Coordinate with other trades as necessary during installation of these devices.

3.02 ACCEPTABLE

A. All installations are subject to evaluation in accordance with NEC requirements and manufacturers recommendations. Contractor shall remove the unacceptable work and correct work at no charge to Owner.

END OF SECTION 16902

SECTION 16903

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the programmable logic controller (PLC) used for control and monitoring, as indicated on Plans. The Owner's System Integrator will provide PLC programming unless otherwise indicated on the drawings.

B. Programming Software will not be required to be furnished as part of the project.

1.02 SUBMITTALS

A. Submittals shall include the following:

1. Manufacturer's data on electrical characteristics, capabilities and physical properties.

2. Wiring diagrams showing connections to all devices; input and output (I/O), analog and discrete. The wiring diagrams shall indicate the I/O address point to be used in the PLC programs.

1.03 MANUFACTURERS

A. The PLC shall be manufactured by Allen Bradley and shall be a ControlLogix series, no equal.

PART 2 - PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER

A. PLCs shall be furnished with hardware and software necessary to monitor and control equipment, as listed in the specifications, and shown on the Plans. Each field input and output shown as an I/O Point shall be connected as per the manufacturers' recommendations. Additionally, the Contractor shall provide the hardware, software, and installation necessary for connecting additional future equipment as indicated on the Plans. The type of field input and output shall be defined as follows unless specified on the plans:

1. Analog inputs and outputs (4 20 mA DC).

2. Discrete inputs (dry contact).

3. Discrete outputs (24 VDC, form "C" relay)

B. Contractor supplied PLC's and OIT's shall be programmed as noted in section 1.01 of this specification.

C. The programmable controllers shall be supplied with Ethernet/IP communication modules or have the Ethernet/IP communication port directly on the processor, and with a TOD clock and battery back as shown on the Plans.

2.02 CENTRAL PROCESSING UNIT (CPU)

A. The PLC CPU shall be a microprocessor based industrial controller with a temperature rating of 0 to 60° C, and a humidity rating of 5 to 85% non-condensing, minimum. The CPU shall have internal memory of a minimum 768 kbytes for user programmed instructions and 64 megabytes of SD non-volatile memory available.

B. The PLC shall have tag-based memory which shall retain information on power failure. Each tag shall be capable of storing 32 bits of data. This information shall represent process set points, timer and counter presets, accumulated values, positions, or other measured process variables.

C. Program control and logic functions shall be solved sequentially during each CPU scan. The scanning tasks shall include, at a minimum:

D. Update of time reference from a built in real-time clock.

E. Diagnostic self-test of PLC to include input and output.

F. Reset watchdog timer which shall be used to verify correct functioning of the PLC and which shall be preset to 100 to 250 milliseconds.

2.03 INPUT/OUTPUT MODULES

A. Input and output bases shall have screw-in type terminals.

B. Analog inputs and outputs shall have a minimum of 12 bits resolution. Analog modules shall be configurable for 4 to 20 mA DC, or 1 to 5 Volt DC signals. Provide external, or user power, as needed.

C. Each discrete output module shall be fused and shall have interposing relays, with fuse blown indicators on each module. Indicator lights shall also be provided on each I/O point to indicate status of each signal. Each individual input or output point shall be optically isolated to protect the controller I/O circuitry from high voltage transients.

D. The power supply shall provide power for the processor, and I/O modules. The power supply shall have built in over voltage and under voltage detection circuitry, protection against overcurrent conditions, and automatic power up sequence that enables outputs only when proper operating tolerances are reached. Power requirements shall be 24 VDC.

E. The I/O system shall be field expandable to the maximum I/O capacity of the CPU, without modifications of the processor. Provide 25% blank, or empty base space for future bases.

F. The PLC system shall be provided with base type I/O, connected to the CPU via a dedicated remote I/O bus port, and be able to communicate over a shielded twisted pair cable at rate of one million bits per second, or greater.

2.04 STORAGE AND DOWNLOADING OF PLC PROGRAMS

A. The PLC shall be programmable through a USB and Network Port, connected to a personal computer through a standard cable.

2.05 OPERATOR INTERFACE

A. The operator interface shall communicate over Ethernet. The operator interface if not specified on the plans shall be a 10” color touch screen. The operator interface shall be powered by 24V DC. The following manufacturers will be acceptable if not specified on the plans:

1. Allen Bradley Panel View 5510 part number 2716P-T10WD.

PART 3 - EXECUTION

3.01 INSTALLATION

A. PLC shall be installed as indicated on the Plans and according to the manufacturer's instructions.

3.02 START-UP AND TESTING

A. Upon completion of the installation, start-up shall be performed by a factory-trained manufacturer representative. Operating and maintenance instruction books shall be supplied upon delivery of the unit and procedures explained to operating personnel.

B. The PLC program and I/O shall be thoroughly tested. Each input and output signal shall be tested for correct indication and control function. The Contractor shall demonstrate operation of the PLC inputs and outputs with simulated signals, and then tested with the Owners programmer and the control logic before the entire system is started, and run in automatic mode.

3.03 TRAINING

A. Provide four (4) hours of training on the control system. Instruction shall include a description of the control system hardware operation and equipment troubleshooting.

3.04 SPARES

A. Furnish a minimum of one (1) spare I/O module of each type, one (1) spare processor, and one (1) power supply module.

B. Furnish twelve (12) fuses of each type and size, used in the power supply and I/O modules.

END OF SECTION 16903

SECTION 16904

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. See Section 16481 "Motor Control Centers" for VFDs installed in motor-control centers.

1.02 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. EMI: Electromagnetic interference.

D. IGBT: Insulated-gate bipolar transistor.

E. LAN: Local area network.

F. LED: Light-emitting diode.

G. MCP: Motor-circuit protector.

H. NC: Normally closed.

I. NO: Normally open.

J. OCPD: Overcurrent protective device.

K. PCC: Point of Common Coupling

L. PID: Control action, proportional plus integral plus derivative.

M. PWM: Pulse-width modulated.

N. P&ID: Process & Instrumentation Diagram

O. RFI: Radio-frequency interference.

P. SCADA: Supervisory control and data acquisition.

Q. TDD: Total Demand Distortion.

R. THD: Total Harmonic Distortion.

S. VFD: Variable-frequency drive.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFDs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.04 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFD indicated.

B. System Harmonics Analysis: For each VFD and for the distribution system as a whole.

C. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings.

2. Schematic and Connection Wiring Diagrams: For power, signal, communications, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Seismic Qualification Certificates: For VFDs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

C. Product certificates.

D. Source quality-control reports.

E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test VFD according to IEEE 344 to withstand seismic forces.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Rockwell Automation, Inc.; Allen-Bradley Brand.

2. Square D; a brand of Schneider Electric.

3. Toshiba International Corporation.

4. Eaton Corporation

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 200 (60 as programmed default) Hz, programmable as voltage proportional to frequency throughout voltage range or with sensorless vector control; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: ±15% of VFD input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding 5%.

3. Input Frequency Tolerance: ±3% of VFD frequency rating.

4. Minimum Efficiency: 97% at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 98% under any load or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: Equal to the rating of the gear feeding the drive. If not listed, 65 kA.

7. Ambient Temperature Rating: Not less than 14°F (-10°C) and not exceeding 122°F (50°C).

8. Ambient Storage Temperature Rating: Not less than -4°F (-20°C) and not exceeding 158°F (70°C)

9. Humidity Rating: Less than 95% (noncondensing).

10. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.

11. Vibration Withstand: Comply with IEC 60068-2-6.

12. Overload Capability: VFD system shall be rated for continuous operation at a minimum of 110% of motor load full load amps (FLA) times the motor service factor. Variable torque inverters shall be capable of delivering 110% of continuous rating for a minimum of 60 seconds. Constant torque inverters shall be capable of delivering 150% of continuous rating for a minimum of 120 seconds.

13. Starting Torque: Minimum 100% of rated torque from 3 to 60 Hz.

14. Speed Regulation: ±0.6 Hz.

15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, VFD isolated from all power circuits.

I. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 100:1 speed range.

J. Internal Adjustability Capabilities:

1. Maximum Speed: 80 to 100% of maximum rpm.

2. Acceleration: 0.1 to 999.9 seconds.

3. Deceleration: 0.1 to 999.9 seconds.

4. Current Limit: 30 to minimum of 150% of maximum rating.

5. Self-Protection and Reliability Features:

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.

2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a% of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.

4. Inverter overcurrent trips.

5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.

6. Critical frequency rejection, with three selectable, adjustable deadbands.

7. Instantaneous line-to-line and line-to-ground overcurrent trips.

8. Loss-of-phase protection.

9. Reverse-phase protection.

10. Short-circuit protection.

11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115% of VFD input current rating.

2. Disconnect Rating: Not less than 115% of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.

2.02 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.

2. Run.

3. VFD Fault.

4. All other lights as shown on the design drawings

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and Plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

C. Historical Logging Information and Displays:

1. Running log of total power versus time.

2. Total run time.

3. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).

2. Motor speed (rpm).

3. Motor status (running, stop, fault).

4. Motor current (amperes).

5. Motor torque (percent).

6. Fault or alarming status (code).

7. PID feedback signal (percent).

8. DC-link voltage (V dc).

9. Set point frequency (Hz).

10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. Speed Reference: The VFD drive shall be capable of being controlled locally by a speed potentiometer or remotely by a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.

b. A minimum of two programmable analog inputs shall be provided and would be typically used for PID process variable and set point. These signals shall be setup to accept a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.

c. A minimum of six multifunction programmable digital inputs. The drive shall be expandable to handle additional digital inputs if required. The digital inputs shall be programmable to perform functions including, but not limited to:

i. VFD Start/Stop Control (2 or 3 wire)
ii. Forward/Reverse/Stop Control
iii. Local/Remote. The VFD shall be programmable so that “Local” control may either be the keypad or by hard-wired start/stop and potentiometer. The VFD shall be programmable so that “Remote” control may either be hard-wired start/stop and 4- to 20mA speed control or via the communications network.
iv. VFD Interlock/Enable. This input when de-energized will not allow the VFD to run the motor under any circumstance.
v. VFD External Fault. This input will trip the VFD and require a reset before allow the motor to run again.
vi. Preset Frequencies. The VFD shall be programmable to run at pre-programmed frequencies with up to 6 different steps.

2. Output Signal Interface:

a. A minimum of two programmable analog output signals 4- to 20-mA dc, which can be configured for any of the following:

i. Output frequency (Hz).
ii. Output current (load).
iii. DC-link voltage (V dc).
iv. Motor torque (percent).
v. Motor speed (rpm).
vi. Set point frequency (Hz).
vii. Motor power (kW)

b. A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following (the drive shall be expandable to handle additional digital outputs if required):

i. Motor running.
ii. VFD ready.
iii. Set point speed reached.
iv. Fault and warning indication (overtemperature or overcurrent).
v. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. SCADA Interface: Factory-installed hardware and software to enable the SCADA to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet.

2. Embedded SCADA Protocols for Network Communications: Ethernet/IP protocol accessible via the communications ports.

2.03 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: All new power distribution systems supplied shall be required to meet the requirements of IEEE 519-1992. Specifically, the system shall adhere to the TDD requirements of Table 10-3 of IEEE 519-1992. If the power distribution system is equipped with an Active Harmonic System, each VFD shall be equipped with a line reactor whose impedance is as recommended by the Active Harmonic System manufacturer (typically 3%). If no Active Harmonic System is part of the power distribution system, the following rules as a minimum shall define the input line conditioning for each VFD (unless further conditioning is required to meet the IEEE 519-1992 limits). With the Engineer’s approval, the contractor may decide to supply an Active Harmonic System even if not shown on the drawings, with corresponding reactors and chokes (this would typically occur if it is more cost effective to meet IEEE 519 with a single system then multiple harmonic filters).

1. All VFD’s sized for motors 50HP or larger shall be equipped with DC-link chokes.

2. All VFD’s sized for motors 40HP and less shall be equipped with 5% line reactors unless specifically called out as otherwise on the drawings.

3. All VFD’s sized for 50HP to 200HP motors shall be equipped with passive harmonic filters with DC Link Chokes.

4. All VFD’s greater than 200HP shall have be setup to have less than 5% THD for both voltage and current. This would typically require that the drive is setup with an 18-pulse front end or with an active harmonic filter. The VFD assembly shall accept a single 3-phase input and shall contain all of the harmonic mitigation equipment as part of the assembly.

B. EMI/RFI Filtering: VFD’s shall be CE marked and certify compliance with IEC 61800-3 for Category C2.

2.04 LOAD CONDITIONING

A. Load Conditioning: For VFD driven loads with conductor lengths between 200 and 1,000 feet, output dV/dt filters shall be provided as part of the VFD assembly. It is strongly recommended that VFD motor leads not be longer than 500 feet and alternative VFD locations should be considered. If absolutely necessary, loads with conductor lengths greater than 1,000 feet shall have output sinus filters shall be provided as part of the VFD assembly. Voltage drop considerations shall be taken into account when selecting the motor’s nameplate voltage.

2.05 LINE AND LOAD CONDITIONING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MTE Corporation.

2. Transcoil International (TCI).

3. Or approved equal.

B. Line Reactors: Reactors shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The reactor shall meet the following criteria:

1. The reactor shall be UL 508 listed.

2. Continuous current rating: 100% RMS.

3. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.

4. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.

5. All wiring shall be copper.

C. Passive Harmonic Filters: Filters shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.

2. The filter shall filter harmonics generated by the nonlinear VFD to satisfy the requirements of IEEE 519-1992 for individual and total harmonic voltage and current distortion at the input terminals of the filter.

3. The TDD of the current at the input terminals of the filter shall not exceed the limits defined in Table 10-3 of IEEE 519-1992.

4. Full load efficiency: 97% or greater

5. The filter shall not resonate with the power distribution system nor attract harmonics from other sources.

6. The harmonic filter shall be a passive series connected low pass filter consisting of an inductor capacitor network. Active electronic components shall not be used.

7. The harmonic filter shall be equipped with a contactor that will connect the capacitor(s) only when the motor is running, avoiding nuisance VFD over-voltage tripping.

8. All wiring shall be copper.

D. dV/dt Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.

2. Maximum peak motor terminal voltage with 500 feet of cable: 15% of bus voltage.

3. Maximum dV/dt: 200 Volts per microsecond.

4. Continuous current rating: 100% RMS.

5. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.

6. Allowed inverter switching frequencies: 1kHz to 8 kHz.

7. Nominal inverter operating frequency: 60Hz; Minimum – 6 Hz; Maximum with de-rating: 120Hz.

8. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.

9. Insertion loss: 3% of rated voltage maximum.

10. All wiring shall be copper.

E. Sinus Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.

2. Harmonic Voltage Distortion: 10% maximum

3. Continuous current rating: 100% RMS.

4. Intermittent current rating: 150% for 60 seconds.

5. Allowed inverter switching frequencies: 2kHz to 8 kHz.

6. Nominal inverter operating frequency: 60Hz; Minimum – 0 Hz; Maximum with de-rating: 90Hz.

7. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.

8. Insertion loss: 10% of rated voltage maximum.

9. All wiring shall be copper.

2.06 BYPASS SYSTEMS

A. Provide Bypass Systems only if indicated on the drawings.

B. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.

2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.

3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Contactor Configuration: Full-voltage (across-the-line) or reduced voltage soft-starter as shown on the drawings.

1. NORMAL/BYPASS selector switch.

2. HAND/OFF/AUTO selector switch.

3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.

4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 100 VA.

6. Overload Relays: NEMA ICS 2.

2.07 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry, Clean and Non-Corrosive Indoor Locations: Type 1.

2. Outdoor or Corrosive Locations: Type 4X, stainless steel.

3. Wash-Down Areas: Type 4X, stainless steel.

4. Other Wet or Damp Indoor Locations: Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.08 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

a. Push Buttons: Maintained and/or momentary as required.

b. Pilot Lights: LED types; colors as shown on P&ID's; push to test.

c. Selector Switches: Rotary type.

B. Bypass contactor auxiliary contact(s) as required.

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Analog Meters:

1. Elapsed time meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4, 4X, and 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4, 4X, 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized: Supply fan, with non-corrosive intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

I. Air Conditioning System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized; sized to maintain internal temperatures at or below 100°F.

2.09 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to its specified motor.

2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 16161 "Control Panels."

B. Seismic Bracing: Comply with requirements specified in Section 16000 "General Electrical Requirements."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFD.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 16477 "600 V Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.02 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 16195 "Electrical Identification."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each VFD with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

3.03 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.

2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation.

2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.

4. Verify that voltages at VFD locations are within 10% of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).

5. Test each motor for proper phase rotation.

6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

9. Perform voltage and current harmonic test with each VFD running at minimum and maximum speed. Submit test results for each VFD. Testing shall be witnessed by the Owner and the Engineer.

E. VFDs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.05 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as required.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs. A minimum of 4 hours of training shall be provided. The training shall cover VFD theory of operation, features and functions available, normal operation, troubleshooting, and routine maintenance. The Contractor shall submit a syllabus for the training session for approval, within 3 weeks of conducting the class. Provide each attendee with a class syllabus detailing each topic to be discussed.

3.07 SPARE PARTS

A. The following spare parts shall be supplied with each type, or frame size, of VFD:

B. 3 sets of all replaceable fuses

C. 3 spare air conditioner or fan filters

END OF SECTION 16904

SECTION 16940

COMMUNICATION CABLING SYSTEMS

PART 1 - GENERAL

1.01 THE REQUIREMENTS

A. The CONTRACTOR shall implement a Structured Cabling System (SCS) complete and operable in accordance with the Contract Documents.

B. The requirements of this Section apply to all components of the SCS unless indicated otherwise.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Contractor Submittals and the following:

1. The CONTRACTOR shall coordinate the installation of the SCS such that the complete SCS will be provided and will be supported by accurate Shop Drawings and Record Drawings

2. Exchange of Technical Information: During the period of these submittals, the CONTRACTOR shall authorize a direct, informal liaison with the ENGINEER for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as indicated may be authorized informally by the ENGINEER, but will not alter the scope of work or cause increase or decrease in the Contract Price. During this informal exchange, no oral statement by the ENGINEER shall be construed to give approval of any component or method, nor shall any statement be construed to grant exception to or variation from these Contract Documents.

B. Shop Drawings

C. Technical Manuals

D. Record Drawings

1.03 SPECIAL WARRANTY REQUIREMENTS

A. Manufacturer Warranty

1. CONTRACTOR shall provide a Ten (10) year warranty on the following items:

a. Fiber Optic Cabling

b. Fiber Optic Terminations and Cross-Connect Equipment

c. Outside-Plant (OSP) Category 5e Cabling

d. Copper Patch Panels and Indoor Category 6 Cabling

e. CTC Hardware (excluding UPS and other electronic devices)

B. Extended Period for Correction of Defects: The CONTRACTOR shall correct all defects in the SCS upon notification from the OWNER within 2 years from the date of Substantial Completion. Corrections shall be completed within 5 days after notification.

PART 2 - PRODUCTS

2.01 GENERAL

A. Code and Regulatory Compliance

1. Telecommunications Industry Association / Electronic Industries Association (TIA/EIA) 568B – Commercial Building Telecommunications Cabling Standards
2. TIA/EIA 569B – Commercial Building Standard for Telecommunications Pathways and Spaces
3. International Standards Organization/International Electrotechnical Commission (ISO/IEC) 11801 – Information Technology – Generic cabling for customer premises
4. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
5. National Electrical Manufacturers Association (NEMA)
6. American Society for Testing Materials (ASTM)
7. National Electric Code (NEC®)
8. Institute of Electrical and Electronic Engineers (IEEE)
9. UL Testing Bulletin

B. Current Technology: Cabling, Hardware and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

C. Hardware Commonality: All fiber cabling

2.02 EQUIVALENT PRODUCTS

A. Equivalent products may be considered for substitution for those products specified, however, the equivalent product must be approved and show demonstrated and documented equivalence to the product specified. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data. The request for product substitution and supporting documentation must be submitted in writing prior to submitting the bid. Written approval for product substitution must be submitted with the bid.

2.03 FIBER OPTIC CABLING

A. Fiber optic cabling shall be provided between facilities and furnished with the quantity of fibers as designated on the contract drawings.

B. All fiber in a cable run shall be from the same manufacturer and shall be the same type. A mix of fibers from different manufacturers may not be used without written permission.

C. Multimode Fiber Specifications

1. All fiber optic cables within the premises shall use multimode, graded-index fibers with 50 micron cores only.

2. Optical Specifications

    a. Fibers shall have dual wavelength capability at 850nm and 1300nm.

    b. Attenuation: ≤ 3.0 dB/km at 850nm and 1.5 dB/km at 1300nm.

    c. Bandwidth: Effective Modal Bandwidth of 4700 MHz*km and shall guarantee operation of 10 Gigabit Ethernet at 550 meters at 850nm.

    d. Numerical Aperture: 0.200 ± 0.015

3. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have CPC® or approved equivalent color coatings that resist color degradation, minimize microbending losses and improve handling. The coating shall be mechanically strippable.

4. Dimensional Specifications

    a. Core Diameter: 50.0 ± 2.5 µm

    b. Cladding Diameter: 125.0 ± 2.0 µm

    c. Core-Clad Concentricity: ≤ 1.5 µm

    d. Cladding Non-Circularity: ≤ 1.0%

    e. Core Non-Circularity: ≤ 5.0%

    f. Coating Diameter: 245 ± 5 µm

    g. Coating-Cladding Concentricity: < 12 µm

5. Environmental Specifications

    a. Operating Temperature: -60ºC to +85ºC

6. Mechanical Specifications

    a. Minimum tensile strength: 100,000 psi

    b. Fiber Minimum Bending Radius: 0.75 inches

    c. Cable Minimum Bending Radius (During Installation): 20 times cable diameter

    d. Cable Minimum Bending Radius (After Installation): 10 times cable diameter

    e. Cable shall be rated for Underground, Buried and Aerial, OSP

    f. Cable shall bear OFNP (Plenum Rated), OFNR (Riser Rated) and/or appropriate markings for the environment in which they are installed.

    g. Cable shall be UV resistant, waterproof, and utilize 3.0mm buffer tubes containing up to twelve 250 µm color-coded optical fibers.

7. Fiber Cabling shall be Corning FREEDM LST 012SSF-T4190D20 or approved equal.

D. Innerduct

1. All fiber cabling shall be run in innerduct and terminated in the CTC. The innerduct shall be sized by the CONTRACTOR.

E. Buffer Tube Fiber Fan-Out Kits

1. Buffer Tube Fan-Out Kits shall be supplied for the termination of each buffer tube at end of the installed fiber cables.

2. Fan-Out Kits shall be color coded to match the color scheme of the fiber cabling.

3. Fan-Out Kits shall have a minimum length of 25 inches

4. Fan-Out Kits shall be Corning FAN-BT25-12 or approved equal.

F. Fiber Optic Connectors

1. Fiber Optic Connectors shall not require the use of epoxy of polish.

2. Fiber Optic Connectors shall be of ceramic construction for 50 µm fiber at bandwidths of 4700 MHz and shall have a loss ≤ 0.5 dB.

3. Fiber Optic Connectors shall utilize the SC type connector.

4. Fiber Optic Connectors shall be Corning UniCam 95-050-41-X or approved equal.

G. Fiber Patch Cords

1. The fiber patch cord shall be duplex and consist of buffered, graded-index fiber with a 50 µm core and a 125 µm cladding for multimode. The fiber cladding shall be covered by aramid yarn and a jacket of flame-retardant PVC.

2. The fiber patch cord shall be rated for 10 Gigabit Ethernet.

2.04 FIBER TERMINATION TOOLKIT

A. Fiber Termination Toolkit shall be provided to the OWNER following the completion of the SCS installation. The Toolkit shall be compatible with the Connectors used for terminating the fiber cabling and shall have the necessary components to make at least 100 additional terminations.

B. The Toolkit shall contain hard copies of installation instructions as well as an installation video that illustrates the step-by-step procedure for installing the Fiber Optic Connectors.

C. The Toolkit shall have test equipment that is capable of determining if a Connector was installed correctly.

D. The Toolkit must be an approved installation system of the manufacturer of the fiber optic cabling and connectors.

E. The Toolkit shall be the Corning TKT-UNICAM-ELITE or equal.

2.05 CROSS-CONNECT EQUIPMENT

A. Cross-Connect Housings shall be provided within each CTC for permanent termination of the fiber optic cabling. The Housing shall be 19” rack mountable and shall be capable to support the termination of four 12-strand fiber optic cables.

B. The Housing shall be suitable for both loose tube, tight-buffered and optical fiber ribbon cables.

C. The Housing shall have a slide-out drawer for easy connector access.

D. The Housing shall be lockable.

E. The Housing shall be the Corning CCH-02U or approved equal.

F. Adapter Panels for the Cross-Connect Housings shall utilize SC type connectors and shall be of ceramic construction for 50 µm fiber at bandwidths of 4700 MHz and shall have a loss ≤ 0.5 dB. The Adapter Panel shall be the Corning CCH-CP12-E7 or approved equal.

2.06 ALUMINUM RACK SYSTEM

A. The 19” Aluminum Rack System shall be able to support and organize electronic equipment, cross-connection and/or termination hardware for fiber optic cabling, station cabling, riser cabling, or building entrance cabling as may be required by design. The rack face shall have a conventional equipment mounting width of 19”. The rack must be designed for cable and jumper management and have hardware to organize and support cabling and patch cords in the vertical and horizontal planes. The rack system shall be equipped for electrical grounding to meet EIA/TIA 606 Standards. The fastening system for the equipment shall facilitate easy installation with roll-formed threads in the screw holes for greater strength and durability. The mounting screws shall have pilot points. All rack components shall be charcoal black in color and made of lightweight 6061-T6 extruded aluminum. The rack shall be shipped with all necessary hardware to assemble the included frame. It shall be packed in cartons with suitable shipping inserts such that no damage occurs to the rack finish. The finish shall not be scratched, chipped or marred.

B. Rack Specifications

1. Self-Supported Rack Framework

a. The self-supporting equipment rack shall be inside the Communications. Termination Cabinet (CTC). Standard grade frames shall be capable of supporting equipment to be mounted inside the CTC.

b. Dimensions: As required to fin in CTC with 19” center mounting and a minimum of 67” of usable vertical space. Base Footprint of 20.25” wide by 15” deep.

c. Hole Pattern: EIA310-D 5/8” – ½” alternating

d. Mounting Screws: #12-24 thread combination Phillips/straight heads and pilot points.

e. Materials: 6061-T6 high strength aluminum

f. Flanges: Flange edge to edge internal measurement is 17.75”

2. Communications Termination Cabinets (CTC)

a. Racks shall be mounted inside NEMA 1 Enclosures with front and rear access doors.

b. Enclosures shall have glass front doors and solid vented rear doors.

c. Approved ground lug and #6 AWG jacketed green ground wire.

d. CTC's shall be installed with at least 36" clear working space in front and behind cabinet.

e. CTC's shall be installed in the Electrical equipment room at each building.

f. CTC's shall be minimum 72" tall free standing enclosures.

g. CTC's shall have a slide-out shelf suitable for a laptop computer to be placed on it for system configuration/programming. The shelf shall be vented. The shelf shall be CPI 12335-719 or approved equal.

h. CTC's shall have a vertical power strip installed with a minimum of 10 outlets rated at 15 amp. The vertical power strip shall be surge protected.

i. CTC's shall be Rittal, Great Lakes, CPI or equal.

2.07 FIBER SPLICING AND CLOSURES

A. No fiber splicing or closures are allowed.

2.08 COPPER NETWORK CABLING

A. Outside Plant Cabling (OSP)

1. All building-to-building fiber optic cabling will have run with it two shielded, outside plant (OSP), Category 5e cables for miscellaneous use such as analog telephones or modems.

2. The cabling shall be terminated in the CTC in each building and shall be punched down at the patch panel on the CTC. The shield shall be grounded only on one end of the cable inside the CTC.

3. Shielded OSP Category 5e Specifications

a. Category 5e Transmission performance characterized to 100MHz.

b. Aluminum metallic shield tape for protection against EMI/RFI

c. Four 24 AWG solid twisted pairs

d. UV/Sunlight resistant black jacket

e. Cable shall be Superior Essex BBDNE 04-003-54 or approved equal.

B. Indoor Cabling

1. Network cabling from the CTC's to wall jacks, control panels, MCCs, phones and all other Ethernet devices shall utilize Category 6 unshielded cable. The Category 6 cable shall be rated for Plenum use if it is ran through any Plenum rated areas, otherwise it shall be rated for Riser use.

2. The following color scheme shall be utilized for indoor network cabling:

a. Blue – Wall Jacks for computers, printers, phones, etc.

b. Gray – Control Panels or MCCs

c. Yellow – Patch Cables within the CTC

d. Black – Outside Plant (OSP) cables

e. Red – Security System / Fire System Cables

f. Pink – Miscellaneous Ethernet devices

3. Unshielded Category 6 Specifications

a. Category 6 Transmission performance characterized to 500MHz.

b. Four 23 AWG solid twisted pairs

c. Plenum rated cable shall have FEP insulation with a FRPVC jacket

d. Riser rated cable shall have FRPE insulation with a PVC jacket.

4. Patch Cords

a. Patch cords shall be TIA/EIA Category 6 Compliant. Cords shall be straight through unless cross-over is necessary. Cords shall be 24AWG stranded copper with FRPE insulation and a PVC jacket. RJ45 jack shall have contacts with 50 micro-inch gold plating and a high-impact, UL 94V-0 rated thermoplastic housing.

b. Patch cords shall have a molded boot cover for protecting the RJ45 connector.

c. All patch cords in the CTC shall be yellow.

2.09 PATCH PANEL

A. The patch panel shall be a 19" rack mountable 110 punch down to RJ45 jack panel. The panel shall support Category 3, 5, 5e and 6 applications. The 110 punch blocks shall support wiring and be labeled for both T568A and T568B standards. The patch panel shall have at a minimum 48 RJ45 ports and at least 12 spare ports. Each RJ45 port shall have a plastic label holder for custom labels.

2.10 WALL JACKS AND PLATES

A. Jacks shall be TIA/EIA Category 6 Compliant and shall support wiring and be labeled for both T568A and T568B standards. Plates shall be constructed of high-impact, flame-retardant, UL 94V-0 thermoplastic. Plates shall be available in single gang with 1-4 ports and double gang with 8 ports. Color of jacks and plates shall be determined by the OWNER.

2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Each CTC shall have a 1000VA UPS installed in it for surge protection and battery backup of critical network equipment. The UPS shall be 19" rack mountable.

B. UPS Specifications

1. Electrical Input Specifications

a. Nominal Voltage: 120VAC

b. Voltage Range: 80-144VAC

c. Input Power Factor: > 0.95

d. Frequency: 60 Hz

e. Frequency Range: 57-63 Hz.

2. Electrical Output Specifications

a. Voltage Regulation: ±3% of Nominal

b. Efficiency: > 85%

c. Frequency Regulation: ±3 Hz on utility, ±1 Hz on battery

3. Communications Specifications

a. A RS-232 serial port and/or a USB port shall be available for monitoring and configuring the UPS. An appropriate cable shall be supplied to connect to the UPS with a PC.

b. An Ethernet port shall be available as an option with the ability to monitor and configure the UPS over an Ethernet network.

4. Battery Specifications

a. All batteries shall be sealed, lead-acid batteries and shall be maintenance free. Batteries shall be hot-swappable. The UPS will indicate when the battery is weak and needs to be replaced.

b. The UPS shall be able to accept additional battery modules to extend the runtime of the UPS. Each UPS shall be capable of running the connected load for a minimum of 30 minutes.

c. UPS shall be Powerware 9125-1000 05146002-6501 or approved equal.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Components of the SCS system shall be installed in a neat, workmanlike manner. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system. Identification markings and systems shall be uniform. TIA/EIA 568B wiring codes as shown on the drawings shall standardize all SCS wiring.

3.02 INSTALLATION

A. The CONTRACTOR shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it provides. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it provides.

B. All components of the SCS shall be the installation responsibility of the CONTRACTOR unless specifically noted otherwise. After the installation of the SCS is completed, the installation shall be inspected jointly by the CONTRACTOR and the Equipment Manufacturer's representatives. Any problems shall be corrected, and when both are satisfied with the installation, a written certification of the installation shall be delivered to the ENGINEER. The certification shall state that all cabling, terminations, CTCs and grounds have been inspected and are installed in accordance with the manufacturer's guidelines.

C. All installations shall be done in conformance with EIA/TIA 568B standards and with the manufacturer's installation requirements. The CONTRACTOR shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the CONTRACTOR to provide in a timely fashion the additional material and labor necessary to properly rectify the failure. Any and all damage to the cables during the construction of this project is the sole responsibility of the CONTRACTOR.

D. Bonding and Grounding

1. The CONTRACTOR shall be responsible for providing an approved ground at all newly installed CTC as well as ensuring bonding to any existing facilities. The CONTRACTOR shall be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes and framework. All grounds shall consist of #6 AWG copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground. Grounding must be in accordance with the NEC, NFPA and all local codes and practices.

E. Power Separation

1. The CONTRACTOR shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

F. Miscellaneous Equipment

1. The CONTRACTOR shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the SCS.

G. Special Equipment and Tools

1. It shall be the responsibility of the CONTRACTOR to furnish any special installation equipment or tools necessary to properly complete the SCS. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable wrenches.

H. Labeling

1. The CONTRACTOR shall be responsible for printed labels for all cables and cords, distribution frames, and outlet locations, according to OWNER specifications. No labels are to be written by hand.

I. Cable Storage

1. The CONTRACTOR shall not roll or store cable reels without an appropriate underlay and the prior approval of the OWNER.

J. Damages

1. The CONTRACTOR will be held responsible for any and all damages to portions of the building caused by it, its employees or subcontractors; including but not limited to:

a. Damage to any portion of the building caused by the movement of tools, materials or equipment

b. Damage to any component of the construction of spaces “turned over” to the CONTRACTOR.

c. Damage to the electrical distribution system and/or space “turned over” to the CONTRACTOR.

d. Damage to the electrical, mechanical and/or life safety or other systems caused by inappropriate operation or connections made by the CONTRACTOR or other actions of CONTRACTOR.

K. Penetrations of Walls, Floors and Ceilings

1. Prior Consent

a. The CONTRACTOR shall make no penetration of existing walls, floors and/or ceilings without the prior consent of the OWNER.

2. Sealing Penetrations

a. Where penetrations through acoustical walls, fire-rated doors or other walls for cableways are to be installed, such penetrations shall be sealed by the CONTRACTOR in compliance with applicable code requirements.

L. Testing

1. Optical Fiber Cable Testing

a. All fiber testing shall be performed on all fibers in the completed end to end system. There shall be no splices unless approved in writing by the ENGINEER. Testing shall consist of a bidirectional end to end OTDR trace performed per EIA/TIA 455-61 or a bidirectional end to end power meter test performed per EIA/TIA 455-53A. All tests shall be conducted using 200ft launch cables. The system loss measurements shall be provided at 850 and 1310 nanometers for multimode fibers.

b. The CONTRACTOR shall test all fiber optic cable prior to the installation of the cable. The CONTRACTOR shall assume all liability for the replacement of the cable should it be found defective at a later date.

c. Loss Budget: Fiber links shall have a maximum loss of:

i. (3.0 dB loss/km) * (km of fiber in link) + (0.5dB) * (number of connectors)
ii. Note that a mated connector to connector interface is defined as a single connector for the loss calculation.
iii. Any link not meeting the requirements of the standard shall be brought into compliance by the CONTRACTOR, at no charge to the OWNER.

d. Documentation of all fiber optic cabling tests shall be provided in both hard and electronic copies to the ENGINEER.

2. Copper Cable Testing

a. Testing of all copper wiring shall be performed prior to system commissioning. All Ethernet cabling shall be certified for conformance to EIA/TIA 568B for Category 6. Testing shall be done with a TIA/EIA Certified Level 3 test set. Test shall include length, mutual capacitance, characteristic impedance, attenuation, near-end and far-end crosstalk. Any pairs not meeting the requirements of the standard shall be brought into compliance by the CONTRACTOR at no charge to the OWNER.

b. Documentation of all copper cabling tests shall be provided in both hard and electronic copies to the ENGINEER.

M. Completion of Work

1. At the completion of the SCS, the CONTRACTOR shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract. All clean up, restoration, and removal noted above will be by the CONTRACTOR and at no cost to the OWNER. If the CONTRACTOR fails in its duties under this paragraph, the OWNER may upon notice to the CONTRACTOR perform the necessary clean up and deduct the costs thereof from any amounts due or to become due to the CONTRACTOR.

N. Inspection

1. On-going inspections shall be performed during construction by the CONTRACTOR and by the ENGINEER to ensure that all work is performed in a high quality manner and the overall appearance is clean, neat and orderly. The following points will be examined and must be satisfactorily complied with:

a. Is the design documentation complete? Are all cables properly labeled, from end-to-end?

b. Have all terminated cables been properly tested in accordance with the specifications for the specific category as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and/or DC voltage?

c. Is the cable type suitable for its pathway? Are the cables bundled in parallel?

d. Have the pathway manufacturer's guidelines been followed? Are all cable penetrations installed properly and fire stopped according to code?

e. Has excessive cable bending been avoided?

f. Have potential EMI and RFI sources been considered?

g. Is Cable Fill Correct?

h. Are hanging supports within 1.5 meters (5 feet)?

i. Does hanging cable exhibit some sag?

j. Are telecommunications closet terminations compatible with applications equipment?

    i. Have Patch Panel instructions been followed?
    ii. Jacket removal point
    iii. Termination positions
    iv. All pair terminations tight with minimal pair distortions
    v. Twists maintained up to Index Strip

k. Are identification markings uniform, permanent and readable?

END OF SECTION 16940

SECTION 16950

ELECTRICAL TESTING

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. 450, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generator Stations and Substations.
   b. C2, National Electric Safety Code.
   c. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
   d. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.
   e. C37.20.3, Metal-Enclosed Interrupter Switchgear.
   f. C62.33, Standard Test Specifications for Varistor Surge Protective Devices.
2. American Society for Testing and Materials (ASTM):
   a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
   b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.
   d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   e. D971, Standard Test Method for Interfacial Tension of 0.1 against Water by the Ring Method.
   f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   h. D1500, Standard Test Method for ASTM Color of Petroleum Products.
   i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   j. D1533, Standard Test Methods for Water in Insulating Liquids.
   k. D1816, Standard Test Method for Dielectric Breakdown Voltage on Insulating Oils of Petroleum Origin Using VDE Electrodes.
   l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin against Water by the Drop-Weight Method.
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
   e. 118, Standard Test Code for Resistance Measurement.
   f. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.

c. WC 7, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
d. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.02 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.
2. List of references to be used for each test.
3. Sample copy of equipment and materials inspection form(s).
4. Sample copy of individual device test form.
5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 14 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

C. Contract Closeout Submittals:

1. Operation and Maintenance Data:
   a. In accordance with references elsewhere in these specifications.
   b. After test of inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.03 QUALITY ASSURANCE

A. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:
1. Scheduled with OWNER prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 GENERAL

A. Tests specified in this section are to be performed in accordance with the requirements elsewhere in these specifications.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Adjust mechanisms and moving parts for free mechanical movement.

E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents.

G. Realign equipment not properly aligned and correct un-levelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform OWNER of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by OWNER, door and panel sections having dented surfaces.
5. Repair or replace, as determined by OWNER, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.

b. If required due to extensive damage, as determined by OWNER, refinish the entire assembly.

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.02 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 4 and Larger For:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends that do not conform with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specifications.
   e. Proper circuit identification.
2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
   a. Proper Shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4 Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than ohm values established by manufacturer.
   d. Provide test reports to Engineer and Owner that show where test measurements were taken and the results
2. Contact Resistance Tests:
   a. Contact resistance in micro-ohms across each switch blade and fuse holder.
   b. Investigate deviation of 50% or more form adjacent poles or similar switches.

3.03 MOLDED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 400 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.

6. Operate frame size and trip setting with circuit breaker schedules or one-line diagram.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohm-meter for 480- and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 10.2.
2. Contact Resistance Tests:
   a. Contact resistance in micro-ohms across each pole.
   b. Investigate deviation of 50% or more from adjacent poles and similar breakers.

3.06 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically that:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.07 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.08 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers and panelboards assemblies for proper connection and tightness.
2. Ground bus connections in motor control centers and panelboards assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.
6. Test ground system using 3 point fall of potential test equipment. Ground system must provide less than 5 ohms to ground resistance. Provide test reports to Engineer

and Owner that show where test measurements were taken and the results. System must be tested at all ground rods, concrete encased electrodes, ground busses and service entrance locations.

3.09 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 10 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate Motor and Check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for proper operation.
   e. Excessive vibration.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
      1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
      2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohm values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

3.10 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air cooling passages.
5. Proper operation of draw out elements.
6. Integrity and contamination of us insulation system.
7. Check Door and Device Interlocking System By:
   a. Closure attempt of device when door is in OFF or OPEN position.
   b. Opening attempt of door when device is in ON or CLOSED position.
8. Check Nameplates for Proper Identification Of:
   a. Equipment title and tag number with latest one-line diagram.

b. Pushbuttons.
c. Control switches.
d. Pilot lights.
e. Control relays.
f. Circuit breakers.
g. Indicating meters.

9. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify that current and potential transformer ratios conform to Contract Documents.
11. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:
    a. Ohm value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
13. Verify performance of each control device and feature furnished as part of the motor control center.
14. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect Contactors For:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of all connections.
17. Compare overload heater rating with full-load current for proper size.
18. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper size.
19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
    d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
    e. Test values to comply with NETA ATS, Table 10.2.
2. Current Injection through Overload Unit at 300% of Motor Full-Load Current and Monitor Trip Time:
    a. Trip time in accordance with manufacturer's published data.
    b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal boards and each device terminal.
    c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.
        1) Insulation resistance to be 1 megohm minimum.
4. Operational test by initiating control devices to affect proper operation.

5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

END OF SECTION 16950

SECTION 17000

INSTRUMENTATION

PART 1 - GENERAL

1.0I APPLICABLE SECTIONS:

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.02 SCOPE:

A. It is the intent of this specification to set forth the minimum acceptable requirements for the design, construction, and vendor support, requirements for the controls panels and instrumentation herein specified.

B. Furnish all labor, material, and equipment associated with the fabrication of the new control panels and associated instrumentation complete in strict accordance with this section of the specification and applicable drawings and subject to the terms and conditions of the contract.

C. Install, calibrate, and perform functional loop tests prior to plant start up. Start up of instrumentation to coincide with the mechanical equipment and process start up as scheduled by the owner, engineer and general contractor.

D. Provide owner with any required operator and maintenance training by factory authorized representatives.

E. Instrumentation equipment, installation, submittal, and record drawings shall be the responsibility of a single party. This party shall be responsible for all parts of this division 17000 and associated requirements.

1.03 WORK INCLUDED:

A. All instruments and all control panels provided for this project. This shall also include vendor and owner supplied equipment.

1.04 SHOP DRAWINGS/SUBMITTALS:

A. Furnish TR20 instrumentation specification sheets indicating exact make, model and part number of instrument to be supplied.

B. Furnish manufacturers specifications and literature on all instruments to be supplied.

C. Furnish complete working shop drawings of all control systems including individual loop wiring diagrams for each instrument to be supplied. Reference design documents for sequence, basic components and suggested piping and wiring. Review the project with the Engineer prior to making submittal. Submit manufacturer's data sheets for all equipment, devices and materials.

D. After initial review, make corrections requested and resubmit in clean format. Work only from final review set.

E. Maintain record drawings in the field. Clean up originals at completion of work and resubmit for Owner's use in operation of the systems.

1.05 OPERATION AND MAINTENANCE MANUALS:

A. O&M manuals shall comply with other sections of this specification. Manuals should include the following:

1. Full drawn size as built loop diagrams, schematics and control diagrams indicating all conductor information, connection information, and device identification.

2. As built TR20 specification sheets

3. Calibration sheets

4. Identification of and lists of all replaceable parts

5. Periodic service requirements

6. Start up procedures

7. Fault reset instructions

8. Factory manuals

B. Prior to start up the contractor shall provide owner and owners integrator with items A, B and C.

PART 2 - EXECUTION

2.01 WIRING:

A. All control wiring, 120 volt and below shall be installed in conduit and wiring boxes. The installation of conduits into control panels shall not permit water to enter the control panels from the conduit.

B. All analog signals shall be terminated on separate terminal blocks from other control conductors. Analog signals should be shielded type conductor as called for on drawings. The shield on each individual conductor should be terminated at one end only in order to prevent ground loops.

C. All conductors in control panels shall be run within wireways. Each conductor shall be labeled and indicated on as built control drawings. One copy of such as-builts shall be affixed to inside of each control panel.

D. Contractor shall use care to not exceed the recommended bending radius of all cables.

E. Contractor shall install and label all termination points for external wiring. This labeling shall coordinate with control as-built drawings.

F. Use no wire smaller than #14 AWG for 120 volt power and #16 AWG for 120 volt control wiring. Use no wire smaller than #20 AWG for DC voltage or current signal wiring.

2.02 INSTALLATION:

A. Field mounting and conductor connections shall be provided by the contractor. Piping, tubing and process connections shall be provided by the contractor.

B. Installation shall be done per the instrument manufacturer's specifications and project drawings. Any discrepancies shall be brought to the attention of the Owner's engineer for resolution.

2.03 CALIBRATION

A. All instruments shall be calibrated using the manufacturer's recommended calibration procedures and equipment.

B. All analog instruments shall be calibrated or tested with three process data points.

C. Factory calibrated equipment shall be tested to verify calibration.

D. Contractor shall supply owner with a written calibration report on each instrument. Calibration reports shall indicate:

1. Instrument by tag Number
2. Test method used
3. Test equipment used
4. Numerical test results (preferably graphed)
5. Date of test
6. Technician

2.04 FUNCTIONAL LOOP TEST:

A. Contractor shall notify Owner in advance of final loop test. Final loop test shall take place with the participation of Owner, Owner's Integrator, and engineer.

B. Owner shall approve final loop check procedures and sign off on check out.

C. Loop check shall be from instrument to HMI screen indication with actual process connection simulating two or three data points per instrument.

2.05 WARRANTY:

A. The vendor shall furnish a written warranty consisting of the following:

1. Warranty parts and labor for two years after startup.

END OF SECTION 17000

SECTION 17111

FLOAT SWITCHES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section includes furnishing all float switches as indicated on the drawings and specified herein.

B. Related work specified elsewhere includes, but is not limited to, Section 16000, Electrical. Also refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:

B. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.

C. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 BALL TYPE FLOAT WITH INTEGRAL SWITCH AND ATTACHED CABLE

A. Float switches shall consist of a mechanical switch, hermetically sealed in a plastic casing, freely suspended at the desired height from its own cable. When the liquid level reaches the float switch, the casing will tilt, and the mechanical switch will change state.

B. The casing shall be constructed of polypropylene with the sheathed cable extruding from the casing. The cable shall be three conductors, made specifically for underwater use and heavy flexing service.

C. The float switch shall have a 10A resistive rating up to 250VAC.

D. Weight and buoyancy shall be such that contaminants like a cake of grease will not result in the float switch changing operating level more than one inch.

E. A NEMA 4X 316SS junction box shall be supplied for termination of the float cable(s) allowing for conventional wiring and conduit to be run from the junction box to a control panel. It shall have terminal blocks for the required number of circuits and shall accept sealed fittings.

F. Float switch cables shall be suspended in a manner that provides minimum strain to the cable and will not damage it. This is typically achieved with a stainless-steel cord support grip or strain relief grip as manufactured by Kellems. When support grips are used, a stainless-steel hook shall be installed for hanging the support. All screws, fasteners, boxes, and grips shall be 316SS. In no way are any steel or galvanized steel components allowed.

G. The float cable length shall be long enough for easily removing the float from the water for testing and long enough to reach its termination junction box.

H. If the float switch is to be installed in a classified area, an appropriate intrinsically safe barrier shall be utilized to guarantee the circuit may not abnormally create an ignition.

I. Manufacturers:

1. Flygt ENM-10.

2. Or Approved Equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed and connected as specified and as shown on the drawings. Contractor shall coordinate with Mechanical and Structural for optimum location of float switches.

3.02 ACCEPTANCE

A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications.

END OF SECTION 17111

SECTION 17120

PRESSURE TRANSMITTERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section includes furnishing Pressure Transmitters as shown on the Plans and specified herein.

B. Related work specified elsewhere includes, but is not limited to Section 16000, electrical. Refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:

1. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.

2. Submit instrument Data sheet for each instrument provided.

3. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

1.04 MANUFACTURERS

A. Pressure transmitter manufacturers shall be Rosemount, Foxboro, or Approved equal.

PART 2 - PRODUCTS

2.01 PRESSURE TRANSMITTER

A. Provide pressure transmitters with ½" NPT process connection, isolation valve, and local indicator scaled in engineering units.

B. Transmitters shall be of a two-wire type, 24 VDC powered, producing a 4 to 20 mA output proportional to the calibrated pressure range of the instrument. Transmitters shall be capable of driving a 500 ohm loop load.

C. Instrument accuracy shall be within ±0.5% of span, and 0.2% repeatability. Dead band shall be within 0.1% of span.

D. Instrument enclosure shall be NEMA 4, with 316 stainless steel wetted parts.

E. Submersible pressure transducers shall be constructed of 316 stainless steel.

F. Submersible pressure transmitters for waste water applications shall have a diaphragm larger than 2”, and shall have a protective covering over the diaphragm.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers’ recommendations, and as shown on the Plans. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

3.02 ACCEPTANCE

A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

Attachments Instrument Data Sheet

END OF SECTION 17120

Pressure Transmitter Instrument Data Sheet

Pressure Instrument				Sheet	of	
Rev	By	Date		Spec No.	Rev	
				Contract	Date 4/12/2001	
				Requsition	P. O.	
				BY	CHK'D	APPR.

	1 Tag No. _____
General	2 Process Location / Service _____ 3 Equipment Located on _____ 4 Service Conditions: ___ Indoor ___ Outdoor ___ Corrosive _____ 5 ___ High humidity/wet ___ Other _____ 6 _____ ft Altitude 7 _____ to _____ deg f Ambient Temperatures 8 Area Classification ___ Unclassified Class _____ Division _____ Group _____ 9 Power Supply _____ Volts _____ VA/Watts _____ Hz ___ DC 10 Other _____ 11 _____
Transmitter	12 Output 1: 4-20 ma ___ 1-5 v ___ Other _____ ___ Isolated 13 Output 2: 4-20 ma ___ 1-5 v ___ Other _____ ___ Isolated 14 Relay Outputs: _____ Form C _____ Form A Rating: _____ Volts _____ Amperes 15 Alarms _____ Control _____ Timer Self and Sensor diagnostics _____ 16 ___ Guage Pres ___ Absolute ___ Vacuum ___ Compound 17 Range _____ To _____ ___ PSIG ___ PSIA ___ in H2O ___ in HG 18 _____ % Accuracy _____ Repeatability 19 ___ Programmable Digital ___ Keypad Entry ___ PC software and cables 20 Communications Port: ___ RS232 ___ RS485 _____ Protocol 21 Special Functions Required _____ 22 ___ Digital Display ___ Digits ___ Analog display 23 Enclosure : Nema _____ Material : Steel ___ Stainless Steel ___ Non metalic 24 Other _____ 25 Mounting: ___ Panel ___ Surface ___ Pipe ___ Yoke 26 Manufacturer _____ ___ Or Equal 27 Model/Part # _____ Serial # _____
Element	28 Process Service _____ 29 Process Pressure: _____ To _____ 30 Process Connection ___ 1/4" NPT ___ 1/2" NPT _____ Flange 31 ___ Guage Pres ___ Absolute ___ Vacuum ___ Compound 32 Type: ___ Diaphram ___ Bourdon ___ Helix ___ Bellows ___ Other _____ 33 Material: ___ 316 SS ___ Hasteloy ___ Ber. Copper ___ Other _____ 34 Range: ___ Fixed ___ Adjustable ___ Set at _____ To _____ 35 Element Range _____ Normal _____ Max _____ Proof 36 Other _____
Other	37 _____ 38

Notes:

SECTION 17121

PRESSURE SWITCHES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. General. The CONTRACTOR shall provide pressure detection switches, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17000 - Process Control and Instrumentation Systems apply to this Section.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 17000.

1.03 SUBMITTALS

A. Submit product information cut sheets containing manufacturer's specifications, Operations and maintenance data, instrument enclosure type, installation location, and process pressure range to be supplied. Indicate product part number in full.

B. Provide submittals in accordance with Section 16000, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 PRESSURE SWITCHES

A. Pressure switches shall have snap action, single-pole, double-throw switching elements with an electrical rating of at least 10 amperes at 120 VAC. Switches shall be enclosed in a NEMA 4X housing for outdoor use.

B. Operating pressures and set points shall be determined in the field, unless otherwise indicated on the Plans.

C. Set points shall be fully adjustable and shall be in the middle of the working range. Accuracy shall be ±1/2 of one per cent of adjustable range.

D. For pressures up to 80 PSIG pressure sensing element shall be of the diaphragm or bellows type, and shall have a proof pressure of at least twice the maximum working pressure. Diaphragms or bellows shall be of stainless steel.

E. Pressure switches shall be as manufactured by Ashcroft or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed and connected as specified and shown on the drawings. Contractor shall coordinate with Mechanical and Piping to insure proper connection to piping and/or other mechanical equipment.

3.02 ACCEPTANCE

A. As a condition precedent to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's guarantee.

END OF SECTION 17121

SECTION 17122

PRESSURE GAUGES

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. General. The CONTRACTOR shall provide pressure gauges, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 17000 - Process Control and Instrumentation Systems apply to this Section.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 17000.

1.03 SUBMITTALS

A. Submit product information cut sheets containing manufacturer's specifications, Operations and maintenance data, instrument enclosure type, installation location, and process pressure range to be supplied. Indicate product part number in full.

B. Provide submittals in accordance with Section 16000, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

A. All inline pressure instruments shall be supplied with isolation ball valve and bleed needle valve for each measurement point. Valve materials shall be selected based upon the properties of the liquid or gas and the atmosphere.

B. Unless otherwise indicated on the Contract Drawings, pressure process measurement devices shall measure process pressure relative to atmospheric pressure (gauge pressure).

C. Pressure process measurement devices which are to measure differential pressure shall have the appropriate inlet and outlet ports and isolation and bleed valves for each port.

D. All pressure instrumentation shall be properly mounted, ideally in locations that are easily accessible and viewable. Supply all appropriate mounting poles, plates, and accessories such that each instrument is properly supported and mounted.

E. Pressure gauges shall be 4-1/2 inches in diameter with white laminated dials and black graduations. Windows shall be shatterproof glass acrylic. Gauges shall have a blowout disc and be encased in phenolic, steel, or cast iron. Measuring element shall be a stainless-steel bourdon tube with welded, stress-relieved joints. Socket shall have wrench flats. Movement shall be rotary geared stainless-steel material. Gauges shall perform as a liquid-filled gauge in a dry gauge and fight against vibration and pulsations. Gauges shall be calibrated to read in applicable units. Accuracy shall be plus and minus 1/2 percent range to 150 percent of the working pressure or vacuum of the pipe or vessel to which they are connected.

F. Provide diaphragm seals for pressure gauges that are connected to process types that contain sewage, sludge, liquids containing solids, pulsating flows or chemical solutions. Seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing. Type 316 stainless steel nuts and bolts. Fill connection and valved flush port size ¼ inch NPT, capable of disassembly without the loss of filler fluid. Fill fluids shall be rated for plus and minus 20% of the rated ambient temperature which is typically -20°C to 50°C for outdoors and 0°C to 50°C for indoors. The fill fluid rating would then typically be as a minimum -35°C to 65°C for outdoors and -10°C to 60°C for indoors.

G. Diaphragms for sewage, sludge and liquids containing solids shall be 316 stainless steel for pressures above 15 psi and elastomer for pressures below 15 psi. Diaphragms shall be Ashcroft model 101, Rosemount model 1199 or approved equal.

H. For chemical solutions, seals shall have a PVC body for removable mounting at 200 psi, with type 316 stainless steel bolts and nuts, ½ inch inlet and ¼ inch outlet, liquid filled with a Teflon diaphragm for pressure and suitable elastomer diaphragm for vacuum service. Diaphragms shall be by Plast-O-Matic Valves, Inc. or approved equal.

I. Acceptable Manufacturers

1. Ashcroft 1279.

2. Or Approved Equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed and connected as specified and shown on the drawings. Contractor shall coordinate with Mechanical and Piping to insure proper connection to piping and/or other mechanical equipment.

3.02 ACCEPTANCE

A. As a condition precedent to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's guarantee.

END OF SECTION 17122

SECTION 17126

SUBMERSIBLE LEVEL TRANSMITTERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section includes furnishing Submersible Level Transmitters as shown on the Plans and specified herein.

B. Related work specified elsewhere includes, but is not limited to Section 16000, electrical. Refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:

1. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.

2. Submit instrument Data sheet for each instrument provided.

3. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE LEVEL TRANSMITTER

A. The submersible level transmitter shall consist of a submersible transducer, electronic transmitter, support cable, and interconnecting cable with cable shield and vent tube for atmospheric reference. The vent tube shall be provided with a replaceable moisture barrier. The submersible transducer shall be the strain gauge type suitable for sensing pressure equivalent to the liquid level range indicated.

B. The transducer shall have 316 stainless steel process wetted parts and shall be provided with a waterproof interconnecting cable. The transducer shall be suspended by a corrosion resistant cable as recommended by the manufacturer. The installation shall allow easy removal of the transducer and cable assembly for maintenance purposes. The electronic level transmitter shall be remote mounted and shall produce a 4 - 20 mA DC signal linearly proportional to the level range indicated and be capable of driving a load of 700 ohms.

C. The interconnecting cable shall have a pull strength of 200 pounds, be factory attached to the transducer, and shall be terminated in a NEMA 4X 316SS enclosure. The enclosure shall house the vent tube moisture barrier and local indication.

D. The measurement system shall be suitable for the area classification and operation over a temperature range of 32 to 122 degrees Fahrenheit with an accuracy of plus or minus 0.5 percent of span. The transmitter shall have a non-fouling, large diaphragm (greater than 2”). The diaphragm shall be protected by a spacer assembly that also allows the transducer to sit on the floor of the wet well.

E. For lengths greater than 20 feet the transducer shall have ½” threads and shall be suspended in the wet well by ½” stainless steel conduit.

F. Acceptable Manufacturers

1. TE KPSI model 750.

2. Mercoid model PBLT2 .

3. Or Approved Equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers’ recommendations, and as shown on the Plans. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

3.02 ACCEPTANCE

A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

END OF SECTION 17126

SECTION 17137

MAGNETIC FLOWMETERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the Magnetic Flowmeters to be provided where indicated on the Drawings. The Flowmeters shall consist of two parts with manufacturer supplied interconnecting wiring, the field installed flow element and the flow indicating transmitter.

B. Related work specified elsewhere includes, but is not limited to Section 16000 Electrical. Refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:

1. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.

2. Submit Instrument Data Sheet for each instrument provided.

3. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 MAGNETIC FLOWMETERS

A. Materials:

1. All mounting hardware shall be 316 stainless steel, the instrument enclosure and the spool mag shall be rated NEMA 4X, the flow sensor liner shall be hard rubber, and the electrode material shall be Hastelloy .

2. Spool size shall be as specified on the drawings.

3. All applications with flow element below grade where no de-watering means or in submersible applications shall provide the flow element as NEMA 6P (IP-68).

4. Transmitter shall be integral or remote to the flow element as shown on the P&ID’s.

B. Design and Fabrication

1. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate. The meter shall use a pulsed DC magnetic field excitation.

2. Provide flanged end connections per ANSI B16 rated for piping system operating and test conditions.

3. Operating pressure: 150 psi.

4. Operating temperature: 32-150□F.

5. Grounding requirements: per manufacturer requirements. Typically, inlet and outlet grounding rings of same material as electrode.

6. When the transmitter is remote to the flow element, provide cable between flow element and transmitter. Coordinate with the installer the length of the cable required. No splices in any way will be allowed.

7. Complete zero stability shall be inherent to the meter system. The system shall have a programmable low flow cutoff.

8. Empty pipe detection to prevent false measurement when pipe is empty or partially filled.

9. Forward and reverse flow measurement and totalization as well as net flow totalization.

10. 4-20mA DC isolated output into maximum 800 ohms. Signal shall be programmable to indicate forward and/or reverse flow.

11. Provide a dry contact output for flow direction indication.

12. Provide a programmable frequency output for flow totalization.

13. ± 0.5% accuracy for flow rates above 1 fps.

C. Acceptable Manufacturers:

1. Endress+Hauser Promag W 400 .

2. Rosemount 8700.

3. ABB WaterMaster.

PART 3 - EXECUTION

A. Equipment and materials specified in this section shall be installed and connected as specified, and as shown on the Plans. The Contractor shall coordinate the installation with the other trades, to insure proper installation of the flow element, transmitter, and associated conduit and cables.

B. The Contractor shall calibrate the instruments to the proper ranges, as required by the Owner and the Engineer. Where analog signals are connected to local, or remote monitoring equipment, the Contractor shall verify that the calibrated ranges and scaling of the local and remote indicators are correct.

3.02 ACCEPTANCE

A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's guarantee.

END OF SECTION 17137

APPENDIX A

SEISMIC PARAMETERS

Table 2
2016 California Building Code (CBC) and ASCE 7-10 Seismic Parameters

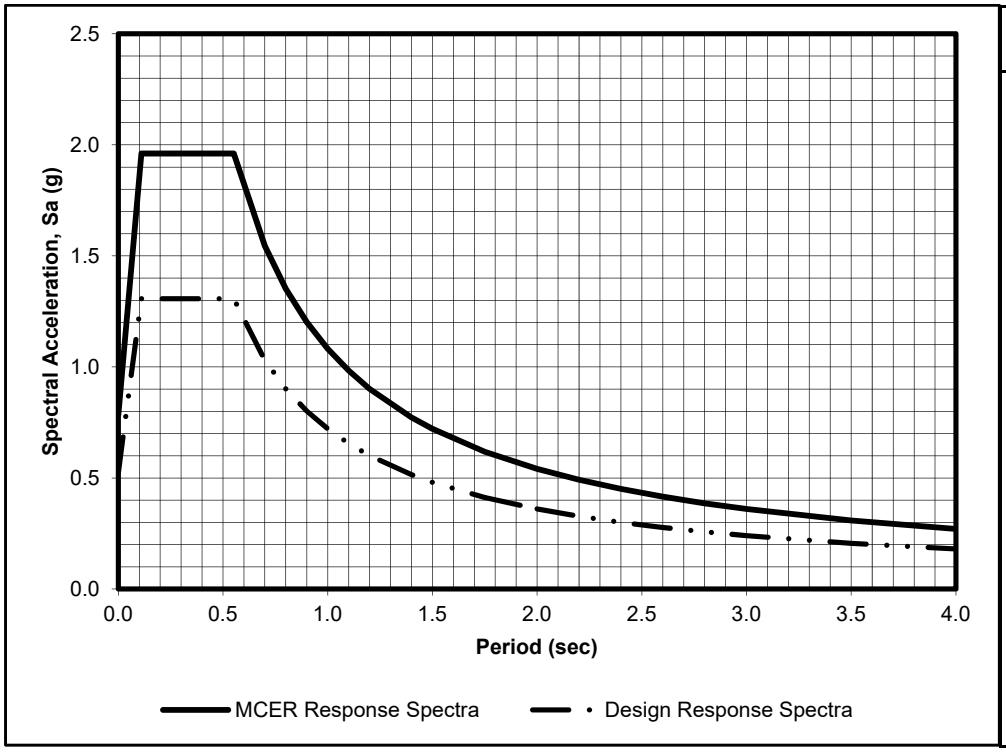
		CBC Reference
Soil Site Class:	**D**	Table 20.3-1
Latitude:	32.8453 N	
Longitude:	-115.5800 W	
Risk Category:	I	
Seismic Design Category:	D	

Maximum Considered Earthquake (MCE) Ground Motion

Mapped MCE_R Short Period Spectral Response	S_s	1.961 g	Figure 1613.3.1(1)	
Mapped MCE_R 1 second Spectral Response	S_1	0.721 g	Figure 1613.3.1(2)	
Short Period (0.2 s) Site Coefficient	F_a	1.00	Table 1613.3.3(1)	
Long Period (1.0 s) Site Coefficient	F_v	1.50	Table 1613.3.3(2)	
MCE_R Spectral Response Acceleration Parameter (0.2 s)	S_{MS}	1.961 g	$= F_a * S_s$	Equation 16-37
MCE_R Spectral Response Acceleration Parameter (1.0 s)	S_{M1}	1.082 g	$= F_v * S_1$	Equation 16-38

Design Earthquake Ground Motion

Design Spectral Response Acceleration Parameter (0.2 s)	S_{DS}	1.307 g	$= 2/3*S_{MS}$	Equation 16-39
Design Spectral Response Acceleration Parameter (1.0 s)	S_{D1}	0.721 g	$= 2/3*S_{M1}$	Equation 16-40
Risk Coefficient at Short Periods (less than 0.2 s)	C_{RS}	1.077		ASCE Figure 22-17
Risk Coefficient at Long Periods (greater than 1.0 s)	C_{R1}	1.038		ASCE Figure 22-18
	T_L	8.00 sec		ASCE Figure 22-12
	T_O	0.11 sec	$=0.2*S_{D1}/S_{DS}$	
	T_S	0.55 sec	$=S_{D1}/S_{DS}$	
Peak Ground Acceleration	PGA_M	0.75 g		ASCE Equation 11.8-1



Period T (sec)	Sa (g)	MCE_R Sa (g)
0.00	0.52	0.78
0.11	1.31	1.96
0.55	1.31	1.96
0.70	1.03	1.55
0.80	0.90	1.35
0.90	0.80	1.20
1.00	0.72	1.08
1.10	0.66	0.98
1.20	0.60	0.90
1.20	0.60	0.90
1.40	0.52	0.77
1.50	0.48	0.72
1.75	0.41	0.62
2.00	0.36	0.54
2.20	0.33	0.49
2.40	0.30	0.45
2.60	0.28	0.42
2.80	0.26	0.39
3.00	0.24	0.36
3.50	0.21	0.31
4.00	0.18	0.27